



OPEN ACCESS

# British Society of Gastroenterology guidelines on sedation in gastrointestinal endoscopy

Reena Sidhu <sup>1,2</sup> David Turnbull, <sup>3</sup> Hasan Haboubi, <sup>4,5</sup> John S Leeds <sup>6,7</sup> Chris Healey, <sup>8</sup> Srisha Hebbar, <sup>9</sup> Paul Collins, <sup>10</sup> Wendy Jones, <sup>11</sup> Mohammad Farhad Peeraly, <sup>12,13</sup> Sara Brogden, <sup>14</sup> Laura J Neilson, <sup>15</sup> Manu Nayar <sup>6,7</sup> Jacqui Gath, <sup>16</sup> Graham Foulkes, <sup>17</sup> Nigel J Trudgill <sup>18</sup> Ian Penman <sup>19</sup>

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/gutjnl-2023-330396>).

For numbered affiliations see end of article.

## Correspondence to

Professor Reena Sidhu, Royal Hallamshire Hospital, Sheffield S10 2JF, UK; [reenasidhu@nhs.net](mailto:reenasidhu@nhs.net)

Received 31 May 2023

Accepted 6 September 2023

Published Online First

10 October 2023



## ABSTRACT

Over 2.5 million gastrointestinal endoscopic procedures are carried out in the United Kingdom (UK) every year. Procedures are carried out with local anaesthetic or with sedation. Sedation is commonly used for gastrointestinal endoscopy, but the type and amount of sedation administered is influenced by the complexity and nature of the procedure and patient factors. The elective and emergency nature of endoscopy procedures and local resources also have a significant impact on the delivery of sedation. In the UK, the vast majority of sedated procedures are carried out using benzodiazepines, with or without opiates, whereas deeper sedation using propofol or general anaesthetic requires the involvement of an anaesthetic team. Patients undergoing gastrointestinal endoscopy need to have good understanding of the options for sedation, including the option for no sedation and alternatives, balancing the intended aims of the procedure and reducing the risk of complications. These guidelines were commissioned by the British Society of Gastroenterology (BSG) Endoscopy Committee with input from major stakeholders, to provide a detailed update, incorporating recent advances in sedation for gastrointestinal endoscopy. This guideline covers aspects from pre-assessment of the elective 'well' patient to patients with significant comorbidity requiring emergency procedures. Types of sedation are discussed, procedure and room requirements and the recovery period, providing guidance to enhance safety and minimise complications. These guidelines are intended to inform practising clinicians and all staff involved in the delivery of gastrointestinal endoscopy with an expectation that this guideline will be revised in 5-years' time.

*Level of agreement: 100%*

## Patient information, choice and expectations

3. We recommend that patients receive comprehensive information about what to expect from the sedation and sensory experience of the procedure.

*Grade of evidence: High. Strength of recommendation: Strong.*

*Level of agreement: 100%*

4. We recommend that patients are involved in shared decision-making, where possible, when choosing which sedative medication (if any) to proceed with during an endoscopic procedure.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

5. We recommend that patient comfort should be continually assessed during the procedure and sedation/analgesia titrated appropriately.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

6. We recommend that patient experience of comfort and sedation should be measured and recorded.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

7. We recommend the use of non-pharmacological interventions, such as auditory or visual distraction, to reduce patient anxiety.

*Grade of evidence: Moderate. Strength of recommendation: Moderate.*

*Level of agreement: 100%*

## EXECUTIVE SUMMARY OF RECOMMENDATIONS

### Type of sedation

1. We recommend that sedation providers should tailor the doses dependent on patient factors, procedure type and duration, and complexity

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

2. We recommend the provision of inhalational agents to provide the patient with an alternative to sedation

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

### Pre-assessment

8. To reduce the risk of sedation-related complications, we recommend pre-assessment to balance the indication and intended aim of the procedure against the physical status of the patient.

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 84.6%*

9. In patients with obstructive sleep apnoea (OSA) and/or a high body mass index (BMI) ( $\geq 35$  kg/m<sup>2</sup>) we recommend pre-assessment and enhanced peri-procedural monitoring as these patients may be at an increased risk of peri-procedural apnoea.



© Author(s) (or their employer(s)) 2024. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

**To cite:** Sidhu R, Turnbull D, Haboubi H, et al. *Gut* 2024;**73**: 219–245.

*Grade of evidence: Low. Strength of recommendation: Strong.  
Level of agreement: 100%*

### Procedure room requirements

10. We recommend that all patients undergoing gastrointestinal endoscopy (sedated or unsedated) have monitoring of pulse, blood pressure, oxygen saturations and respiration rates as a minimum before and after the procedure. We recommend supplemental oxygen where any level of sedation is used

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

11. Electrocardiography (ECG) monitoring is not recommended routinely for patients requiring gastrointestinal endoscopy with minimal sedation.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

12. We recommend that where the endoscopist-sedationist administers sedation and also performs the procedure, there must be at least an appropriately trained second member of the team monitoring the patient's status.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

13. We recommend that an accurate, contemporaneous record of all drugs is completed and becomes part of the patient record and endoscopy report. This should include additional drugs (eg, hyoscine) used to assist endoscopy.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

14. We recommend that for patients undergoing endoscopy under deep sedation (propofol) or general anaesthetic, ECG, automated non-invasive blood pressure, capnography and core body temperature should be monitored and recorded.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

### Sedation protocol

15. We recommend governance oversight of the process of sedation for endoscopy.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

### Recovery and discharge

16. We recommend that monitoring of sedation should extend into the recovery period until the patient's conscious state has consistently returned to baseline. This requires sufficient staff trained in sedation, monitoring and the recognition of complications.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

17. We recommend that the endoscopist-sedationist should be responsible for ensuring the safe and complete recovery of the patient after endoscopy.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

18. We recommend that patients should be formally assessed for suitability for discharge. This should be documented

to demonstrate recovery from sedation and the absence of complications.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

19. We recommend that patients receiving sedation and/or analgesia for endoscopy should not drive a vehicle or ride a bicycle, operate machinery, sign legal documents or make important decisions, or drink alcohol for 24 hours after the procedure.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

20. We recommend that all patients and any carers providing support after the procedure should receive clear instructions and advice for late recovery, in verbal and written form that includes contact information.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

### Complications related to sedation and reversal agents

21. In patients with opiate or benzodiazepine-induced respiratory depression during or following endoscopy, we recommend the use of a relevant reversal agent.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

22. We recommend that only low-strength midazolam (1 mg/mL) is stocked and used instead of high-strength midazolam to reduce the risk of adverse events related to oversedation.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

23. We recommend that all endoscopy rooms (or units) stock flumazenil and naloxone; and all endoscopy clinical staff should be aware of where they are stored and how to access them in case of sedation-related emergencies.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

24. We recommend that all cases of benzodiazepine or opiate toxicity, requiring the use of reversal should be reported through local incident reporting systems, and any lessons learnt disseminated.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

25. We do not recommend routine benzodiazepine reversal after gastrointestinal endoscopy in patients receiving conscious sedation with a benzodiazepine.

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 100%*

### Special considerations: emergency endoscopy in the sick patient

26. In the critically ill patient requiring emergency endoscopy, we recommend discussion with the anaesthetic team about the choice of sedation technique and the appropriateness of escalation to critical care.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

**Special considerations: upper gastrointestinal endoscopy**

27. There is no evidence to suggest that the combination of throat spray and sedation increases the risk of aspiration, although we advise caution in those at increased risk of aspiration.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

28. We recommend that deep sedation may be required for specific upper gastrointestinal procedures, such as polypectomy/resection of neoplasia, endoscopic bariatric surgery and foreign body retrieval.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

**Special considerations: endoscopic ultrasound (EUS)/endoscopic retrograde cholangio-pancreatography (ERCP)**

29. We suggest that minimal/moderate sedation is usually adequate in diagnostic EUS and level 1/level 2 ERCP.

*Grade of evidence: Low. Strength of recommendation: Weak.*

*Level of agreement: 100%*

30. We suggest that complex ERCP, therapeutic EUS and combined EUS+ERCP procedures are performed with deep sedation/general anaesthesia.

*Grade of evidence: Low. Strength of recommendation: Weak.*

*Level of agreement: 100%*

**Special considerations: device-assisted enteroscopy (DAE)**

31. We recommend that conscious sedation, deep sedation and general anaesthesia (GA) are all options for DAE. The choice of sedation should be dependent on patient and procedural factors and local resources.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

**Special considerations: transnasal endoscopy (TNE)**

32. We recommend unsedated TNE as an acceptable alternative to conventional oral endoscopy for routine diagnostic upper endoscopy.

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 100%*

**Special considerations: lower gastrointestinal endoscopy**

33. We recommend for colonoscopy that alternatives to sedation, including no sedation, inhalational agents and other adjuncts, are considered.

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 100%*

34. We suggest that lower gastrointestinal endoscopy with deep sedation (propofol) or general anaesthesia should be available for selected patients undergoing planned prolonged procedures or complex endotherapy.

*Grade of evidence: Low. Strength of recommendation: Weak.*

*Level of agreement: 100%*

**Special considerations: high-risk groups**

35. We recommend that clinicians fully discuss with patients at an increased risk from sedation for endoscopy (eg, due to age, frailty or comorbidity), the benefits and potential risks of sedation and alternatives to sedation, including no sedation.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

36. We recommend that frail, elderly or comorbid (American Society of Anesthesiologists (ASA) grade 3 or greater) patients are given half or less of the dose required for younger healthy patients and smaller incremental doses, if required.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

37. We suggest that patients with established cardiovascular disease at high risk of cardiac dysrhythmias undergo ECG monitoring and be given supplemental oxygen during endoscopy with sedation.

*Grade of evidence: Low. Strength of recommendation: Weak.*

*Level of agreement: 84.6%*

38. We recommend that patients at risk of myocardial ischaemia during endoscopy with sedation should continue their normal anti-anginal therapy and receive supplemental oxygen before, during and after endoscopy.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

39. We recommend that patients with decompensated chronic liver disease undergoing endoscopy with sedation should be assessed for hepatic encephalopathy prior to endoscopy.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

40. We recommend that patients undergoing endoscopy, with hepatic encephalopathy or chronic liver disease with ASA grade 4 or higher, should have this undertaken with anaesthetic support.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

41. We recommend adjunctive non-invasive ventilation and the use of high-flow oxygen in patients with chronic progressive neuromyopathic disorders and severely impaired respiratory function (forced vital capacity <50%) undergoing endoscopy with conscious sedation.

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 100%*

42. We recommend that patients with renal impairment (estimated glomerular filtration rate <30 mL/min/1.73 m<sup>2</sup>) undergoing endoscopy with sedation should have their doses of opioids or benzodiazepines reduced.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

43. We recommend the use of adjunctive non-invasive ventilation (NIV) and high-flow oxygen in patients with respiratory failure undergoing endoscopy.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

**Special considerations: pregnancy and breast feeding**

44. We recommend that sedation providers should be aware of the actions and interactions of sedative agents in pregnant women, including the increased risk of aspiration.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

45. The use of diazepam in the first trimester has been associated with congenital malformations, whereas no associations have been reported for midazolam. We recommend single doses of midazolam for endoscopic procedures during pregnancy if clinically necessary.

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

46. We recommend that fentanyl, propofol and nitrous oxide (Entonox) can safely be used in pregnancy

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

47. We recommend that breast feeding does not need to be suspended after a single intravenous dose of midazolam, fentanyl or pethidine or when used in combination, or after administration of propofol.

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

### Other special considerations: including transition group and learning difficulties

48. We recommend that young patients undergoing endoscopy should participate in a structured transition programme, including education around the choice of sedative agents.

*Grade of evidence: Very Low. Strength of recommendation: Strong. Level of agreement: 92.3%*

49. We recommend that information about the risks and benefits of endoscopy with sedation should be tailored to the individual young person.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

50. We recommend that in patients with cognitive impairment and/or learning disability, an assessment of capacity is carried out to inform the discussion around choice of sedation.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

51. We recommend that if during a sedated endoscopy, the patient appears to be tolerating the procedure poorly, the endoscopist should stop the procedure (if safe to do so) in order to assess the patient's wishes and decide if the procedure should be abandoned and alternatives arranged.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

### Special considerations: lone working

52. We recommend that a minimum of two appropriately trained endoscopy assistants are required for endoscopic procedures in which sedation has been administered.

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

53. We recommend that sedation should be administered only if there is immediate access to the resources (staff and facilities) required to manage complications of sedation

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

### Training

54. We recommend that all endoscopy staff responsible for assessment of risk, administering sedation and monitoring of patients, undergo formal training in the recognition and management of related complications, and this should be a continuing process

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

## PATIENT/LAY SUMMARY

### Introduction

Gastrointestinal endoscopy procedures are those where flexible cameras are inserted into the gut, to investigate patient symptoms or monitor diseases. The type of camera used and length of

the examination can be varied. Some cameras also have an ultrasound probe attached to obtain extra images, and small samples can be taken to make or confirm a diagnosis or assess severity of a disease. Procedures can either be done unsedated with a local anaesthetic ('throat spray') alone or in combination with a sedative drug and/or painkiller. Sedation can help to make some examinations more comfortable or tolerable. The type of sedation administered is dependent on the nature and complexity of the procedure and also patient and local factors.

### Methodology

These guidelines have been produced by the BSG Endoscopy Committee with other stakeholders. Two patient representatives formed part of the guideline development group (GDG). A comprehensive literature search was conducted followed by several meetings of the GDG. The final recommendations after four rounds of voting by the experts/GDG members form the basis of this guideline.

### Patient information

A significant number of patients are anxious prior to an endoscopy. Patients should receive comprehensive information about what to expect from the sensation of the procedure and effects of any sedative drug, to provide better understanding. Patients should be involved in shared decision-making when choosing which sedative medication (if any) to proceed with during an endoscopic procedure.

### Provision of sedation

Sedation can sometimes be associated with unwanted complications. Clinicians need to weigh the benefits and risks of sedation to ensure that the patient has good or acceptable tolerance of the procedure while achieving the aim of the procedure and minimising unwanted side effects. This process starts from the pre-assessment when patients' medical history is carefully scrutinised. Certain medical conditions, such as kidney, liver, chest or heart problems, or older age, may make the patient more susceptible to the effects of sedative drugs or increase the risk of aspiration (stomach contents inadvertently going into the lungs), and these are taken into account when sedation is considered. Some patients may require the involvement of anaesthetic doctors to provide them with a deeper level of sedation or even a general anaesthetic. The critical care team should be involved when a very unwell patient requires a sedated endoscopy, if deemed appropriate. All such patients should have a clear plan of the 'ceiling of care' outlined in their records.

### Patient monitoring

This guideline provides recommendations for the monitoring equipment the patient needs before, during and after the procedure, depending on the type of sedation and for when the patient can be safely discharged. Where the clinician administers sedation and also performs the procedure, there must be at least an appropriately trained second member of the team present to monitor the patient. Patient comfort should be assessed routinely during the procedure and sedation/pain medication adjusted accordingly with additional medication given as required and recorded, in a safe fashion. Additional interventions, such as music, can also help to alleviate anxiety for some patients.

