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Complications of colonoscopy: common and rare—recognition, assessment and management

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ABSTRACT

An understanding of the potential complications of diagnostic lower gastrointestinal endoscopy is a necessary part of being an independent endoscopist. Creating a culture of safety and prevention of adverse events (AEs) should be part of routine endoscopy practice. Appropriate patient selection for procedures, informed consent, peri-procedure risk assessments and an inclusive team approach, all contribute to preventing 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 lower gastrointestinal endoscopy, including their recognition, treatment and prevention.

INTRODUCTION

Colonoscopy is accepted as the gold standard test for examining the large bowel, allowing diagnosis, tissue sampling and a number of endoscopic therapies. Colonoscopy detects and prevents bowel cancer, both through removal of precursor lesions (polyps) and bowel cancer screening programmes.[1] While colonoscopy and flexible sigmoidoscopy are invasive procedures, they are often performed under conscious sedation, or in awake patients and generally well tolerated with a low risk of adverse events (AEs). There are up to one million colonoscopies performed in the UK each year.[2] Documented complication rates vary from 2.8/1000 colonoscopies in screening populations[3] to 5/1000 in symptomatic patients[4] and are higher following polypectomy.

Delivering safe, high-quality colonoscopy and sigmoidoscopy requires endoscopists to clearly understand potential procedure-related complications, to both minimise their occurrence and optimise their management. In this review, we cover common and rarer complications of diagnostic lower gastrointestinal (GI) endoscopy, focusing on how to recognise them, their early management and strategies to minimise their occurrence. Complications after advanced therapeutic procedures, such as complex endoscopic mucosal resection and endoscopic submucosal dissection are beyond the scope of this review.

GENERAL PRINCIPLES: PREVENTING COMPLICATIONS

Maintenance of quality and safety standards in endoscopy through joint advisory group (JAG) accreditation (JAG on GI endoscopy) and the global rating scale standardises the approach to quality and safety in endoscopy.[5 6] Additional specific guidelines provide quality and safety performance indicators for lower GI procedures.[7]

Prevention of complications should be embedded in our practice and the culture of endoscopy units. There are some general principles to help prevent and manage complications.[8] Procedures should be performed by competent and experienced endoscopists. There should be provision of adequate supervision of trainees, less experienced endoscopists and clinical nurse endoscopists. A safe and inclusive team culture is essential, with a prelist team brief, a non-rush ethos and use of the WHO checklist. Procedures should be undertaken in an appropriately resourced setting, with the right equipment and access toan intensive care unit (ITU), radiology and surgery should, management of emergencies, be required. Systems should be in place for risk stratification and triaging the appropriateness of referrals for procedures. JAG audits should be carried out, with regular morbidity and mortality meetings, and a culture that does not apportion blame, but provides constructive feedback to promote learning objectives from AEs.

TERMINOLOGY: AES OR COMPLICATION?

Consistent use of terminology is important to standardise recording and auditing of

endoscopy-related events. The term AE is used in American endoscopy guidelines and 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.[9] The term complication carries an implication of direct causality between medical care and the occurrence of an AE.[10] The distinction between avoidable errors and events that are expected complications occurring in a high-quality endoscopy is an important part of the post event 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.

DUTY OF CANDOUR

It is our responsibility as clinicians, to ensure serious complications or AEs are transparently disclosed, with a full explanation to the patient and/or the patient's family.[11] 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.

CARDIOPULMONARY AND SEDATION-RELATED AES

Cardiopulmonary AEs are the most common type of endoscopy-related events, accounting for over 60% of unplanned events during endoscopy.[12] These range from minor events, 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 for these events include advancing age or an ASA (American Society of Anaesthesiologists) grade of 3 or above.[13]

The majority of diagnostic endoscopy is performed under conscious sedation, with the patient able to maintain ventilatory function and follow simple commands.[14] Sedation-related AEs include oversedation, that is, excessive 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, prolonged sedation effects, cardiac dysrhythmias and aspiration pneumonia are other sedation-related AEs to be aware of.