In cases where deeper levels of sedation are used, greater monitoring is required with a heart rhythm trace (ECG) in addition to blood pressure, pulse, oxygen levels and body temperature.



Sometimes complications associated with sedation occur. This guideline informs clinicians on when a reversal agent should be used to counter the effects of sedative drugs and highlights the importance of all endoscopy staff being aware of where these drugs are kept in case of emergencies. Sedation should only be administered if there is immediate access to the resources (staff and facilities) to manage any complications that might arise. In addition, only lower strengths of the sedative drug midazolam should be stocked to prevent inadvertent oversedation. Any occurrence of oversedation that requires a reversal agent needs to be reported through local safety incident reporting systems, and lessons learnt should be shared within the organisation.

### Patient discharge

Patients should be formally assessed for suitability for discharge. This should be documented to demonstrate recovery from sedation and the absence of complications. With the majority of sedative drugs, a responsible adult is required to accompany the patient home as these drugs can last for up to 24 hours in the body after the procedure. Patients are also advised not to drive or operate machinery for the first 24 hours after having sedation. Clear instructions should be provided at discharge for late recovery with appropriate contact information.

### Specific patient groups

This guideline also covers sedation for specific groups. There are certain procedures where a deeper level of sedation is recommended. Examples include patients with reduced conscious level due to advanced liver disease, when the camera goes deep into the small bowel, when a pancreatic cyst requires drainage or when a metal/plastic tube is inserted into the bile duct (therapeutic ERCP). Smaller doses of sedation should be used in the elderly or in patients with kidney or liver failure. Additional heart trace monitoring (ECG) is recommended in patients who have heart disease with a history of significant abnormal heart rhythms. Breathing machines can be used as an adjunct when using sedation in patients with significant chest and neurological disorders.

A thin camera via the nose (TNE) which can be carried out without sedation, is a reasonable alternative to oral endoscopy in specific groups of patients. For camera tests of the large bowel (colonoscopy), alternatives to sedation such as inhaled gases (eg, nitrous oxide/Entonox) can also be considered as an adjunct, but deeper sedation may be required for planned prolonged or complex procedures. Special consideration is given to younger people (16–18 year olds), who should be invited to a structured transition programme where education around the choice of sedative agents used for endoscopic procedures are covered. The key to a good patient experience is balancing communication, understanding and expectations.

Some patients who require endoscopy might have a learning disability. Information about the endoscopic procedure, including a description of the use and risks of sedation, should be provided in a format that is tailored to the patient's needs and preferred method of communication. Sufficient time should be employed to allow the patient to ask questions.

If during a sedated endoscopy, a patient appears to be tolerating the procedure poorly, the clinician should stop the procedure in order to assess the patient's capacity and wishes. Further sedation may be appropriate. If the patient has capacity but indicates withdrawal of consent, the procedure should be stopped (unless this would result in immediate patient harm).

This guideline also provides recommendations on which sedative drugs can safely be used in the pregnant patient and highlights the increased risk of aspiration in pregnancy. Mothers are safe to breast feed after endoscopy with the vast majority of drugs used.

### Training

This guideline recommends that all endoscopy staff involved in providing sedation have formal training in sedation practices and that this is a continuing process. Every hospital should have a sedation committee to ensure safe practice is carried out and monitored.

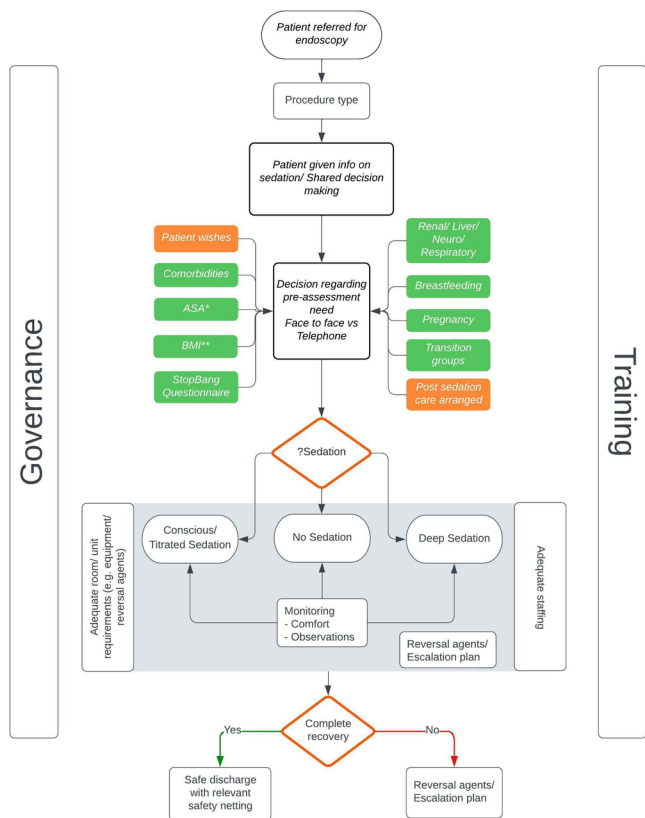
## INTRODUCTION

In the United Kingdom, over 2.5 million gastrointestinal endoscopic procedures are carried out annually. The majority are performed with local anaesthetic or conscious sedation, with deep sedation and general anaesthetic support being used for a minority of procedures. In the last decade, both the complexity and volume of endoscopic procedures undertaken have increased. There is a need for better patient experience and tolerance in line with patient expectation and acceptability. The increased use of sedation brings safety concerns. The main objectives of these guidelines are to provide evidence-based recommendations on the evaluation of adult patients undergoing gastrointestinal endoscopy with or without sedation, the roles and competencies required for clinicians to safely deliver sedation, the minimum monitoring requirements and the prevention and management of adverse events from sedation. This guideline encompasses the commonly used drugs for sedation, interactions and postprocedure discharge criteria. The indications and criteria for deep sedation or general anaesthetic for endoscopic procedures by anaesthesiologists are also detailed. These guidelines update the previous 2013 guidelines.<sup>1</sup>

## DEVELOPMENT OF GUIDELINES

This guideline was commissioned by the BSG Endoscopy Committee and developed in collaboration with representatives from key stakeholders, including the Joint Advisory Group on GI Endoscopy (JAG), the Royal College of Anaesthetists (RCoA) and the British Society of Gastroenterology Nurses Association (BSGNA). The aim of the guideline is to review and update the previous 2013 guideline, encompassing advances and the complexity of endoscopic procedures carried out currently. The guideline development group (GDG) members were selected from the BSG Endoscopy Committee as well as representatives from affiliated committees and stakeholder organisations. The BSG also advertised for two other members of the BSG (not members of the Endoscopy Committee) to apply for positions within the GDG, via submission of a curriculum vitae and supporting statement. Two patient representatives were also invited to form part of the GDG, one through the Royal College of Physicians Patient Involvement Unit.

The GDG met via multiple teleconferences using both Microsoft Teams and face-to-face meetings. The domains for the guideline were discussed in detail. As these guidelines have an impact on several groups of health professionals, stakeholders were invited to comment on the agreed domains to be covered by the guideline. These stakeholders included RCoA, JAG, Association of Upper Gastrointestinal Surgery of Great Britain and Ireland (AUGIS), Association of Coloproctology of Great Britain and Ireland (ACPGBI), British Geriatric Society (BGS) and British Society of Gynaecology and Pancreatic Society of Great Britain



**Figure 1** Flowchart illustrating the patient journey. ASA, American Society of Anesthesiologists; BMI, body mass index.

and Ireland. Based on stakeholder feedback, revised domains were constructed prior to starting the guideline.

These guidelines are based on a comprehensive literature search for key evidence over the last 10 years. Individual members of each section provided key search/MESH terms and references from Medline/PubMed/Embase were retrieved into a reference manager.

Section members developed PICO statements (where P stands for population/patient; I for intervention/indicator; C for comparator/control; and O for outcome) to inform searches for available evidence to support the statements. Assessment of the literature by the section members and the development of recommendations have been made according to the 'Grading of Recommendations, Assessment, Development and Evaluation (GRADE)' system, which was subsequently reviewed via a Delphi voting process. The clinical statements were adapted and/or excluded during the iterative rounds during the Delphi voting process. The agreement that is given for the different statements refers to the last voting round in the Delphi process. A statement

was accepted if at least 80% agreement was reached. If such agreement was not achieved, the GDG members discussed the statements during teleconferences and two face-to-face meetings and rephrased the statements to reflect the comments of the voting group. The guidelines were reviewed by AUGIS, ACPGBI, United Kingdom and Ireland EUS Society (UKIEUS), BSGNA, JAG and the RCoA with several revisions prior to endorsement.

These guidelines are intended to inform practising clinicians and all staff who are involved in the delivery of endoscopy and sedation. Figure 1 depicts the patient journey in relation to sedation. It is expected that these guidelines will be revised in 5-years' time.

### Type of sedation

1. We recommend that sedation providers should tailor the doses dependent on patient factors, procedure type and duration, and complexity

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

2. We recommend the provision of inhalational agents to provide the patient with an alternative to sedation

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 100%*

A number of drugs are routinely used within UK endoscopy services either on their own or in combination to provide differing levels of sedation (defined in table 1). The most frequently used are midazolam, fentanyl, pethidine, and propofol and each will be summarised briefly.

### Drug selection

In the UK the vast majority of endoscopic procedures are performed either with oropharyngeal local anaesthetic sprays (upper GI) or intravenous sedation using mainly fentanyl and midazolam.<sup>2</sup> However, advanced and prolonged therapeutic procedures may be more successful and better tolerated if performed under propofol. High-quality evidence on selecting patients for deep sedation or general anaesthesia are lacking.<sup>3</sup> However, education delivered to staff concerning sedation may translate into reduced adverse events.<sup>4</sup>

### Midazolam

Midazolam is a short-acting benzodiazepine with a short elimination half-life (1.5–2.5 h) and better retrograde amnesic effect than similar drugs such as diazepam.<sup>5</sup> Given intravenously, midazolam has onset at around 2 to 3 min and is metabolised into an active metabolite called  $\alpha$  1-hydroxymidazolam. Several factors may affect the metabolism of midazolam, including age (the elderly and young children), renal function, liver function

**Table 1** Levels of sedation

	Minimal sedation anxiolysis	Moderate sedation/analgesia ('conscious sedation')	Deep sedation/analgesia	General anaesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful response to verbal or tactile stimulation	Purposeful response following repeated or painful stimulation	Unrousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate

While most sedatives in large doses can provide deeper levels of sedation, for many this would not be practical in routine use. The drugs used frequently that can provide a defined level of sedation are indicated.  
fentanyl,<sup>57</sup> midazolam<sup>57</sup> propofol,<sup>57,9</sup> nitrous oxide<sup>5</sup>

and other medications. The elderly and young children may have an increased elimination half-life and therefore caution should be used in these groups<sup>6–8</sup> JAG recommend that in patients over the age of 70 years, a total dose >2.5 mg should be used with extreme caution, especially if combined with an opiate.<sup>9</sup>

Midazolam is metabolised by glucuronide conjugation by the cytochrome P450-3A4 enzyme in the liver and by glucuronide conjugation. Other medications that interact with midazolam generally do so via interaction with this enzyme system. Prolonged action of midazolam can be seen with drugs that inhibit metabolism and include nefazodone, sertraline, fluoxetine, protease inhibitors, macrolide antimicrobials and diltiazem. Enhanced effect of midazolam also occurs with sedating antidepressants, some anticonvulsants such as carbamazepine, sedating antihistamines, opiates and alcohol.<sup>10</sup>

Most of the side effects of midazolam are those that are desirable for producing a sedative effect. However, the effects may last several hours, and return to normal function and cognition is variable.

### Remimazolam

Remimazolam is an ultra-short-acting intravenous benzodiazepine undergoing organ-independent metabolism with no significant accumulation of active components.<sup>11</sup> Approval for clinical use was provided in the USA and Europe in 2020. Clinical reports provide evidence of clinical application in endoscopy.

Remimazolam can be differentiated from other intravenous sedatives by its low liability for cardiovascular depression, respiratory depression and injection pain.

A single dose, repeat bolus or infusion of remimazolam can be used safely and effectively for procedural sedation.

Remimazolam reversal with flumazenil can be achieved. The short duration of action may not expose the patient to re-sedation with flumazenil breakdown.<sup>12</sup>

Several published clinical trials have used remimazolam as a sedative for upper gastrointestinal endoscopy and colonoscopy.<sup>13 14</sup> There is some evidence of performance improvements in comparison with midazolam and propofol.

### Fentanyl

Fentanyl is a strong synthetic opioid commonly used as an adjunct to benzodiazepines during endoscopic procedures and should be given first. It has a rapid onset and its effects generally last for under 2 hours.<sup>15</sup> Common side effects of fentanyl include nausea, vomiting, constipation, sedation and confusion.<sup>15</sup> Serious side effects may include respiratory depression, hallucinations, serotonin syndrome, low blood pressure or development of an opioid use disorder.<sup>15</sup>

Use of concomitant opiates potentiates the effects of the benzodiazepine, meaning that doses should be reduced, particularly in patients with renal disease, liver disease, cardiorespiratory disease and increasing age.<sup>9</sup>

### Pethidine

Pethidine (also known as meperidine) is a synthetic opioid initially used for the treatment of moderate to severe pain. The side effect profile is similar to that of other opiates but due to interactions with serotonergic drugs, additional problems can occur if used in combination with monoamine oxidase inhibitors or selective serotonin reuptake inhibitors.<sup>16</sup>

Pethidine has a rapid onset but can last in the serum for 120–150 min. Doses should also be reduced in high-risk groups and the elderly.<sup>3</sup>

### Entonox

Entonox is a gaseous mixture of 50% nitrous oxide and 50% oxygen that is a potent analgesia that is used widely in health-care, including obstetrics, emergency units and endoscopy. It has a rapid, predictable onset and is eliminated from the body within a very short time. It can be used alone or in addition to other analgesics and sedatives, and in endoscopy is a very useful adjunct for lower intestinal endoscopy.<sup>17 18</sup>

Entonox has been shown to be as effective for colonoscopy in comparison with intravenous sedation with midazolam, fentanyl or propofol.<sup>19</sup> Entonox is easy to administer using a mouthpiece-held delivery device, and the onset of action is within 1–2 min. The rapid elimination means that patients can return to normal functioning more quickly than with intravenous agents.<sup>20</sup>

The recovery profile allows discharge within 30 min of procedure completion. There are no requirements regarding driving or supervision overnight. Both diagnostic and therapeutic colonoscopy procedures show high completion rates without complications.<sup>21</sup> There are several important patient groups for whom Entonox should not be used, which include those with recent eye surgery involving gas bubble insertion, head injury, pneumothorax, suspected intestinal obstruction, bullous emphysema, middle ear procedures and following a recent dive. There are environmental concerns regarding staff exposure and the broader impact of nitrous oxide as a greenhouse gas. Scavenging systems are, however, available to reduce staff exposure but are currently limited.<sup>19</sup> Installation of catalytic destruction systems to reduce environmental escape could have considerable impact on reducing greenhouse gas emissions. These factors need to be considered in the overall gases strategy of every hospital.

### Patient information, choice and expectation

**3. We recommend that patients receive comprehensive information about what to expect from the sedation and sensory experience of the procedure**

*Grade of evidence: High. Strength of recommendation: Strong. Level of agreement: 100%*

Providing patients with adequate information is a basic principle of consent and this should occur prior to attendance for the procedure.<sup>22</sup> Information may be written, but, where possible, it should be tailored to individual patients' needs or preferences and may include verbal, web-based or video formats. Online supplemental appendix 1 includes a patient leaflet on sedation, adapted from the RCoA.

Patient experience may be negatively affected when there is a mismatch between their expectations and the reality of sedation effects or the sensory experience of endoscopic procedures—that is, what the procedure feels like to the patient.<sup>23 24</sup> A significant proportion of patients choosing sedation are not aware that they will not be 'put to sleep' during the procedure, which may not only affect patient experience and increase anxiety, but raises the question as to whether these patients have received adequate information to allow informed consent.<sup>23 25</sup>

Providing information about the expected effects of sedation can reduce patient anxiety.<sup>26 27</sup> Anxiety may also be reduced when information is provided about the sensory experience and comfort of the procedure.<sup>28 29</sup> It is therefore crucial that preprocedural information is easily understandable, tailored to the individual and encompasses the effects of sedation and the sensory experience of the procedure.

**4. We recommend that patients are involved in shared decision-making, where possible, when choosing which sedative medication (if any) to proceed with during an endoscopic procedure**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

The NHS constitution states that patients should be involved in decisions about their care and that care should meet their needs and reflect individual preferences.<sup>30</sup> Control and shared-decision making is important to patients and may reduce anxiety and improve experience.<sup>24 31 32</sup>

Clinicians should be aware of potential factors relating to sedation choice and explore these with patients to enable an individualised approach to sedation or analgesia choice. Factors which might affect patient choice include: previous experience, ability to resume daily activities or work, ability to drive home, convenience, ability to stay in control during the procedure, absence of an escort, perceived effectiveness of the sedation or analgesic option, perceived discomfort of the procedure, not wishing to be conscious during the procedure.<sup>24 33–35</sup> While patient preferences are important, this should be considered within the context of maintaining safety and assessing other patient factors.

Informed choice and consent should include information about the benefits and risks ahead of attending for the procedure.<sup>22</sup> Where alternative procedural options exist, such as TNE or CT colonography, the merits and drawbacks of each should be discussed to help patients make informed choices.

**5. We recommend that patient comfort should be continually assessed during the procedure and sedation/analgesia titrated appropriately**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

Patient comfort during the endoscopic procedure is an important aspect of overall experience. Patients who have previously experienced painful or uncomfortable procedures are more likely to be anxious about repeat procedures.<sup>36</sup> Comfort correlates with patient satisfaction and with quality of endoscopic procedures.<sup>37</sup>

Measuring comfort in real time allows endoscopists and nurses to adjust any procedure-related factors contributing to discomfort but also allows titration of analgesia or sedation. Various tools have been developed to measure real-time patient comfort, but these tend to be nurse- or endoscopist-measured without patient input.<sup>38–40</sup> Patients may display varying reactions to pain/discomfort, and endoscopists should pay attention to vocalisation, patient body language and expressed anxiety or emotion.<sup>39</sup>

While direct feedback from patients will provide the most accurate assessment of comfort, this is not always possible due to the nature of the test. Patient-reported comfort scores may correlate more strongly with nursing assessments than with endoscopist assessment of comfort, however; this has not been replicated universally.<sup>38 41</sup>

**6. We recommend that patient experience of comfort and sedation should be measured and recorded**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

Patient experience is an important dimension of high-quality clinical care. Increasing emphasis is now being placed on it as positive patient experiences are associated with better patient outcomes.<sup>42</sup> The BSG and European Society for Gastrointestinal Endoscopy (ESGE) have both highlighted the importance of measuring and acting on patient-reported experience within endoscopy.<sup>43 44</sup>

Patient-reported experience measures (PREMs) are validated questionnaires designed to measure patient perceptions of their care and their interactions with health professionals and the health service.<sup>43</sup> PREMs give more information than a simple

satisfaction rating and can therefore produce meaningful feedback to improve experience of care and services.

No PREM measures endoscopy-related comfort or sedation alone, but it assesses this within the broader patient experience (Newcastle ENDOPREM).<sup>45</sup> A focused PREM which assesses the tolerability of endoscopic procedures using conscious sedation (PRO-STEP) has been validated and while this does not assess experience of sedation, it does assess comfort and tolerability of the procedure.<sup>46</sup>

We recommend that patient experience of comfort and sedation should be measured routinely. This might be included within broader PREMs but should be based on what patients report as important. Patient experience of comfort and sedation should be assessed as a quality indicator and fed back to endoscopists to enable practice changes where required.

**7. We recommend the use of non-pharmacological interventions, such as auditory or visual distraction, to reduce patient anxiety**

*Grade of evidence: Moderate. Strength of recommendation: Moderate.*

*Level of agreement: 100%*

Anxiety is an important aspect of patient experience and can have effects on sedation, comfort and overall experience of the procedure.<sup>24 32 47 48</sup> Increased preprocedural anxiety is independently associated with discomfort, tolerance, panic and fear during endoscopy.<sup>29 49</sup> Anxiety is often not limited to concern about the procedure itself, but also to the potential clinical findings.<sup>24</sup> Increased anxiety in patients undergoing colonoscopy is more frequently associated with female sex, no previous experience of the procedure, previous negative experience of the procedure and confusing instructions.<sup>24 29</sup>

While conscious sedation has anxiolytic properties, non-pharmacological interventions may reduce patient anxiety prior to and during endoscopy. Communication plays an important role, and verbal distraction and communication by staff in the procedure room may distract and reassure patients.<sup>24</sup>

Previous studies have focused on reducing anxiety by improving information either through videos, verbal or written information, but these demonstrated varying results.<sup>47</sup> A systematic review and meta-analysis found that music can reduce anxiety during GI endoscopy, in addition to improving pain and satisfaction scores.<sup>50</sup> Further work has shown that this effect is present in patients who also undergo conscious sedation.<sup>51</sup>

Increasing attention is being given to visual distraction. One study demonstrated that a head-mounted display with silent video can reduce intraprocedural anxiety in those patients who have the highest preprocedural anxiety levels; however, a further study playing nature scenes and sounds on a digital screen had no effect on overall anxiety.<sup>52 53</sup> The use of virtual reality is promising and a recent group assessed the use of a virtual reality head-mounted display which played several short clips featuring tropical islands and forests with soothing music.<sup>54</sup> Median pain scores and 'nervousness' as measured using a wrist band were improved in the intervention group; however, this was a single-site study with a relatively small sample size.

## Pre-assessment

**8. To reduce the risk of sedation-related complications we recommend pre-assessment to balance the indication and intended aim of the procedure against the physical status (eg, ASA class) of the patient**

*Grade of evidence: Moderate. Strength of recommendation: Strong.*



*Level of agreement: 84.6%*

Patient assessment is key prior to consideration of any endoscopic intervention and the principles of 'first, do no harm' (*primum non nocere*) should be adhered to. This involves full evaluation of the indication and intended aim of the endoscopic procedure balanced with the physical status and cardiopulmonary reserve of the patient. Risk stratification is an essential component of a thorough preprocedure evaluation and to determine selected patients that should undergo formal pre-assessment. A systematic approach, including patient history and comorbidities and physical examination, should be balanced with the expectation of the patient. The pre-assessment also allows the identification of other high-risk problems to alert the team that additional tests—for example, pulmonary function test or echocardiogram, may be required prior to interventional endoscopy.

The requirement for anaesthetic assessment should be highlighted at the time of consideration of the endoscopic procedure. Patient and procedural factors help to determine which patients should be considered for formal anaesthetic assessment. Procedures where deep sedation should be considered include those of longer duration and where complex therapeutic intervention is likely to be required.

Patients attending the pre-assessment should have prior knowledge and understanding of the indication and risks of the procedure, including that of sedation and types of sedation that can be reasonably offered safely. The discussion should be balanced, detailing sedated and unsedated endoscopy. Patients referred via the open access route would have received information via their general practitioner at time of referral, endoscopy information leaflets that are subsequently posted out and usually via a telephone nurse triage.

It is well documented that patients with a higher ASA class (online supplemental appendix 2) are at increased risk of complications during endoscopy.<sup>55</sup> A recent study of patients undergoing ERCP demonstrated a significantly higher risk of adverse events (particularly cardiopulmonary) in those with performance status 4 compared with performance 0–3.<sup>56 57</sup>

Physiologic changes that occur with older age also have the ability to affect drug metabolism and pharmacokinetics. A recent nationwide population based study in South Korea identified that both sedation and older age were independent risk factors for cardiac and cerebrovascular events. Approximately 2.23% of study subjects who underwent diagnostic GI endoscopy (222.5/10 000 people) had cardiac and cerebrovascular adverse events within 14 days after endoscopy.<sup>58</sup>

Similarly, another small study of 250 inpatients showed that the risk of lower respiratory infections and pneumonia was increased in older patients (>65 years) undergoing sedated endoscopy compared with age, gender-matched patients without endoscopic intervention.<sup>59</sup> During pre-assessment, the fasting instructions preprocedure (eg, 6 hours before upper GI endoscopy) should be highlighted. In certain cases, this fasting may need to be extended depending on patient characteristics (eg, for patients with gastroparesis).

**9. In patients with obstructive sleep apnoea (OSA) and/or a high body mass index ( $\text{BMI} \geq 35 \text{ kg/m}^2$ ) we recommend pre-assessment and enhanced peri-procedural monitoring as these patients may be at an increased risk of peri-procedural apnoea.**

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Morbidly obese patients are at higher risk of respiratory complications for several reasons, including increased upper airway resistance with propensity for OSA and the potential for obesity-hypoventilation syndrome.

Hypoxia is the the most common sedation-related adverse event no matter which sedative agent is used. Hypoxaemia can occur in, and results from, the combination of airway obstruction by the endoscope, anaesthesia-induced upper airway collapse, and respiratory depression and lung compression because of intestinal gas insufflation which may be more problematic for upper GI and small bowel procedures.

Although meta analyses have not demonstrated an increased cardiopulmonary risk related to conscious sedation for patients with OSA, clinicians need to be aware of the potential risk of apnoea.<sup>60–62</sup>

Patients at risk of OSA can be identified during pre-assessment by validated instrument tools such as the Berlin or STOP-BANG questionnaires as some cases may be undiagnosed. Parameters within the tool include male sex, age >50 years, hypertension, regular snoring, daytime somnolence, episodes of apnoea/gasping,  $\text{BMI} \geq 35 \text{ kg/m}^2$  and increased neck circumference.<sup>63–66</sup>

Management of patients with OSA undergoing sedation requires understanding of different pharmacological options available, where minimal doses of hypnotics should be used and opioids carefully titrated. The questionnaire should be used as a tool to highlight to the endoscopy team those at higher risk.<sup>67</sup>

This would enable the endoscopist to discuss the risk of sedation, during the process of consent. The information would also be useful in deciding whether a procedure could be done unsedated or if the dose of sedation requires titration or a referral for anaesthetic assessment, particularly for therapeutic or anticipated prolonged procedures. These patients require enhanced peri-procedural monitoring. A suggested monitoring schedule includes observations (non-invasive blood pressure, oxygen saturations using pulse oximetry, respiratory rate and pulse every 10 min during the procedure) and monitoring continued for a minimum of 90–120 min after the procedure.

Pulse oximetry is the most commonly used technique to evaluate oxygenation levels owing to its simplicity and non-invasive design. Nonetheless, it does not provide additional information about the adequacy of ventilation or precise arterial oxygenation, particularly when arterial oxygen levels are extremely high or low.

The measurement of end-tidal carbon dioxide with capnography, is another non-invasive method for estimating  $\text{PaCO}_2$ . Bedside capnography can easily measure end-tidal carbon dioxide and detect apnoea.<sup>68</sup> Capnography has been shown to reduce the incidence of hypoxaemia and oxygen desaturations compared with pulse oximetry alone, in the emergency setting<sup>69 70</sup> and with procedural sedation for dental procedures.<sup>71</sup> In this high-risk group, we would strongly advise the use of capnography as an additional monitoring tool to reduce the risk of such adverse events.

The delivery of sedation is affected by a number of both procedural and patient-related factors, which include systemic comorbidities and airway-specific considerations, as detailed in table 2.

Patients who have oropharyngeal abnormalities or who take large amount of pain medications are at risk. The Mallampati Classification is recognised as an important tool to help anaesthetists measure and categorise the amount of space in a patient's oral cavity. It helps to predict difficulty with any proposed endotracheal intubation. This classification is based on the structures visualised with maximal mouth opening and tongue protrusion in the sitting position. Patients with a higher Mallampati class (III–IV) have more difficult airway management and this should be assessed prior to consideration of complex endoscopic procedures requiring deeper levels of sedation.<sup>72</sup>

**Table 2** Patient and procedural factors to be considered in the choice of sedation

Patient factors	Drug history: high intake of pain medications/sedatives Potential drug interactions/previous problems with sedation/anaesthesia Patient preference Oral/jaw or neck abnormalities, dysmorphic features: micrognathia, retrognathia or significant malocclusion, limited neck extension OSA/patients at risk of OSA Pregnancy Comorbidity: severe pulmonary, cardiac, neurological, renal, hepatic disease or high-risk of aspiration, elderly
Procedural factors	Upper and lower GI: polypectomy/resection of neoplasia/prolonged procedures >60 min Endoscopic bariatric surgery Large variceal bleed/significant gastric contents Foreign body retrieval Hepatobiliary procedures: Therapeutic endoscopic ultrasound or endoscopic retrograde cholangiopancreatography Pancreatic fluid collection drainage Small bowel device-assisted enteroscopy, including double balloon, single balloon or spiral enteroscopy

OSA, obstructive sleep apnoea.

### Pre-assessment in pregnancy

The pre-assessment of the pregnant patient should involve the obstetric team especially to determine the degree of fetal monitoring required. There should be a strong indication for endoscopy, and elective procedures should preferably be deferred until the second trimester. The impact of sedation and monitoring requirements in the different patient groups are discussed in more detail in subsequent sections.