Prevention and treatment

Preprocedure risk assessment is key to preventing cardiopulmonary and sedation-related AEs, this should include a discussion with the patient during the consent process of the risks, benefits and alternatives.[15] Higher ASA grade (3 or above) increases the risk of AEs in GI endoscopy,[16] the 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 (eg, sleep apnoea) should all form part of a preprocedure risk assessment.[14] 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 lower GI cancers at endoscopy should be included in preprocedure consent as a potential AE. Units should have a system in place for recording and reporting missed cancers.[7 17] A missed cancer is defined as when a previous negative endoscopy for cancer has taken place within 3 years of cancer diagnosis. Postcolonoscopy colorectal cancer (PCCRC) incidence in the UK varies significantly, and although reduced, the 3-year-PCCRC rate remained at 6.5% in 2013,[18] that is, 6.5% of colorectal cancers had a false-negative colonoscopy within 3 years of diagnosis. The majority of PCCRC is likely due to inadequate examination at the original colonoscopy, in a retrospective study 58% of PCCRC had either poor bowel prep or incomplete caecal intubation.[19] Rates of PCCRC are higher in women, older age, inflammatory bowel disease, diverticulosis and those with previous cancers, while the lowest incidence of PCCRC was in bowel cancer screening (BCS) colonoscopies.[18] This highlights the importance of careful bowel washing and insufflation, with adequate mucosal inspection time and interrogation of high-risk areas or 'blind spots', all of which are necessary components of high-quality lower GI endoscopy to minimise the chance of missing lesions.[7 17 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.[21] The reported incidence of transient bacteraemia ranges from 0% to 25% after sigmoidoscopy and colonoscopy.[21 22] 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.[23] In the setting of severe neutropenia (neutrophils $<0.5\times10^9$/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.[24] Antibiotic use in the setting of therapeutic endoscopy is covered by specific British Society of Gastroenterology (BSG) guidelines.[23]

HARM SEVERITY

By its definition, an AE results in a deviation from the planned course of investigation or treatment. However, the subsequent course of events varies significantly depending on the degree of harm sustained and the resulting corrective treatment that is needed. In surgery, the Clavien-Dindo classification for reporting AEs is in widespread use and is established as a system for grading AEs based on the treatment that was needed to treat the AE.[25] Reporting of AEs in endoscopy also requires standardisation and should avoid the use of subjective terminology to describe severity. In the UK, the Care Quality Commission mandates reporting through Duty of Candour (https://www.cqc.org.uk/guidance-providers/all-services/duty-candour-notifiable-safety-incidents) for any safety incidents that have or might result in moderate harm or above, for example, unplanned hospital admission or admission to ITU. A recent study developed and validated the AGREE classification system for AEs in GI endoscopy.[26] From grade I—an AE without the need for additional treatment, to grade V—an AE resulting in death. Implementation of this system may facilitate more standardised reporting of AEs and improved quality assurance in endoscopy.

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.[15]

COMMON POSTPROCEDURAL SYMPTOMS

Up to 10% of patients experience moderate to severe discomfort during a colonoscopy,[17] including abdominal pain, cramping, nausea and bloating. These symptoms, including bloating, abdominal pain and altered bowel function can persist post-colonoscopy in up to 34% of patients, with the majority (94%) resulting in 2 days or fewer of normal function lost in total.[27] Although these symptoms are not considered AEs, appropriate counselling is important to ensure patients understand what to expect.

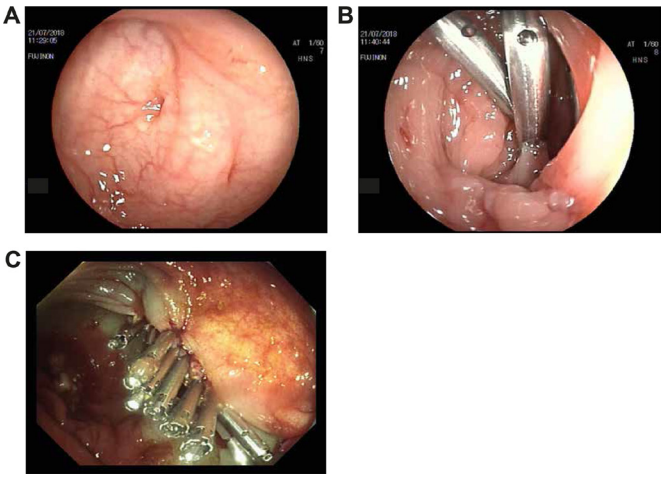

Figure 1 (A) Colonic perforation visible as two adjacent defects in the mucosal wall. (B) Image showing appearances after successful closure with through the scope (TTS) clips placed intraprocedurally. (C) A case of colonic perforation after polypectomy, here showing the appearances after placement of multiple TTS clips along the length of the defect.