### Procedure room requirements

**10. We recommend that all patients undergoing gastrointestinal endoscopy (sedated or unsedated) have monitoring of pulse, blood pressure, oxygen saturations and respiration rates as a minimum before and after the procedure. We recommend supplemental oxygen where any level of sedation is used.**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Sedation practices and therefore room requirements vary across countries supported by heterogeneous society guidelines and position statements. There is often a lack of evidence to support these differences, which most probably reflect local custom and practice development.<sup>73</sup> How this affects patient access, utility, safety and effectiveness remains unclear. It is attractive to place safety first and increase the amount of monitoring and staff, but this can increase costs, complexity and resource consumption. Room requirements for endoscopy using sedation include the staff, their roles and equipment available to monitor sedated patients.<sup>73</sup> Staff are drawn from many different professional groups, including endoscopists (surgical, medical, clinical/non-medical), endoscopy nurses, healthcare support workers and operating department assistants. Leadership of sedation, while remaining usually with the endoscopist, is also shared by appropriately trained endoscopy nurses. All members of the team should be cognisant of the importance of safe sedation in endoscopy delivery.

Staffing requirements for endoscopy in the UK have been reviewed by the BSG.<sup>74</sup> It is difficult to be prescriptive about a minimum standard and this has been the cause of debate even within the UK where there are differences across the devolved nations and challenges to professional boundaries—for example, the development of advanced healthcare support workers. In addition to the endoscopist/sedationist, a minimum of two additional members of staff has been recommended by the BSG and recently endorsed by the Academy of Medical Royal Colleges (AoMRC) update.<sup>75</sup> There should always be an endoscopist/

sedationist as a minimum supported by at least one registered professional trained to monitor the patient's safety, comfort and level of sedation, usually a qualified nurse and an additional assistant to the endoscopist. When the procedure is long or complex or the patient has significant comorbidity, a dedicated sedationist should be considered.

Monitoring the patient's status and physiology during endoscopy allows both the direct effect of the procedure and, if used, sedation, to be assessed, monitored and recorded.<sup>1</sup> This is facilitated during both unsedated and sedated (minimal/moderate) procedures by use of pulse oximetry, which is widely available. Pulse oximetry supports early recognition of disturbances to circulation and oxygenation, even prior to the start of the test.<sup>76</sup>

Practice of sedation within the UK and its use in multiple different clinical settings has been guided by the Academy of Medical Royal Colleges with the detailed publication of standards and guidance<sup>1</sup> in 2013 followed by an update in 2021.<sup>77</sup> Dossa et al 2021 established that the most consistent advice from learnt societies and national bodies is that as a minimum non-invasive blood pressure monitoring and pulse oximetry is required for all sedated patients.<sup>73 78</sup>

**11. ECG monitoring is not recommended routinely for patients requiring GI endoscopy with minimal sedation**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

The need for ECG monitoring depends on the level of sedation used and whether the patient is considered to be at increased risk of cardiovascular complications (see statement 1537 later). Data to support its use are lacking but ECG monitoring is recommended in most international guidelines where moderate sedation is used. For minimal sedation, the advice is varied. The UK AoMRC advice from 2013<sup>1</sup> states that “where conscious sedation is used and continuous verbal contact is maintained, ECG monitoring is not essential”. This position is supported here as ECG monitoring has disadvantages as well as strengths—for example, additional use of consumables, or inhibition of patient position change. The AoMRC update in 2021 suggests that ECG monitoring is required for patients in deeper plane of sedation other than minimal sedation.<sup>75</sup>

**12. We recommend that where the endoscopist-sedationist administers sedation and also performs the procedure, there must be at least an appropriately trained second member of the team solely monitoring the patient's status**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

All members of the endoscopy team responsible for monitoring the patient must be suitably trained to use the equipment, able to assess the level of sedation and recognise the patient's condition/sedation level.<sup>77</sup> If the second member of the team is required to assist the endoscopist-sedationist with technical aspects of therapeutic intervention—for example, ERCP or advanced polypectomy, they can no longer be relied on to be fully cognisant of the patient status. The endoscopist must consider if there are enough trained individuals within the room to support any planned intervention before starting.<sup>77</sup>

**13. We recommend that an accurate, contemporaneous record of all drugs is completed and becomes part of the patient record and endoscopy report. This should include additional drugs (eg, hyoscine) used to assist endoscopy**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Accurate and complete recording of any endoscopy procedure should include the dose of drugs given, whether single bolus or aliquots and the time administered. This facilitates management of recovery, any arising complications, audit and governance.

### Deep sedation

**14. We recommend that for patients undergoing endoscopy under deep sedation (propofol) or general anaesthetic, ECG, automated non-invasive blood pressure, capnography and core body temperature should be monitored and recorded**

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Deep sedation (propofol) or general anaesthesia services are often procedure-specific and involve a multidisciplinary team of experts. In the UK, this can only be delivered by trained anaesthetists. The facilities are often set apart from the main theatre environment. The non-theatre environment is known to be high-risk for anaesthesia and sedation services.<sup>79</sup> When considering safety and monitoring requirements, the focus should not be centred on equipment and facilities, rather the starting point should be a positive safety culture, an educational programme and an institutional network of sedation providers developing local protocols, collecting critical incidents data and sharing best practice.<sup>80</sup> It is important to highlight that even with the delivery of deep sedation, it is imperative that the sedation team, which should include an anaesthetic nurse or operating department practitioner, have the skills to identify and deal with patients who are inadvertently in a deeper plane of sedation than expected.

This organisational approach to delivering patient safety should work alongside considerations of monitoring and room requirements.<sup>81 82</sup> Patient monitoring platforms applied to procedural monitoring should be comparable with monitoring provided in the preoperative and postoperative periods, and familiar to staff. Physiological changes of deep sedation are comparable to the changes observed during general anaesthesia. Non-invasive blood pressure, ECG and pulse oximetry are minimal requirements and are shown to reduce the number of sedation-related adverse effects.<sup>83</sup>

Hypoxia and apnoea dominate the critical events associated with procedural sedation.<sup>84</sup> Traditional low-flow nasal or facial oxygen therapy techniques are often insufficient to maintain acceptable oxygen levels and prevent periprocedural hypoxia. High-flow nasal oxygen delivers warm humidified oxygen up to 70 L/min, at oxygen concentrations between 21% and 100% and reduces the incidence of hypoxic events. Many studies observe that pairing procedural sedation with high-flow nasal oxygen

reduces the number of hypoxaemic events.<sup>66 85</sup> High-flow nasal oxygen should be made available for procedural sedation where patients are at risk of periprocedural hypoxia.<sup>86</sup>

Procedural capnography is complementary to qualitative, clinical observations of respiratory pattern by a skilled operator able to recognise and manage respiratory deterioration.<sup>71 87</sup> The National Audit Project (NAP4): Major complications of airway management in the UK, examined patients who had anaesthesia and rapid sequence induction in the emergency department and in the intensive care unit and highlighted the importance of capnography to reduce deaths in such settings.<sup>69</sup> Capnography has also been studied for procedural sedation with dental procedures. A meta-analysis of 16 studies showed that capnography had a higher sensitivity to detect adverse respiratory events than standard monitoring alone with pulse oximetry (0.92; 95% CI 0.65 to 0.99).<sup>71</sup> While further studies are awaited within endoscopy, the benefit noted in other settings suggests that this should also be used in high-risk patient groups or patients undergoing prolonged procedures under moderate sedation to reduce the risk of inadvertent entry into a deeper plane of sedation than intended. The high-risk groups include the elderly and comorbid patients, those with significant respiratory and chronic progressive neuromyopathic disorders. This is particularly important if top-up doses of sedation are used.

Monitoring of the conscious level may limit the opportunity for the depth of sedation to exceed deep sedation. However, there is no evidence that depth of sedation monitoring, through EEG analysis, confers any safety benefits over clinical observation.<sup>88 89</sup>

The thermal redistribution of core body temperature with subsequent temperature drop is likely to be a feature of deep sedation, as it is with general anaesthesia. Core temperature may fall up to 1.5°C in the first 30 min of general anaesthesia. Few clinical studies of temperature monitoring during deep sedation are available for review. Therefore, a pragmatic solution is that if perioperative hypothermia is expected, measurements of core temperature should be done routinely. Similarly, methods to provide surface warming in the perioperative period should be considered.<sup>90</sup>

Prospective record keeping should be a requirement for deep sedation procedures. While the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) has highlighted deficits in the recording of monitoring during sedation cases, the frequency of recording of vital signs is not defined. In the absence of clinical trial data, it would be precautionary to provide a monitoring chart recording data prior to induction, at 5- or 10-minute intervals during the procedure, and thereafter the frequency and duration of monitoring to be prescribed by the clinical team depending on the procedural and patient risk factors.<sup>91 92</sup>

### Sedation protocol

**15. We recommend governance oversight of the process of sedation for endoscopy**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

Good governance and leadership should be at the heart of procedural sedation services to ensure patient safety.<sup>93</sup> Clinical governance of a procedural sedation service should have an objective of continuous quality improvement. The procedural sedation service will involve many stakeholders, including sedation practitioners, anaesthetists, medical staff, operators, nurses,

managers, administrators and finally, users. The governance of a sedation service should be a collaborative approach involving all those stakeholders with an investment in service delivery.<sup>94</sup> The objective of governance of the sedation service should be supporting continuous improvement through training, auditing and risk management including clinical incidents.<sup>95</sup> The structure of the governance and its delivery will be locally led by the sedation committee, with broad objectives determined, in part, by national organisations. While the evidence is low for the introduction of a sedation committee to oversee clinical governance, this approach is recommended by both European and North American Societies.<sup>96</sup>

The sedation committee should also oversee local training in sedation. The standards for training in sedation can be determined by national organisations, with local committees providing individual accreditation and documentation for sedation practitioners. Training is discussed in more detail in the subsequent section.

The governance structure should provide clear lines of accountability from national organisations, local committees to individuals. The performance of sedation practitioners can be regularly assessed and compared with local and national standards with regards to outcomes and number of procedures performed. Within governance, mild and moderate sedation should be considered separately from deep sedation. The role of governance of sedation services is one element in a chain linking national organisations setting standards, and local provision of services. The role is an oversight of the safety of the service and to promote improvements in professional and clinical standards.<sup>97</sup>

The training in sedation including deep sedation can consider six elements<sup>98</sup>

- ▶ Levels of sedation provided and procedural and patient risks.
- ▶ Perioperative planning including pre-assessment and follow-up.
- ▶ Drugs and therapeutics used in sedation.
- ▶ Basic and intermediate and cardiopulmonary resuscitation, with an emphasis on airway rescue.
- ▶ Monitoring and oxygen therapy.
- ▶ Patient safety and safeguarding

The gastroenterology team should provide regular data to assist the process of auditing outcomes within the broader aspect of delivery of endoscopy services, and this should feed into the regular endoscopy user group meetings:

- ▶ Named clinicians responsible for delivering sedation.
- ▶ Training certificates in sedation and resuscitation certificates that are up to date.
- ▶ Clinical activity, number of procedures, average doses of sedation and complication data.
- ▶ Record of clinical incidents and discussion through morbidity and mortality meetings.

## Recovery and discharge

**16. We recommend that monitoring of sedation should extend into the recovery period until the patient's conscious state has consistently returned to baseline. This requires sufficient staff trained in sedation, monitoring and the recognition of complications**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Recovery from endoscopy and any required sedation is an important part of an endoscopy service and should be efficient, reliable and safe.<sup>1</sup> Safe recovery from sedation requires the same

level of training and competency in monitoring and the recognition of complications as required in the endoscopy room itself. Recovery from endoscopy can be divided into several stages<sup>199</sup>:

First stage: the return to baseline consciousness levels and function—that is, the patient is awake and protective reflexes have returned.

Second stage: covers the patient being made ready to leave the endoscopy unit. This will include information exchange, follow-up planning and discharge advice for both patient and carers. At this stage, the patient will be able to resume normal activities such as eating and drinking.

Late stage: occurs after the patient has left the department.

Monitoring of the effects of sedative drugs is most crucial within the first stage; however, complications arising from sedation or the procedure itself may only become apparent in the second or final stage. Protocols and practices need to ensure safety of the patient throughout all three stages.

The degree of monitoring established for the patient should be continued until baseline levels are reached. In first-stage recovery, the emphasis is on normalisation of physiology.<sup>99</sup> It is possible that complications that arise from either sedation or the procedure itself become apparent only within this first-stage recovery period or subsequent second or late recovery.

Appropriate staffing for endoscopy recovery needs to be considered carefully for each individual endoscopy service.<sup>1</sup> Patients who receive moderate or deep sedation (or undergo high-risk procedures) may require one to one nursing during this period. Additionally, for an anaesthetic-led deep sedation list, two recovery nurses trained in resuscitation have been previously proposed.<sup>3</sup> This recommendation can be extended to cases where the sedationist, other than anaesthetic personnel, uses moderate or deep sedation. Staffing needs within a recovery area are determined by the case mix and degree of sedation but also by additional factors, including number of patients, gender mix, layout of the recovery area and availability of automatic or remote monitoring equipment. Decisions on the correct level of staffing within recovery and the endoscopy service overall are supported by the non-medical staffing BSG document.<sup>74</sup>

**17. We recommend that the endoscopist-sedationist should be responsible for ensuring the safe and complete recovery of the patient after endoscopy**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

The sedationist-endoscopist remains responsible for the patient beyond the endoscopy room and throughout the complete recovery period.<sup>1</sup> Clinical duties often mean that an endoscopist will leave the unit before the discharge of all the list's patients. Therefore, after the list is complete, endoscopists should ensure they are contactable and that the recovery staff are aware of their location. This responsibility can be transferred to a suitable deputy who is capable of the recognition and management of complications from either the procedure or sedation. It is good practice on completion of an endoscopy list for the responsible endoscopist to visit the recovery area, to review progress, discuss any issues with recovery staff and therefore facilitate safe discharge of patients<sup>100</sup> (see below).

**18. We recommend that patients should be formally assessed for suitability for discharge. This should be documented to demonstrate recovery from sedation and the absence of complications**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*



*Level of agreement: 100%*

Standards and guidance for sedation from the AoMRC recommend discharge criteria as follows<sup>1</sup>:-

1. The patient has returned to their baseline level of consciousness.
2. Vital signs are within normal limits for that patient.
3. Respiratory status is not compromised.
4. Pain and discomfort have been addressed.

Patients meeting discharge criteria following sedation should be discharged into the care of a suitable adult (18 years and above). This carer needs to be available to support the patient for 24 hours after the procedure.<sup>99</sup> Verbal and written instructions should be provided that are appropriate for both the sedation received, and procedure performed. This evaluation of recovery and readiness for discharge should be recorded in endoscopy documentation and retained in the patient record.<sup>199</sup>

**19. We recommend that patients receiving sedation and/or analgesia for endoscopy should not drive a vehicle or ride a bicycle, operate machinery, sign legal documents or make important decisions, or drink alcohol for 24 hours after the procedure**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

Many endoscopy procedures occur with minimal or moderate sedation where the patient remains conscious and communicative both during the test and after the procedure. However, owing to the ongoing effects of the sedative drugs, cognition and therefore critical decision-making can be altered and unpredictable. This may not be appreciated by patients, carers and family. The British National Formulary (BNF)<sup>101</sup> clearly states that patients who have received intravenous benzodiazepines should not drive a car, operate machinery, sign legal documents or drink alcohol for 24 hours. This list can extend to anything which requires critical decision-making and can have an adverse impact on the patient or others in their care, such as children. While there is no evidence to make recommendations against flying, patients need to be aware of being in a position where there is no immediate prospect of medical support being available.

This should include all forms of intravenous sedation/analgesia (eg, opiates) which establishes these restrictions as precautionary, therefore straightforward and easy to follow for carers and relatives. It is in line with the RCoA advice for caring for someone recovering from a general anaesthetic or sedation.<sup>99</sup> Treating all forms of intravenous sedation equally with respect to restrictions during recovery prevents trade-offs in discussions with patients about the nature and choice of sedative in order to prioritise patient comfort and safety.

**20. We recommend that all patients and any carers providing support after the procedure should receive clear instructions and advice for late recovery, in verbal and written form that includes contact information**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Owing to the alteration of critical decision-making secondary to sedation and/or the physiological effects of endoscopy itself, patients may require additional support following discharge—that is, late recovery. Clear advice in an appropriate form must be given to responsible third parties, carers and families about how to look after patients in the late recovery period.<sup>1102</sup> This includes both verbal discussion and written information that must be supported by including patient information leaflets and

discharge advice sheets. An example document is provided in the online supplemental appendix.<sup>102 103</sup>

This should include information on where to seek advice on postprocedure complications, when and how to contact the endoscopy department, or alternate forms of support both in and out of working hours.

One common alternative to intravenous sedation is to use nitrous oxide to provide anxiolysis and analgesia to the patient during the procedure.<sup>104</sup> The advantages of nitrous oxide over traditional conscious sedation are that patients are deemed fit to drive 30 min after their procedure and do not require a responsible adult to accompany them home. The recovery time is also reduced, having a positive impact on the endoscopy recovery for safe and efficient discharge.

Entonox is a 50:50 mix of oxygen and nitrous oxide,<sup>105</sup> and the latter is now recognised as an important potent greenhouse gas. Therefore, its clinical efficacy must be balanced against its environmental impact. This balance should be understood by both staff and patients to support informed choice of this agent when used as an alternative to traditional sedation. This is discussed further in the BGS/JAG position statement on green endoscopy.<sup>106</sup>

**Complications related to sedation and reversal agents**

Sedation-related complications during GI endoscopy are mostly cardiopulmonary in nature: hypoxaemia, hypotension, aspiration pneumonia, arrhythmia and vasovagal syncope.<sup>107–111</sup>

Comparing the rates of sedation-related complications can be challenging owing to differing definitions of ‘adverse event’ across studies, varying inclusion criteria for patients and procedures, and different sedation regimens. Based on findings from studies looking at sedation-related complication rates from more than 100 000 endoscopic examinations, the complication rate is estimated as between 0.01% and 0.9%, with a sedation-related mortality rate of 0.0006% to 0.008%.<sup>107 109 111</sup> The ProSed2 study, a multicentre German prospective observational study included more than 350 000 endoscopies performed under sedation (81% propofol-based sedation and 6.5% midazolam alone). The major sedation-related complication rate (defined as need for intensive care support, resuscitation or death) was 0.01% and the minor (defined as increased restlessness, oxygen saturation <90% for >10 s, drop in blood pressure by more than 20%, drop in heart rate >20%, tachycardia >100/min) sedation-related complication rate was 0.3%.<sup>107</sup>

Independent risk factors associated with complications included, but were not limited to, ASA score >2, prolonged procedure time and therapeutic endoscopy.<sup>107</sup> A previous meta-analysis showed no difference in complication rates between propofol-based and benzodiazepine-based sedation with opiate.<sup>108</sup> The complication rate for midazolam-based sedation during GI endoscopy is estimated to be 0.38%, most commonly due to hypoxaemia (40.7% of all complications).<sup>112</sup>

Different reported thresholds have been used for defining respiratory depression and other associated abnormal physiological parameters (eg, oxygen desaturation, changes in heart rate, arterial CO<sub>2</sub> partial pressure).<sup>113–117</sup> For these guidelines, we define respiratory depression secondary to opiates or benzodiazepines as a reduced respiratory rate <10 breaths/min, which may or may not lead to an oxygen desaturation to <90%, elevated arterial CO<sub>2</sub> partial pressure >6.66 kPa or reduced levels of consciousness.<sup>118</sup>

In instances of respiratory depression or hypoxaemia during or shortly after administration of conscious sedation, supportive

measures include verbal or physical stimulation of patients to encourage deeper breathing; administration of supplemental oxygen<sup>87</sup> to target an oxygen saturation level of 94% and above, or between 88% and 92% in those at risk of hypercapnic respiratory failure, fluid resuscitation if hypotensive and consideration for use of reversal agents as outlined below, alongside further anaesthetic support if spontaneous ventilation does not maintain adequate ventilatory status.<sup>87 119</sup>

In the UK, data extrapolated by the National Endoscopy Database showed that reversal agents were used in 0.02% of colonoscopies, 0.05% of gastroscopies and 0.08% of ERCPs, where opiates or sedatives were used for the procedure.<sup>120</sup>

### Opiate-related toxicity and naloxone

Opiate toxicity can lead to respiratory depression, reduced consciousness, pin-point pupils, arrhythmia, hypotension, desaturation, seizures, apnoea and respiratory arrest. The hallmark feature of opiate-related toxicity requiring reversal is respiratory depression.

Naloxone is a rapid-acting opioid receptor antagonist, with an onset of action of 1–2 min, and a half-life of 30–120 min, dependent on the route of administration. When administered intravenously, it rapidly reverses sedation, the analgesic effect and respiratory depression related to opiates. Careful consideration needs to be given to patients receiving long-term opiates due to the risk of acute withdrawal symptoms after naloxone administration. Common potential side effects include dizziness, headache, hypertension, hypotension, vomiting and arrhythmias.<sup>121</sup>

Observational studies and case reports show the successful reversal of respiratory depression and oxygen desaturation after naloxone administration in non-anaesthetic supported units.<sup>122–124</sup> The recommended regimen according to the BNF is an initial dose of 400 µg IV, followed by 800 µg for up to two doses at 1 min intervals if no response, then increased to 2 mg for one dose if there is still no response. If repeated administration of naloxone is needed, an infusion of naloxone and transfer to an appropriately monitored environment, such as a high-dependency unit, may be considered.

Due to the potential for further sedation following initial administration of naloxone, extended monitoring may be recommended. The American multisociety curriculum on sedation in GI endoscopy suggests a period of observation of up to 2 hours.<sup>125</sup>

### Benzodiazepine-related toxicity and flumazenil

Symptoms of benzodiazepine-related overdose include reduced consciousness, hypotension, respiratory depression and apnoea. Management is largely supportive, although flumazenil, a benzodiazepine antagonist, which acts by competitively binding at a benzodiazepine-binding site on the γ-aminobutyric acid receptor,<sup>126</sup> can be used to reverse the effects of benzodiazepine toxicity. It has more efficacy at reversing central nervous system depression than respiratory depression. Thus, in patients administered both benzodiazepine and opiate as part of their sedation regimen, it would make sense to give naloxone first before flumazenil.<sup>127</sup>

Flumazenil is given intravenously and has a rapid onset of action of 1–2 min, with the maximal effect reached within 10 min after administration. The BNF recommends a dosage of 200 µg, administered over 15 s, followed by 100 µg every minute, if required, up to a maximum of 2 mg.<sup>128</sup>

Potential side effects related to flumazenil are nausea, vomiting, headaches and dizziness.<sup>129</sup> There are also reported cases of benzodiazepine reversal-related seizures, in particular in patients receiving long-term benzodiazepines<sup>130</sup> or high-dose tricyclic antidepressants.<sup>131</sup>

The reversal of the effects of midazolam with flumazenil may occur within 2 min. Since midazolam has a longer duration of action than flumazenil, re-sedation may occur following administration of flumazenil. It is prudent to observe patients receiving flumazenil for an extended duration period in recovery (eg, 2 hours longer than usual).<sup>78</sup>

**21. In patients with opiate or benzodiazepine-induced respiratory depression during or following endoscopy, we recommend the use of a relevant reversal agent**

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

**22. We recommend that only low-strength midazolam (1 mg/mL) be stocked and used instead of high-strength midazolam to reduce the risk of adverse events related to oversedation**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

**23. We recommend that endoscopy rooms (or units) should stock flumazenil and naloxone; and all endoscopy clinical staff should be aware of where they are stored and how to access them in case of sedation-related emergencies**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

**24. We recommend that all cases of benzodiazepine or opiate toxicity, requiring the use of reversal, should be reported through local incident reporting systems, and any lessons learnt disseminated**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

### Routine use of flumazenil after GI endoscopy

**25. We do not recommend routine benzodiazepine reversal after gastrointestinal endoscopy of patients receiving conscious sedation with a benzodiazepine**

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Some studies have looked at the routine use of flumazenil after benzodiazepine-based sedation for GI endoscopy. Routine use of flumazenil has been associated with resolution of baseline psychomotor skills within 30 min,<sup>132</sup> improvements in levels of consciousness compared with placebo,<sup>133</sup> and decreased stay in recovery rooms,<sup>134 135</sup> without significant differences in patient satisfaction, psychological status or procedure-related discomforts.<sup>136</sup>

Although some of these studies may suggest an overall decrease in length of stay in the recovery room, clinical benefit from routine use of flumazenil has not been shown. Additionally, flumazenil carries risks of adverse events.<sup>137</sup>

### Risk management considerations to reduce sedation-related complications

Between 2004 and 2008, the UK's former National Patient Safety Agency (NPSA) received reports of 498 midazolam-related patients safety incidents (not exclusive to endoscopy units), including three deaths. Concerns were raised from a

rapid response report of the lack of awareness of the short half-life of the benzodiazepine reversal agent, flumazenil (in comparison with midazolam), leading to residual sedation. Numerous actions were proposed by the NPSA<sup>138</sup> to reduce the risk of midazolam-related adverse events, including some relevant to endoscopy units. In England and Wales, misselection of high-strength midazolam (5 mg/mL or 2 mg/mL instead of 1 mg/mL) during conscious sedation is listed as a 'never event' requiring reporting to NHS England via local incident reporting arrangements.<sup>139</sup>

Key risk management considerations at unit level include preferable stocking and use of only low-strength midazolam (1 mg/mL in 2 mL or 5 mL ampoules) rather than high-strength midazolam (5 mg/mL in 2 mL and 10 mL ampoules or 2 mg/mL in 5 mL ampoules) for conscious sedation in non-anaesthetic settings, ensuring the availability of reversal agents, the development of hospital or departmental policies relating to sedation, with overall responsibility assigned to a senior clinician.<sup>177 138 140</sup>

Evaluation of changes in practice arising over 15 months after the release of the rapid response report from the NPSA showed that there were no incidents resulting in severe harm or death from midazolam-related safety incidents.<sup>141</sup> However, drug-related harm in endoscopy remains a burden to patient safety. The 2019 JAG census of UK endoscopy services showed that drug-related incidents were the most likely patient safety incidents to be reported by endoscopy users,<sup>142</sup> about three-quarters of services had an endoscopy-specific sedation policy, although fewer than half had a named sedation or anaesthetic lead for endoscopy.<sup>142</sup> Similarly, other serious adverse events such as cardiac arrests, significant hypotension or hypoxia requiring intervention should also be reported via local incident reporting systems.

### Special considerations: emergency endoscopy in the sick patient

**26. In the critically ill patient requiring emergency endoscopy, we recommend discussion with the anaesthetic team about the choice of sedation technique and the appropriateness of escalation to critical care**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

There are a limited number of well-established indications for emergency endoscopy, of which acute upper GI bleeding is the most common. Current guidelines recommend performing endoscopy within 24 hours of patient presentation, while emphasising haemodynamic stabilisation before the procedure.<sup>143 144</sup> Emergency ERCP may be required in patients with severe cholangitis who rapidly deteriorate in spite of antibiotic treatment.<sup>145</sup>

Emergency upper GI endoscopy is associated with a higher risk of serious cardiopulmonary complications, including aspiration pneumonia, pulmonary oedema and acute lung injury. Up to 20% of patients in the intensive care unit undergoing upper GI endoscopy for GI bleeding develop new radiographic pulmonary infiltrates, most of which are accompanied by fever, leucocytosis and hypoxaemia.<sup>146</sup> Cardiac arrest is the most feared complication in critically ill patients undergoing emergency endoscopy.<sup>147</sup>

In critically ill patients, decision-making on the choice of sedation, the need for prophylactic intubation prior to endoscopy<sup>148</sup> and the need for intensive care treatment after endoscopy is complex. Factors that favour prophylactic endotracheal

intubation and general anaesthesia include ongoing haematemesis, cardiopulmonary status, altered mental status, targeted level of sedation or a need for protection of the airway.<sup>149</sup> It is also important to note that intubation itself is associated with adverse events, including hypoxaemia and pulmonary aspiration.<sup>150</sup> In one study,<sup>151</sup> prophylactic endotracheal intubation before upper GI endoscopy for brisk upper GI bleeding in critically ill patients was associated with an increased risk of patients developing pneumonia.

There is no universally agreed approach to the level of monitoring and anaesthetic support required for emergency endoscopy in critically ill patients. This needs detailed discussion with the anaesthetic team.

### Special considerations: upper GI endoscopy

**27. There is no evidence to suggest the combination of throat spray and sedation increases the risk of aspiration, although we advise caution in those at increased risk of aspiration.**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Good evidence shows that combining sedation with oropharyngeal anaesthesia improves tolerance and comfort of gastroscopy.<sup>152–155</sup> Topical pharyngeal anaesthesia reduces the gag reflex in patients sedated with propofol.<sup>156</sup> However, concerns have been raised as to whether the combination of throat spray and sedation increases the risk of aspiration pneumonia<sup>152 157–159</sup>; no published evidence is available to substantiate these concerns. The combination of an opiate and benzodiazepine, however, may lead to a better quality examination due to improved patient tolerance.<sup>160</sup>

The risk of aspiration is higher in patients with serious underlying illness, active gastrointestinal bleeding, or those having therapeutic procedures.<sup>8</sup> It is advisable to exercise caution in patients with increased risk of aspiration and, in selected patients, general anaesthesia with airway protection needs to be considered.

**28. We recommend that deep sedation may be required for specific upper GI procedures, such as polypectomy/resection of neoplasia, endoscopic bariatric surgery and foreign body retrieval**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

Therapeutically complex upper GI procedures, such as endoscopic submucosal dissection, bariatric endoscopy and foreign body retrieval, might require prolonged procedure times. This might be further increased by patient movement and safety concerns (gag reflex, cough, oropharyngeal suctioning). Any patient movements might impede the chances of successful completion of a procedure and/or increase the risk of complications—for example, bleeding, perforation or aspiration pneumonia. There is no consensus on the optimal technique of sedation or anaesthesia for these complex procedures.