PERFORATION

Frequency and risk factors

Colonic perforation (figure 1A) may result from mechanical force (shearing stress), barotrauma or a direct result of polypectomy. Iatrogenic perforation has been reported in 0.03%–0.8% of diagnostic and screening colonoscopies and flexible sigmoidoscopies.[28–30] A systematic review and meta-analysis of population based studies found a higher rate of perforation in colonoscopies with polypectomies (0.8/1000), compared with colonoscopies without polypectomies (0.4/1000).[31]

The sigmoid colon and rectosigmoid junction are the most common sites of perforation during diagnostic colonoscopy due to the shearing force applied by the shaft or tip of the instrument during insertion. Caecal perforation has been reported because of barotrauma, particularly if excessive air is introduced above an area of stenosis[32] but this is unlikely with carbon dioxide due to the rapid absorption. Severe diverticular disease, pericolonic adhesions and inflammatory bowel disease increase the risk of perforation, especially in patients with active disease or on corticosteroids.[33] Other risk factors include older age, comorbidities and endoscopist experience.[34]

Recognition

Recognition of full thickness tears is often immediate during the procedure but can be delayed by up to 3 days.[34] Colonic perforation can be intraperitoneal or extraperitoneal. Intraperitoneal perforation results in leakage into the peritoneum. In severe cases, patients can develop tension pneumoperitoneum (abdominal compartment syndrome), which can lead to haemodynamic compromise, breathing difficulty and gut ischaemia. Extraperitoneal colonic perforation can lead to passage of air into the retroperitoneal space, which can then diffuse along

the fascial planes and large vessels, resulting in pneumoretroperitoneum, pneumomediastinum, pneumopericardium, pneumothorax and subcutaneous emphysema. Such patients can have atypical symptoms such as subcutaneous crepitus, neck swelling, chest pain and breathlessness.[35]

Colonic perforation: signs and symptoms

Early:

1. Abdominal pain—especially persistent or disproportionate.
2. Abdominal distension.

Late:

1. Haemodynamic compromise.
2. Breathing difficulty.
3. Signs of gut ischaemia.
4. Surgical emphysema: neck swelling, chest pain, subcutaneous crepitus.
5. Pneumothorax.
6. Systemic inflammatory response.
7. Confusion.

Early recognition within 2–4 hours has been shown to substantially improve patient outcomes, as it makes surgical intervention possible in an uncontaminated environment.[36 37] CT scanning without intravenous contrast but with rectal water-soluble contrast is the preferred investigation. The advantages of CT over plain radiograph include higher sensitivity to detect small amounts of air and fluid in the peritoneal and retroperitoneal space and using intraluminal contrast to evaluate the efficacy of endoscopic closure if attempted. It is, however, important to note that extraluminal air can be seen on CT as a result of air insufflation during endoscopic treatment in up to 3% of patients. It does not reflect the success or failure of endoscopic closure or the size of the perforation and cannot serve as an indication for surgery, in the absence of other symptoms.

Treatment of perforation

Treatment of iatrogenic colonic perforation (figure 1B,C) depends on the time to recognition, size of perforation and endoscopist expertise. ESGE recommends that endoscopic closure should be attempted if a smaller mucosal tear is identified during or immediately after the procedure (<4 hours), assuming that bowel prep is still adequate. Endoscopic closure can prevent peritonitis and reduces risk of adhesions compared with surgery.[34] Endoscopic closure (figure 1B,C) of mucosal defects up to 20 mm can be achieved by TTS endoclips or OTS clips with overall technical and clinical success rates up to 93% and 89%, respectively.[38 39] TTS clipping is more effective for perforations after therapeutic procedures that are <10 mm in size than diagnostic perforations, which are usually larger in size. Recent systematic reviews have reported that OTS clips are safe, easy to use and efficacious for both diagnostic and therapeutic perforations.[40 41]

After endoscopic closure, further management depends on the estimated success of closure and the patient's general condition. Hospital admission is usually required, but in cases of small asymptomatic perforations, patients can be discharged following a successful endoscopic closure. General supportive measures are always recommended during the hospital stay, including intravenous fluids, broad spectrum antibiotics and close monitoring for early detection of any clinical deterioration.

If a patient develops tension pneumoperitoneum, signs may include acute distress, severe abdominal pain, with a rigid distended abdomen, dyspnoea, hypovolaemia or shock if the inferior vena cava becomes compressed, and crepitus in the abdominal wall, or rarely rectal prolapse. In this rare situation, immediate peritoneal decompression should be performed using a large bore needle such as a 16G venous catheter, which may also be used to aid views during endoscopic defect closure. This potentially lifesaving intervention may be required in the emergency department or intensive care unit and should involve surgical presence where possible. Once significant pneumoperitoneum has developed, >80% of cases require surgical intervention, and once large volume, symptomatic-free air has developed laparotomy is the best approach.[42] In general, surgery is indicated where a large perforation is detected, endoscopic treatment has failed, or the patient develops faeculent peritonitis due to leakage of colonic contents.

POST POLYPECTOMY SYNDROME

Frequency and risk factors

Post polypectomy syndrome (PPS), also called post polypectomy electrocoagulation syndrome, results from electrocoagulation-induced thermal injury to the bowel wall during polypectomy. It causes transmural damage and localised peritonitis without evidence of frank perforation on radiological investigations. The incidence of PPS requiring hospital admission has been reported to be 3–4/10 000 colonoscopies.[4 43 44] A multicentre study reported hypertension, large lesion size (>2 cm) and non-polypoidal morphology as independent predictors of PPS. In this study, 2.9% required intensive care admission but no mortality was reported.[43]

Presentation and management

Patients typically present with fever, localised abdominal pain and peritoneal signs better recognised by abdominal percussion, with raised leukocytes and CRP within 1–5 days of colonoscopy. Full thickness burns can result in wall necrosis and delayed perforation. PPS can typically be conservatively managed with intravenous fluids, broad-spectrum antibiotics, bowel rest and close monitoring of bloods and clinical signs until symptoms subside.[45] Differentiating between PPS and colonic perforation is crucial as PPS is usually managed conservatively with a favourable outcome, while colonic perforation often requires urgent closure and sometimes surgery and carries a

higher risk of significant morbidity and mortality. CT scanning is the test of choice to differentiate PPS from perforation, PPS may show focal colonic wall thickening with some localised stranding, but the absence of extraluminal gas excludes perforation.[46]

BLEEDING

Frequency and risk factors

Diagnostic colonoscopy with mucosal biopsies has a minimal risk of bleeding. Recent meta-analyses have reported overall bleeding rates of 2.4–2.6/1000 colonoscopies with a significantly higher rate of bleeding after polypectomy (9.8/1000).[31 47] However, studies reporting post polypectomy bleeding rate are confounded by heterogeneity of definitions of intraprocedural and post polypectomy bleeding. Risk factors for post polypectomy bleeding include patient comorbidities such as cardiovascular and chronic renal disease, polyp size ≥10 mm, pedunculated polyps with thick stalks, multiple polyps, depth of submucosal resection (presence of muscle fibres and submucosal haematoma), recent use of anticoagulation and antiplatelets (except aspirin) and right-sided location.[48–54]

Recognition

Bleeding may occur immediately or can be delayed up to 2 weeks after the procedure. Delayed bleeding is more likely in patients who are on antiplatelets or anticoagulation following the procedure. It is important to differentiate between minor bleeding associated with polypectomy, which is controlled at the time of procedure, and significant haemorrhage, which is defined as visible blood or melaena following polyp resection, resulting in a fall of haemoglobin by >20 g/L, and requiring hospital admission, blood transfusion, surgery or further endoscopic therapy.[55 56] It is critical that patients are not only advised of the risk of bleeding after the procedure but are given written advice on how to seek medical advice should they notice bleeding following discharge.

Management and prevention

ESGE and the BSG have produced a joint guideline to mitigate the risk of bleeding for patients on antithrombotics undergoing endoscopic procedures, these should be followed when advising patients regarding adjusting their medications.[56 57]

Routine endoscopic treatment of all polypectomy sites to prevent bleeding is not cost-effective.[58 59] A meta-analysis reported that prophylactic treatment with either mechanical therapy (including clips and endoloops) or epinephrine-saline injection reduced the risk of early bleeding but did not influence the rate of delayed bleeding.[43] Another meta-analysis on the prophylactic role of clipping did not show a significant reduction in bleeding rates.[58]

In almost all cases of immediate or delayed post colonoscopy bleeding, it should be possible to manage bleeding with supportive care and endoscopic therapy. Intraprocedural bleeding can be managed by use of endoscopic coagulation (eg, coagulation forceps or snare-tip soft coagulation) or mechanical therapy, for example, TTS clips, with or without the combined use of dilute epinephrine injection. A TTS clip can be applied directly on the bleeding stalk or vessel or the area adjacent to the polypectomy site to provide a tamponade effect on the surrounding blood supply. In case of delayed bleeding, if a patient is haemodynamically compromised or has ongoing bleeding, an attempt at endoscopic management should precede surgery. ESGE suggests that less than 5% of patients experiencing post polypectomy bleeding should require surgery.[55]

Preventing post polypectomy syndrome:

1. Submucosal injection prior to cautery.
2. Tenting the polyp away from the bowel wall.
3. Cutting the stalk half to one-third from the base for pedunculated polyps.
4. Suction gas prior to cautery to reduce tension on the wall.
5. Cold snare polypectomy.
6. Short bursts of pure cut blended current using microprocessor diathermy units for piecemeal resections.