Studies have described both general anaesthesia and endoscopist-controlled, anaesthetist-maintained sedation protocols for endoscopic submucosal dissection and emergency foreign body retrieval.<sup>161–166</sup> In a study of sedation for upper GI endoscopy in obese patients with gastric bypass,<sup>167</sup> procedure length and not absolute BMI was the predictor of sedation requirement. Thus, in selected patients where procedures are prolonged or therapeutically complex, for example, endoscopic submucosal dissection (particularly in



the upper GI tract), certain foreign body retrieval procedures and prolonged bariatric endoscopy, deep sedation and especially, general anaesthesia may be safer and decrease procedure times.

### Special considerations: EUS/ERCP

Endoscopic ultrasound uses larger echoendoscopes, which are wider and bigger than standard endoscopes and the therapeutic range of EUS is widening significantly.

Endoscopic retrograde cholangiopancreatography is a highly complex procedure used to treat biliary and pancreatic pathologies. The therapeutic range of ERCP has also broadened with the use of cholangioscopy in managing difficult stones and strictures.

EUS and ERCP are also increasingly performed as a double procedure at the same time (eg, diagnostic EUS±biopsy followed by ERCP; and therapeutic EUS following failed ERCP).

**29. We suggest that minimal/moderate sedation is usually adequate in diagnostic EUS and level 1/level 2 ERCP**

*Grade of evidence: Low. Strength of recommendation: Weak.*

*Level of agreement: 100%*

There is no specific evidence to support the level of sedation required for EUS and ERCP. Common practice for performing either ERCP or EUS in UK is with conscious sedation.<sup>168</sup> The availability of a deep sedation/GA service to support these procedures in the UK is currently limited. Diagnostic EUS and non-complex ERCP (grade 1–2) are quicker to perform and usually better tolerated than therapeutic EUS and complex ERCP (grade 3–4). Titrated doses of conscious sedation may be adequate in the majority of these procedures.<sup>169</sup>

It is important to note that even grade 1 and grade 2 ERCP and diagnostic EUS can at times be challenging and prolonged. Apart from the expected procedural complexity, the patient's anxiety level, BMI, ASA class, cardiopulmonary comorbidity, medication history and tolerance of previous procedures under sedation need to be considered when deciding whether mild/moderate sedation is adequate in these patients.

**30. We suggest that complex ERCP, therapeutic EUS and combined EUS+ERCP procedures are performed with deep sedation/general anaesthesia**

*Grade of evidence: Low. Strength of recommendation: Weak*

*Level of agreement: 100%*

Complex ERCP, therapeutic EUS and combined EUS and ERCP procedures take longer even in skilled hands. The range of therapeutic EUS has widened. EUS-guided pseudocyst and gallbladder drainage, EUS-guided bile duct access, vascular therapy and cyst ablation are being performed. Combined EUS and ERCP is a feasible approach to establish a tissue diagnosis, complete local staging and relieve the biliary obstruction in a single session. Ensuring patient comfort and safety and achieving successful completion of these procedures may require significantly higher doses of sedative agents, risking unintended adverse effects.

In a meta-analysis,<sup>170</sup> overall sedation-related side effects were similar between groups of patients receiving propofol or general anaesthesia. Propofol could be a safer alternative to general anaesthesia. It remains unclear whether propofol/GA is safer than conscious sedation, but patients sedated with propofol recover more quickly than patients who receive conscious sedation.<sup>171–175</sup>

### Special considerations: device-assisted enteroscopy (DAE)

**31. We recommend that conscious sedation, deep sedation and GA are all options for DAE. The choice of sedation should be dependent on patient and procedural factors and local resources**

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Device-assisted enteroscopy allows deep intubation into the small bowel for histological sampling and therapeutic intervention. This includes double balloon, single balloon or spiral enteroscopy. The insertion route depends on prior findings of capsule endoscopy or radiology. The average procedure is 75 min or longer for the retrograde route. The technique involves repeated advancement and withdrawal of enteroscope and overtube which results in stretching of the mesentery and might result in pain. Conscious sedation, propofol and general anaesthetic have all been used for DAE. A large German registry highlighted that 0.5% of complications during DAE were related to sedation.<sup>176</sup> While DAE can safely be done on an outpatient basis, in patients with significant comorbidity an inpatient procedure is recommended with prolonged monitoring after the procedure.

Insufficient data currently exist that relate to different DAE techniques or to different insertion routes according to the sedation regimen. Similarly, specific data about patient satisfaction according to sedation or different devices are lacking. Some studies have highlighted that DAE is poorly tolerated under conscious sedation, particularly by the antegrade route.<sup>177</sup> However, there are no prospective randomised trials comparing different sedation techniques in DAE. Evidence to date is mainly from retrospective studies, which suggest no difference in outcomes even when including elderly groups.<sup>178–180</sup>

As for other advanced endoscopic procedures, the choice of sedation regimen depends on patient-related, clinical factors, technical issues (eg, expected procedure duration, planned therapy, etc) and also on local organisational protocols.

Other endoscopic adjuncts should also be considered for DAE. A meta-analysis of four randomised controlled trials (two on double-balloon enteroscopy and two on single-balloon enteroscopy; 461 patients overall, 235 randomised to undergo enteroscopy with air and 226 with CO<sub>2</sub> insufflation) demonstrated that, compared with air, use of CO<sub>2</sub> significantly increased the insertion depth for antegrade enteroscopy, but not for the retrograde approach. The use of CO<sub>2</sub> significantly reduced postprocedure abdominal pain in both retrograde and antegrade DAE.<sup>181</sup>

Use of high-flow supportive nasal oxygen therapy has shown reduction in hypoxaemic events (oxygen desaturation <90% for 60 s or more) in patients undergoing gastroscopy using propofol. These data could be extrapolated for DAE.<sup>182</sup>

### Special considerations: transnasal endoscopy (TNE)

**32. We recommend unsedated transnasal endoscopy as an acceptable alternative to conventional oral endoscopy for routine diagnostic upper endoscopy.**

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 100%*

In patients who require sedation for an upper GI examination but who are unable to have analgesia or sedation, TNE can be considered. TNE is performed without sedation using an ultrathin endoscope (approximate diameter 5–6 mm) inserted via the nasal passages. Despite the smaller diameter, the latest instruments have most of the functionality of standard endoscopes, and numerous studies have shown TNE to have similar effectiveness in routine practice for diagnostic upper GI endoscopy.<sup>183–185</sup>

Studies comparing tolerance for unsedated TNE and conventional transoral oesophagoduodenoscopy (with or without sedation) report better patient tolerance, satisfaction and acceptability for TNE, using a variety of patient, nurse or endoscopist-reported questionnaires.<sup>186–190</sup> Less gagging and discomfort are



reported with TNE, at the expense of more pain on insertion and a risk of mild epistaxis of up to 4%.<sup>191</sup> Patients are also more likely to express a preference to undergo TNE than conventional oral endoscopy in the future.<sup>186 187 191 192</sup> The lack of standardised definitions of discomfort, tolerance and acceptability, the use of subjective and non-validated tools for measurement and lack of blinding in often small studies limits the strength of these findings.

TNE is also an attractive option in patients with comorbidity and at risk of sedation-related complications. Studies have shown that TNE causes fewer effects on cardiovascular function than sedated transoral endoscopy, with less tachycardia and less hypotension in some, but not all, studies.<sup>186 187 190 193</sup> Studies using objective markers of cardiovascular stress, such as pulse rate, systolic blood pressure (SBP) and double product (DP = SBP × heart rate (HR)), rate–pressure product (RPP = HR × SBP/100) or sympathetic stimulation (power spectral analysis), have found less impact on these parameters than with oral endoscopy.<sup>187 190 194</sup> Mori *et al* found that sympathetic stimulation occurred only with oral endoscopy, but not with TNE.<sup>195</sup>

As TNE is performed unsedated, there are no specific sedation-related complications. Other complications and adverse effects are infrequent and limited to minor epistaxis in up to 3–4% and inability to pass the endoscope transnasally due to narrow nasal passages or altered anatomy in 3–8% of patients.<sup>196</sup>

### Special considerations: lower GI endoscopy

**33. We recommend for colonoscopy that alternatives to sedation, including no sedation, inhalational agents and other adjuncts, are considered**

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 100%*

In a case series of 22 725 colonoscopies in the Polish bowel cancer screening programme, the majority of colonoscopies were undertaken without any sedation (64%), and 73% of these patients subsequently reported no discomfort during or after the procedure.<sup>197</sup> In an older case series of colonoscopies, when given the choice, patients were more likely to choose unsedated rather than sedated colonoscopy if they were male or not anxious before the procedure. There was no difference in caecal intubation rate or time to reach the caecum between the two groups. Although unsedated colonoscopy was statistically more uncomfortable, there was no reported difference in the willingness to repeat the procedure if needed in future.<sup>198</sup>

In a randomised controlled trial, Entonox (50% nitrous oxide and 50% oxygen) has been shown to provide better control of pain than sedation, better patient satisfaction and more rapid recovery during colonoscopy.<sup>20</sup> A systematic review concluded that nitrous oxide is as good at controlling pain or discomfort as sedation and safer.<sup>199</sup>

Another randomised trial showed that either water exchange during intubation and carbon dioxide (rather than air) insufflation on extubation or carbon dioxide throughout the procedure reduced discomfort and interference with activities on the day of colonoscopy.<sup>200</sup>

A number of factors can predict pain during endoscopy and guide clinician advice on sedation and alternatives. Female sex, age <40 years, previous abdominal surgery, abdominal pain as an indication for colonoscopy, expectation of pain, a previous painful colonoscopy, previous sexual abuse<sup>201</sup> and a history of diverticulitis were independently associated with pain during colonoscopy.<sup>202</sup>

**34. We suggest that lower GI endoscopy with deep sedation (propofol) or general anaesthesia should be available for selected patients undergoing planned prolonged procedures or complex endotherapy**

*Grade of evidence: Low. Strength of recommendation: Weak.*

*Level of agreement: 100%*

In a systematic review of 20 studies of propofol for colonoscopy, recovery and discharge times were shorter and there was higher patient satisfaction. There was no difference in procedure time, caecal intubation rate or complications.<sup>203</sup> In a more recent case series of 22 725 colonoscopies, in the Polish bowel cancer screening programme, undertaken with no sedation, benzodiazepine/opiate or propofol, independent modifiable factors associated with less pain during the procedure included propofol sedation, adequate bowel preparation, newer endoscopes and high colonoscopy volume endoscopists.<sup>197</sup>

In the UK, the use of propofol has been limited owing to concerns about its narrow therapeutic index, the lack of an antidote, the need for anaesthetic support and the risk of cardio-respiratory complications, especially in the elderly.<sup>3</sup> It has been recommended that propofol (or general anaesthesia) is considered for patients undergoing planned prolonged procedures (>60 min) or complex endotherapy in the colon.<sup>3</sup> Deep sedation can also be considered for selected patients who are unable to tolerate colonoscopy with standard sedation and where alternative procedures are deemed not suitable.

Concerns have been raised about an increased rate of perforation during colonoscopy and an increased rate of aspiration pneumonia and other anaesthetic complications following deep sedation with propofol. In a single-centre retrospective study of 118 000 colonoscopies, deep sedation with propofol was associated with a threefold increased risk of perforation during therapeutic colonoscopy.<sup>204</sup> The results of subsequent large population-based studies of deep sedation and colonoscopy are conflicting, with three having not revealed an increased perforation risk<sup>205–207</sup> and one revealing an increased risk in patients undergoing colonoscopy and polypectomy.<sup>208</sup> All these studies were unable to control for the complexity of polypectomy, and it is possible that the increased risk in two of the studies relates to the underlying polyp and polypectomy rather than the use of deep sedation. However, all of the population-based studies reported an increased risk of aspiration pneumonia or anaesthetic complications with anaesthetic support to provide deep sedation with propofol.<sup>205 207 208</sup>

### Special considerations: high-risk groups

**35. We recommend that clinicians fully discuss with patients at an increased risk from sedation for endoscopy (eg, due to age, frailty or comorbidity), the benefits and potential risks of sedation and alternatives to sedation, including no sedation**

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

The 2004 National Confidential Enquiry into Patient Outcome and Death ‘Scoping our practice’ reviewed 30-day mortality associated with gastrointestinal endoscopy.<sup>209</sup> Of patients who died, 79% had received some form of sedation. Sedation was considered inappropriate in 14% of cases, with excessive drug doses and drug combinations, particularly in the elderly, being identified as issues. Reversal of sedation was needed in 14% of cases, often owing to poor recognition by endoscopists of how sensitive those with comorbidity can be to the effects of sedation and the use of a ‘standard’ dose of sedation, most commonly 5 mg IV midazolam, which was clearly too

**Table 3** Suggested dose adjustments in high-risk groups

High-risk groups	Benzodiazepine	Opioid
Elderly/frail	Reduce dose and increments	Reduce dose and increments
Decompensated chronic liver disease	Reduce dose and increments 50% adult dose	Reduce dose and increments 50% adult dose
Chronic renal failure (eGFR<30)	Reduce dose and increments 50% adult dose	Reduce dose and increments 50% adult dose
Respiratory failure (FVC<50% predicted)	Minimise dose and consider adjunctive NIV	Minimise dose and consider adjunctive NIV
Chronic progressive neuromyopathic disorders (FVC<50% predicted)	Minimise dose and consider adjunctive NIV	Minimise dose and consider adjunctive NIV
NB: Benzodiazepines and opioids act synergistically and if co-administered further dose reduction (by, for example, 30%) should be considered. Short-acting opioids should be preferred. <sup>6,8</sup> eGFR, estimated glomerular filtration rate; FVC, forced vital capacity; NIV, non-invasive ventilation.		

much for many patients. Following the publication of guidelines for standards of colonoscopy training and practice, the safety of sedation for colonoscopy in the UK has improved significantly, with a national audit reporting the use of reversal agents during colonoscopy in only 0.1% in 2011, compared with 14% in 2004.<sup>210 211</sup>

**36. We recommend that frail, elderly or comorbid patients (ASA grade 3 or greater) are given half or less of the dose required for younger healthy patients and need smaller incremental doses, if required**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 92.3%*

Elderly patients (over 70 years of age) are more sensitive to sedative and analgesic drugs than younger patients due to a combination of factors, including age-related pharmacokinetic changes (eg, reduced hepatic and renal drug clearance), increased central sensitivity and blunted cardiorespiratory stimulation by hypoxia or hypercapnia.<sup>212</sup> The dose of any sedation given to the elderly needs to be carefully considered. Subsequent incremental and cumulative doses should also be reduced.<sup>213</sup> Finally, needing to use reversal agents for sedation has also been reported to be more common with increasing ASA grade, when age is adjusted for.<sup>214</sup> Table 3 recommends dose adjustments in high-risk groups.

Capnography has been shown to reduce the incidences of hypoxaemic events during procedural sedation in emergency and elective dental setting.<sup>69 71</sup> Although there is limited evidence of the role of capnography in GI endoscopy, we would recommend its use in this patient group to reduce the risk of adverse events.

**37. We suggest that patients with established cardiovascular disease at high risk of cardiac dysrhythmias undergo ECG monitoring and have supplemental oxygen during endoscopy with sedation**

*Grade of evidence: Low. Strength of recommendation: Weak. Level of agreement: 84.6%*

Cardiopulmonary adverse events are the the most common type of endoscopy-related events, accounting for over 60% of unplanned events during sedated upper GI endoscopy.<sup>215</sup> These include significant cardiovascular events, such as dysrhythmias, angina, myocardial infarction or stroke. Patient-related risk factors for these events include pre-existing cardiopulmonary disease, advancing age, an ASA grade of 3 or above and inpatient status.<sup>109 216 217</sup> An analysis of nearly 2 million endoscopies revealed that age was the key predictor for cardiocerebrovascular events following upper GI endoscopy, which typically occurred within 3 days of endoscopy, but age and sedation were independently associated with such events following colonoscopy.<sup>58</sup>

Sinus bradycardia can be induced by vagal stimulation, which usually occurs during stretching of the sigmoid mesentery during colonoscopy or flexible sigmoidoscopy. More serious

dysrhythmias are rare during endoscopy, but assessing heart rate prior to endoscopy on baseline observations and using ECG monitoring in patients with cardiovascular disease at increased risk of dysrhythmias (eg, pacemaker or known dysrhythmia) is suggested as good practice. In addition, the endoscopist performing the procedure should have sufficient training to interpret ECG and recognition of arrhythmia and when to seek assistance of the cardiology team.

**38. We recommend that patients at risk of myocardial ischaemia during endoscopy with sedation should continue their normal anti-anginal therapy and receive supplemental oxygen before, during and after endoscopy**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

Myocardial infarction can occur either during, or in the few days after, endoscopy with or without sedation. Haemodynamic changes with increased myocardial oxygen demand and reduced myocardial perfusion during endoscopy may contribute.<sup>218</sup> The following measures have been suggested to prevent or minimise the risk of myocardial ischemia/infarction during endoscopy: (1) pre-oxygenation in at risk patients and continuous oxygen during the procedure; (2) continuing normal anti-hypertensive or anti-anginal therapy right up to the endoscopy in all patients with a history of ischaemic heart disease; managing angina during an endoscopy by giving sublingual glyceryl trinitrate, oxygen and discontinuing the examination; and (4) if angina or myocardial infarction is suspected during or following endoscopy, arrange an urgent ECG to exclude myocardial infarction.<sup>218</sup>

**39. We recommend that patients with decompensated chronic liver disease undergoing endoscopy with sedation should be assessed for hepatic encephalopathy prior to endoscopy**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 92.3%*

Chronic liver disease can impair the metabolism of drugs usually administered for sedation for endoscopy. Liver dysfunction can reduce both the clearance of drugs eliminated by hepatic metabolism or biliary excretion and affect plasma protein binding.<sup>219</sup> Chronic liver disease is also associated with a reduction in drug-metabolising activities, such as the activity of the CYP450 enzymes.

In a case series from Pakistan of patients undergoing endoscopy with sedation with midazolam, 4.2% developed clinically overt encephalopathy following endoscopy, although all recovered by 6 hours.<sup>220</sup> This was related to higher Child-Pugh class and midazolam dose. The pre-endoscopy evaluation of patients with Child-Pugh B or C cirrhosis should therefore include an assessment of neuropsychiatric findings suggestive of hepatic encephalopathy.

**40. We recommend patients with hepatic encephalopathy or chronic liver disease with American Society of Anesthesiologists (ASA) grade 4 or more who are undergoing endoscopy should have this undertaken with anaesthetic support**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

General anaesthesia with endotracheal intubation should be considered in patients with decompensated chronic liver disease undergoing endoscopy, if airway protection may be an important clinical issue. This mostly commonly arises in patients with chronic liver disease with gastrointestinal haemorrhage or other complicating factors, such as encephalopathy, that place the patient at high risk of aspiration.<sup>221</sup>

**41. We recommend adjunctive non-invasive ventilation and high-flow oxygen in patients with chronic progressive neuromyopathic disorders and severely impaired respiratory function (forced vital capacity <50% predicted) undergoing endoscopy with conscious sedation.**

*Grade of evidence: Moderate. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Patients with chronic progressive neuromyopathic disorders (eg, motor neurone disease) often require endoscopy for the insertion of a percutaneous endoscopic gastrostomy (PEG) when they cannot safely meet their nutritional needs by the oral route. Traditionally this is done with conscious sedation but PEG insertion without sedation can be acceptable to patients and should be discussed with them prior to endoscopy.<sup>222</sup> Unsedated PEG insertion has been facilitated in patients with chronic progressive neuromyopathic disorders by the availability of ultrathin endoscopes.<sup>223</sup>

We recommend multidisciplinary pre-assessment and management of such patients undergoing endoscopy. This may include gastroenterologists, nutrition teams, neurologists, anaesthetists and respiratory physicians, depending on the indication for endoscopy. Pulmonary function tests and arterial blood gas assessment may be helpful in risk stratification of patients prior to endoscopy. While there is inadequate evidence to mandate this in all patients, it should be considered on a case to case basis.<sup>224</sup> Periprocedural NIV has been used during endoscopy to improve oxygenation and avoid general anaesthesia and its attendant risks.<sup>225</sup> The development of dedicated NIV equipment to permit endoscopy at the same time, allows pre-endoscopy, during endoscopy and postendoscopy NIV to permit safe and effective respiratory support for insertion of PEG tubes with minimal sedation in patients with chronic progressive neuromyopathic disorders.<sup>226 227</sup> There is some evidence that high-flow oxygen reduces the incidence of hypoxia during endoscopy and it may therefore have a role in high-risk groups, such as those with respiratory and neuromyopathic disorders.<sup>85</sup> Extrapolating evidence from other settings, we would recommend capnography in this patient group, to reduce the risk of episodes of hypoxaemia.<sup>69 71</sup>

**42. We recommend that patients with renal impairment (estimated glomerular filtration rate <30 ml/min/1.73 m<sup>2</sup>) undergoing endoscopy with sedation should have their doses of opioids or benzodiazepines reduced**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

In a case series of 500 patients with upper GI bleeding, aspiration pneumonia developed in 4.8% after endoscopic haemostasis.<sup>228</sup> Endotracheal intubation was required for three of them, and one died of the complication. Multivariate analysis revealed that haemodialysis (OR=3.6 (95% CI 1.2 to 11),  $p=0.024$ ) was independently associated with developing aspiration pneumonia.

Midazolam has delayed metabolism and elimination in significant renal impairment, and the dose should be reduced if used for sedation. Opiates also accumulate in significant renal failure, and thus the doses used for sedation at endoscopy should be reduced and shorter-acting opiates are preferable.

**43. We recommend the use of adjunctive non-invasive ventilation (NIV) and high-flow oxygen in patients with respiratory failure undergoing endoscopy**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

A small study of patients with chronic respiratory failure undergoing endoscopy, who were receiving long-term home oxygen therapy, found that the degree of respiratory failure influenced the decrease in oxygen saturation during endoscopy.<sup>229</sup> Cardio-pulmonary adverse events account for over 60% of unplanned events during sedated upper GI endoscopy.<sup>215</sup> These include significant respiratory events, such as oxygen desaturation, aspiration pneumonia and respiratory arrest.

We recommend multidisciplinary pre-assessment and management of such patients undergoing endoscopy. This should include gastroenterologists, anaesthetists and respiratory physicians. Pulmonary function tests and arterial blood gas assessment may be helpful in risk stratification of patients prior to endoscopy. Dedicated NIV equipment for endoscopy permits safe and effective respiratory support for patients with chronic progressive neuromyopathic disorders,<sup>226 227</sup> and this approach would be equally applicable to patients with respiratory failure (forced vital capacity <50% predicted) requiring endoscopy with sedation. Similarly, high-flow oxygen and capnography would also be beneficial and recommended in this group.<sup>85</sup>

### Special considerations: pregnancy and breast feeding

**44. We recommend that sedation providers should be aware of the actions and interactions of sedative agents in pregnant women, including the increased risk of aspiration**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

**45. The use of diazepam in the first trimester has been associated with congenital malformations, whereas no associations have been reported for midazolam. We recommend single doses of midazolam for endoscopic procedures during pregnancy if clinically necessary**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 92.3%*

**46. We recommend that fentanyl, propofol and nitrous oxide (Entonox) can safely be used in pregnancy**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

**47. We recommend that breast feeding does not need to be suspended after a single intravenous dose of midazolam, fentanyl or pethidine (or when used in combination), or after administration of propofol**

*Grade of evidence: Low. Strength of recommendation: Strong. Level of agreement: 100%*

### Pregnancy

Endoscopic procedures can be required in pregnant and breast feeding women and some conditions are more prevalent in these patients—for example, gallstones. First and foremost, the risks to the patient need to be considered, both from performing an endoscopy and from opting for alternative, non-endoscopic management. From a sedation perspective there are some additional risks that need to be considered—namely, an increased

**Table 4** Drugs in pregnancy and breast feeding

Agent	Pregnancy	Breast feeding
Local anaesthetic throat spray	Compatible for use	Compatible for use
Nitrous oxide	Compatible for use	Compatible for use
Hyoscine	Single dose probably safe if needed	Compatible for use
Benzodiazepines	Diazepam to be avoided Midazolam can be used for procedural sedation	Breast feeding can continue when mother alert and awake
Opioids	Compatible for use	Breast feeding can continue when mother awake and alert
Propofol	Compatible for use	Breast feeding can continue when mother alert and awake

risk of aspiration as pregnancy progresses and the possibility of medication-related effects on the fetus, particularly early in pregnancy.<sup>230 231</sup> Additionally, positioning for endoscopy can become more challenging later in pregnancy, particularly for procedures such as ERCP, which again may increase the aspiration risk. Early anaesthetic involvement is important to assess whether deep sedation or general anaesthesia with airway protection should be considered. If conscious sedation is deemed appropriate then the lowest effective doses should be administered. Opiates and propofol appear to have the best safety profile

Prolonged use of diazepam has been associated with neurological birth defects, but no study has examined single doses of midazolam used for an endoscopic procedure in this setting.<sup>232</sup> If a benzodiazepine is needed then midazolam is recommended. **Table 4** delineates recommendations for drugs used in endoscopy in the pregnant patient or those who are breast feeding.

#### Breast feeding

In general, most sedative and anaesthetic agents have poor oral bioavailability and although some are excreted into breast milk, the concentrations are low.<sup>233</sup> Midazolam is excreted into breast milk, but the levels are virtually undetectable around 7 hours after administration, with studies finding a level of 0.004% of the maternal dose within 24 hours.<sup>234 235</sup> The latest national guidance suggests that breast feeding can recommence once the patient has recovered enough cognitive function.<sup>233 236</sup> Fentanyl is excreted into breast milk, but the levels are 0.024% within 24 hours of administration, meaning that breast feeding does not need to be suspended.<sup>235 236</sup> Pethidine is metabolised to normeperidine, which can cause neurotoxic effects. Normeperidine is concentrated in breast milk and has been associated with neurological effects in breastfeeding children, but one study showed that this was seen only in infants under 6 weeks old.<sup>237</sup> However, there is no evidence that a single intravenous dose of pethidine leads to significant toxicity in breastfeeding infants. Propofol is excreted into breast milk but at very low levels and the oral bioavailability is low. Breast feeding after propofol does not need to be suspended and can be resumed as soon as the patient has recovered from anaesthesia.<sup>125 233 236</sup>

#### Adjunctive medications

Several other medications are regularly used in patients undergoing gastrointestinal endoscopy, including local anaesthetic agents, nitrous oxide and hyoscine. Local anaesthetic agents have been shown to cause fetal bradycardia when used intravenously, but the amounts used in topical throat spray are unlikely to cause problems for either the unborn child or the breastfeeding infant. Nitrous oxide is commonly used during labour and is safe. Nitrous oxide is eliminated extremely quickly and therefore has no consequences for the breastfeeding infant.

Regular use of hyoscine is not recommended in pregnancy, but this can be a useful adjunct in both colonoscopy and ERCP. Fortunately, these procedures are rarely required in pregnancy but should a single dose of hyoscine be required then this could be considered. There appear to be no consequences of using hyoscine during breast feeding. **Table 4** details safety of drugs in pregnancy.

#### Special considerations: transition group

**48. We recommend that young patients undergoing endoscopy should participate in a structured transition programme, including education around the choice of sedative agents**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

**49. We recommend that information about the risks and benefits of endoscopy with sedation should be tailored to the individual young person**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

Young patients (aged 16–18 years) undergoing endoscopy may be having investigation or endoscopic therapy for a chronic condition for which they have been under the care of paediatric services. Young people transitioning from paediatric to adult services (with previous experience of endoscopy under a general anaesthetic) will probably benefit from participating in a structured transition programme.<sup>238</sup> Such patients might have undergone previous procedures under general anaesthetic. This might influence their expectations and preconceptions when they move into adult services, where general anaesthetic is not routinely used for most endoscopic procedures.

For all young patients, a discussion about the choice of sedation and alternatives (such as the use of a general anaesthetic) will be framed on a case-by-case basis. Factors such as patient anxiety, complexity and length of the procedures should be taken into account.

Young people (16–18 years) are presumed to have capacity to consent for endoscopic procedures.<sup>22</sup> Parents and other primary caregivers may assist in the discussions with the young person about the procedure. Information should be provided in a format that is suitable for the individual patient. The intended effect of sedation in a young person is the same as in an adult population—that is, to facilitate a successful endoscopic procedure by minimising anxiety or discomfort.<sup>239</sup>

#### Special considerations: including learning disability

**50. We recommend that in patients with cognitive impairment and/or learning disability, an assessment of capacity is carried out to inform the discussion around choice of sedation**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*



*Level of agreement: 100%*

**51. We recommend that if during a sedated endoscopy, the patient appears to be tolerating the procedure poorly, the endoscopist should stop the procedure (if safe to do so) in order to assess the patient's wishes and decide if the procedure should be abandoned and alternatives arranged**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 92.3%*

There is primary legislation covering capacity in England, Wales and Scotland.<sup>240 241</sup> In Northern Ireland, common law governs decision-making around medical interventions in those who lack capacity.<sup>242</sup> In all parts of the UK, the laws governing the medical care of patients who lack capacity presume that an adult has capacity unless it has been clearly established that they do not. For patients with cognitive impairment or learning disability, an assessment of capacity should therefore be undertaken to determine if the patient is able to give consent for the procedure.

The mental capacity legal framework allows for the use of proxy decision-makers (lasting power of attorney relevant to health and welfare or a court-appointed deputy), an advanced directive/statement and the use of an independent mental capacity advocate. The process of consent takes into account the patient's best interests.