SPLENIC INJURY

Frequency and risk factors

Splenic injury is a rare but potentially fatal complication of colonoscopy, with mortality of up to 4.5%.[60] It can result from direct trauma when the colonoscope is traversing the splenic flexure or rupture of the splenic capsule due to traction on the spleno-colic ligament or from pre-existent adhesions. Splenic injury can be parenchymal, subcapsular or with intraperitoneal extension. Large series have reported rates of 1 to 4.5/10 000 colonoscopies.[61 62] Risk factors include previous abdominal surgeries, splenomegaly, endometriosis, inflammation (inflammatory bowel disease, diverticular disease, pancreatitis) and anticoagulant use.[62] Case reports have also been documented in patients with connective tissue disorders such as Ehlers-Danlos syndrome (EDS), specifically vascular EDS, and in Marfan syndrome.[63] In such cases, non-invasive testing may be preferable prior to considering colonoscopy and a discussion with the patient about the increased procedural risks is necessary.

Presentation and recognition

Presentation can be non-specific and variable in timing, so a high degree of suspicion is necessary. Patients can present with diffuse abdominal discomfort or pain localised to the left upper quadrant. It can be associated with left shoulder pain (Kehr's sign). Symptoms can develop immediately or, less frequently, delayed by days. Rarely cases can present with shock. Investigations may show anaemia. CT with intravenous contrast is the preferred imaging modality, enabling characterisation of the severity and extent of splenic injury.

Ultrasound abdomen is an alternative for patients who are haemodynamically unstable.

Management and prevention

If splenic injury occurs, haemodynamically stable patients can be managed conservatively with blood transfusion, intravenous fluids and antibiotics. Splenic artery embolisation is reported to be an effective treatment option if medical management fails.[64] Splenectomy is reserved for patients with active bleeding and haemodynamic instability. Splenic injury is a rare event and prevention is difficult as the mechanism is not always clear. Scope guide is recommended and might anticipate any splenic trauma by preventing the development of loop formation or recognising excessive traction as it occurs, early position changes are often helpful when difficulty is encountered in this region. In general, care should be taken not to use excessive force or traction when traversing the splenic flexure, and or instrumentation in this region, for example, biopsy forceps or polypectomy. This is especially relevant during loop correction, cases with a mobile splenocolic ligament or patients with a known history of adhesions or connective tissue disorders, where sudden or excessive traction should be avoided.

Consent for colonoscopy: risks

1. Risks of sedation.
2. Cardiopulmonary events.
3. Perforation (<1:2000 without polypectomy, <1:1000 with polypectomy).
4. Bleeding (1:400 without polypectomy, 1:100 with polypectomy).
5. Missed lesion.
6. Repeat procedure.

AIR EMBOLISM

Air embolism is an extremely rare but potentially catastrophic complication of colonoscopy. Use of carbon dioxide for insufflation can eliminate the risk. Large air emboli can cause cardiovascular and pulmonary collapse and neurological symptoms.[65] Air embolism should be considered in patients who develop sudden hypotension, arrhythmia, cyanosis, tachypnoea, unresponsiveness or acute confusion after colonoscopy. Chest CT can detect air embolism with higher sensitivity for massive emboli.

High index of suspicion is the most important step in the management of air embolism. Simple manoeuvres to decrease the impact include immediately stopping the procedure if possible, administering 100% oxygen to reduce air bubble expansion, initiating intravenous fluids, placing the patient in the Trendelenburg position (feet higher than the head) and left lateral decubitus position to minimise air migration to the brain. Bedside echo should be performed, which can demonstrate air in the right heart. Hyperbaric oxygen may reduce air bubble size and increase oxygen content in arterial blood.

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 including clear and transparent communication with the patient. This review provides an overview of AEs in lower GI endoscopy and should facilitate continued learning on this important topic.

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