The consent process will include a consideration of the use and risk of sedation and potential alternatives, such as general anaesthetic or investigations that do not use sedative drugs. In order to share information about the procedure with the patient, information may need to be provided in a number of different formats. Pictures and/or verbal descriptions may be more appropriate than written information for some patients, and the patient's preferred method of communication should be ascertained to facilitate consent.

Preparation for a procedure undertaken under sedation requires a period of psychological preparation.<sup>1</sup> This may be particularly pertinent for patients with learning disabilities. Carers play an important role in preparing the patient for the procedure and in facilitating the consent process. Learning disability teams exist in most hospitals and should be used to support the consent process for this patient group.

A full set of recommendations relating to consent for patients undergoing gastrointestinal endoscopy with and without capacity is provided in separate BSG guidance.<sup>22</sup>

During an endoscopic procedure, if a patient appears to be tolerating the procedure poorly or gives any other indication that they wish the procedure to stop, the endoscopist should, if possible, stop the procedure and attempt to establish the patient's concerns. It may be appropriate to recommence the endoscopy following reassurance or the administration of further sedation. The administration of sedation in patients with prior capacity may lead to a degree of cognitive impairment such that it can be difficult to assess capacity during the test. If the endoscopist establishes that the patient has capacity and wishes the procedure to be discontinued (withdrawal of consent), the procedure should be stopped, unless this would result in the patient coming to immediate harm. If a patient, regardless of capacity, has persistent distress, termination of the procedure should be considered and alternatives discussed and arranged.

### Special considerations: lone working

**52. We recommend that a minimum of two appropriately trained endoscopy assistants are required for endoscopic procedures in which sedation has been administered**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

**53. We recommend that sedation should be administered only if there is immediate access to the resources (staff and facilities) required to manage complications of sedation**

*Grade of evidence: Very Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

For patients undergoing deep sedation, a dedicated sedationist will be present. For most endoscopic procedures undertaken under conscious sedation, the endoscopist will be the person responsible for administering sedative drugs. While performing the endoscopic procedure, the operator may have insufficient situational awareness to monitor the patient's condition safely. A minimum of two endoscopy assistants is required.<sup>1</sup> While one assistant may be assisting with the endoscopic procedure, the other assistant should be entirely focused on monitoring the patient and is responsible for alerting the endoscopist to any important changes.

In the event of a complication of sedation arising, such as respiratory depression or a cardiorespiratory arrest, the endoscopy assistant should have the skills to assist in managing the medical emergency. Endoscopy assistants should have appropriate training (and timely retraining) to undertake this role.

Some endoscopy is undertaken in units outside an acute hospital. Sedation should only be administered in the non-hospital setting if adverse events related to sedation can be immediately managed. The range of facilities (including immediate access to a resuscitation trolley) and the skills of available staff that can be immediately mobilised in the event of a complication of sedation should be commensurate to that available in an acute hospital.<sup>1</sup>

### Training

**54. We recommend that all endoscopy staff responsible for risk assessing, administering sedation and monitoring of patients, undergo formal training in the recognition and management of related complications, and this should be a continuing process**

*Grade of evidence: Low. Strength of recommendation: Strong.*

*Level of agreement: 100%*

### Current gap in training

Appropriate training in sedation practices and in the recognition and management of potential complications are vital aspects of training for endoscopists. In the UK, the 2004 National Confidential Enquiry into Patient Outcome and Death (NCEPOD)<sup>209</sup> highlighted an existing gap in sedation training for endoscopists, with only 35% of surveyed endoscopists having attended a sedation course. A subsequent survey of UK gastroenterology higher specialty trainees a few years later showed that only 49% had received sedation training.<sup>243</sup> The need for formal training for all practitioners providing sedation has been recognised as a matter of priority by the RCoA<sup>140</sup> and the AoMRC.<sup>1 77</sup>

### Available curricula

The Multisociety Sedation Curriculum for Gastrointestinal Endoscopy,<sup>125</sup> the Society of Gastroenterology and Endoscopy Nurses and Associates (ESGE/ESGENA)<sup>244</sup> and the UK AoMRC<sup>77</sup> have provided curricula and competency assessment guidance for sedation training. A common denominator across all guidelines is the need for training in both theoretical and practical skills related to sedation and potential associated

complications, involving both endoscopists and assisting staff. The training must include recognition of airway compromise, with inadvertent entry into a deeper plane of sedation than intended, in addition to basic life support for all staff within endoscopy. In addition, at least one member of the endoscopy team within every room should have training in immediate life support according to RCoA guidance. All endoscopy units should ensure this recommendation on immediate life support training is implemented in the next 2 years.

Formal evaluation of such training programmes to demonstrate improved objective patient safety outcomes is, however, lacking.<sup>4 245</sup>

In the UK, JAG have endorsed multiple national endoscopy courses for trainees, focusing on the knowledge and technical and non-technical skills required to perform safe endoscopies. The basic upper GI and lower GI courses are mandatory for trainees wishing to attain full certification in respective endoscopic modalities.<sup>246</sup> Some objectives relating to sedation competencies are covered in most of these courses, but the content does not cover the breadth and depth offered by the ESGE/ESGENA<sup>244</sup> (online supplemental appendix 3) and expected by the AoMRC (online supplemental appendix 4).<sup>1</sup> Unsurprisingly, a previous survey of UK gastroenterology trainees has highlighted gaps in trainees' knowledge on sedation agents.<sup>243</sup> To increase the validity of training courses on safe sedation by non-anaesthetists, the RCoA also recommends the involvement of anaesthetists in the training of non-anaesthetists in the provision of safe sedation.<sup>140</sup> A commercial 'National Safe Sedation' course, endorsed by the Academy of Medical Royal Colleges, and supported by the RCoA is available to UK trainees but not mandated.<sup>13 247</sup>

### Guideline implications for service providers

The recommendations in this guideline might have implications for endoscopy services, including significant costs. Although most units have existing robust processes to ensure the quality and safety of endoscopic procedures, the clinical landscape is continually evolving, with the ability to perform increasingly complex, and/or prolonged procedures in ageing and often frail patients. The importance of individualised patient consent that emphasises proportionality of risk has been highlighted in GMC<sup>91</sup> and BSG guidance,<sup>22</sup> and this extends to choice of sedation method(s) for endoscopy. Units may need to review information provided to patients regarding sedation, including alternatives—for example, general anaesthesia, use of no sedation, etc, in their consent and pre-assessment processes. Use of non-pharmacological interventions as adjuncts to sedation and regular auditing of patient experience of sedation might also have implications for services, as might the recommendation that patients with OSA or with a BMI  $\geq 35$  kg/m<sup>2</sup> should undergo formal pre-assessment.

The recommendation for ECG monitoring and consideration of capnography for specific groups and patients having procedures under deep sedation or GA might have implications for equipment costs and training, but many of these procedures will be performed in operating theatres where such facilities already exist. The expanded use of deep sedation or GA support for patients undergoing interventional procedures such as complex ERCP, interventional EUS or DAE might also impact units where these are currently performed under mild-moderate sedation. The recommendations for enhanced monitoring, including monitoring of patients with established cardiac disease, the need for anaesthetic support for patients with advanced chronic liver disease (eg, ASA grade 4, hepatic encephalopathy) and the

availability of non-invasive ventilation (NIV) high-flow oxygen and capnography for those with severe neuromyopathic disease or respiratory failure might also have implications for service providers.

Lastly, there is a need to ensure that all endoscopy staff involved in the care of patients undergoing sedation have formal training in safe sedation practices, including the recognition and management of sedation-related complications and this should be a career-long continuing process. This might require additional funding for training courses.

The use of inhalational agents (Entonox) as an alternative to sedation has implications for the environment and sustainability. Hospitals should review the overall gas strategy in every department, and scavenging and catalytic destruction systems should be considered.

### Areas for development, audit and research

Many of the recommendations in this guideline are based on low-quality evidence, which is a limitation, and there is need for further audit and research in many areas of sedation practice for GI endoscopy.

The impact of PREMs as quality metrics to measure patient experience of comfort and sedation during endoscopic procedures merits further research.

The impact of pre-assessment, especially in reducing adverse events in patients at higher risk of sedation-related complications, requires further evaluation. This includes patients with OSA, BMI  $\geq 35$  kg/m<sup>2</sup>, those with significant cardiorespiratory disease or other major comorbidities. Similarly, the role of ECG monitoring in these patients merits further study. Within this guideline, we have recommended the use of capnography as per RCoA, for specific high-risk groups and prolonged procedures under moderate sedation. This warrants further study including a NICE technology appraisal to clarify the value of these interventions in these patient groups to support additional funding of infrastructure and personnel training. The GDG would modify these recommendations if future studies showed clear benefit in other patient populations or procedures.

There is low-quality evidence that many adverse events occur late after endoscopy—for example, infections, thromboembolic or circulatory events, and large scale, prospective studies of the true rate of late postendoscopy, sedation-related complications are required.

We have not suggested any change to the recommendation that patients should not drive, operate machinery, etc for 24 hours following sedation to remain in line with recommendations of other authorities (RCoA, BNF) but this merits further study, recognising that such research may be logistically difficult to design and undertake. Various factors can affect patient comfort levels, including previous abuse. The evidence in this area is lacking and merits further study in the future.

### Author affiliations

<sup>1</sup>Academic Department of Gastroenterology, Royal Hallamshire Hospital, Sheffield, UK

<sup>2</sup>Department of Infection, Immunity & Cardiovascular Disease, The University of Sheffield, Sheffield, UK

<sup>3</sup>Department of Anaesthetics, Royal Hallamshire Hospital, Sheffield, UK

<sup>4</sup>Department of Gastroenterology, University Hospital Llandough, Llandough, UK

<sup>5</sup>Institute of Life Sciences, Swansea University, Swansea, UK

<sup>6</sup>Hepato-Pancreato-Biliary Unit, Freeman Hospital, Newcastle upon Tyne, UK

<sup>7</sup>Newcastle University Population Health Sciences Institute, Newcastle upon Tyne, UK

<sup>8</sup>Airedale NHS Foundation Trust, Keighley, UK

<sup>9</sup>Department of Gastroenterology, University Hospital of North Midlands, Stoke-on-Trent, UK

<sup>10</sup>Department of Gastroenterology, Liverpool University Hospitals NHS Foundation Trust, Liverpool, UK

<sup>11</sup>Specialist Pharmacist Breastfeeding and Medication, Portsmouth, UK

<sup>12</sup>Digestive Diseases Unit, Kettering General Hospital; Kettering, Kettering, UK

<sup>13</sup>Department of Population Health Sciences, College of Life Science, University of Leicester, Leicester, UK

<sup>14</sup>Department of Gastroenterology, University College London, UK, London, UK

<sup>15</sup>Department of Gastroenterology, South Tyneside District Hospital, South Shields, UK

<sup>16</sup>Patient Representative on Guideline Development Group and member of Independent Cancer Patients' Voice, Sheffield, UK

<sup>17</sup>Patient Representative on Guideline Development Group, Manchester, UK

<sup>18</sup>Department of Gastroenterology, Sandwell General Hospital, West Bromwich, UK

<sup>19</sup>Centre for Liver and Digestive Disorders, Royal Infirmary Edinburgh, Edinburgh, UK

**Twitter** Reena Sidhu @drreenasidhu1, John S Leeds @Nendoscopy, Mohammad Farhad Peerally @FarhadPeerally2, Manu Nayar @drmanuknayar and Ian Penman @Gastronautan

**Acknowledgements** The authors gratefully acknowledge the contributions and support of Dr Stuart Gittens, ECD Solutions in assisting with the online voting platform.

**Contributors** HH undertook the literature search and initial sorting of manuscripts. Subsequent review of manuscripts was undertaken by Core Writing Group leads: JSL (type of sedation, LN (patient information, choice and expectations), RS (pre-assessment), CH (procedure room requirements), DT (deep sedation and sedation protocols), CH and SB (recovery and discharge), MFP (complications relating to sedation agents and reversal agents and training), SH (upper GI endoscopy, endoscopic ultrasound and endoscopic retrograde cholangio-pancreatography), MN (endoscopic ultrasound/endoscopic retrograde cholangio-pancreatography), RS (device-assisted endoscopy), IP (transnasal endoscopy), NJT (lower GI endoscopy and high-risk groups), JSL (pregnancy and breast feeding), PC (transition groups, learning disability and lone working). PICO Statements and guideline statements were developed within these working groups by all members. All members contributed to discussion and voting (organised by HNH through ECD Solutions). All core writing group leads contributed to manuscript writing within their group. RS completed all other sections including all revisions and provided responses to all comments from the stakeholders. Lay members contributed comments to all parts of the manuscript preparation, including structure of the domains, the lay summary and with particular input on the section on patient information, choice and expectation. All other authors fulfil the ICMJE recommendations for authorship with appropriate involvement at all stages of the guideline development process, and drafting of the manuscript.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Disclaimer** These Guidelines have been endorsed by the Joint Advisory Group, British Society of Gastroenterology Nurses Association (BSGNA), Association of Coloproctology Great Britain & Northern Ireland (ACPGBI), United Kingdom & Ireland EUS Society (UKIEUS) and the Royal College of Anaesthetists (RCoA).

**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Ethics approval** Not applicable.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

## ORCID iDs

Reena Sidhu <http://orcid.org/0000-0003-0820-2400>

John S Leeds <http://orcid.org/0000-0002-5140-6225>

Manu Nayar <http://orcid.org/0000-0002-1196-3406>

Nigel J Trudgill <http://orcid.org/0000-0002-8040-8158>

## REFERENCES

- 1 AoMRC. Practice for healthcare. 2013. Available: [https://www.aomrc.org.uk/wp-content/uploads/2016/05/Safe\\_Sedation\\_Practice\\_1213.pdf](https://www.aomrc.org.uk/wp-content/uploads/2016/05/Safe_Sedation_Practice_1213.pdf)
- 2 Rajasekhar PT, Clifford GM, Lee TJW, *et al*. Bowel cancer screening is safe, detects earlier stage cancer and adenomas in 50% of cases: experience of the prevalent round of screening from two first wave centres in the north east of England. *Frontline Gastroenterol* 2012;3:10–5.
- 3 Sidhu R, Turnbull D, Newton M, *et al*. Deep sedation and anaesthesia in complex gastrointestinal endoscopy: a joint position statement endorsed by the British Society of Gastroenterology (BSG), Joint Advisory Group (JAG) and Royal College of Anaesthetists (RCoA). *Frontline Gastroenterol* 2019;10:141–7.
- 4 Manno M, Deiana S, Gabbani T, *et al*. Implementation of the European Society of Gastrointestinal Endoscopy (ESGE) and European Society of Gastroenterology and Endoscopy Nurses and Associates (ESGENA) sedation training course in a regular endoscopy unit. *Endoscopy* 2021;53:65–71.
- 5 McQuaid KR, Laine L. A systematic review and meta-analysis of randomized, controlled trials of moderate sedation for routine endoscopic procedures. *Gastrointest Endosc* 2008;67:910–23.
- 6 Medicines.org. Midazolam 1 mg/ml solution for injection or infusion. n.d. Available: <https://www.medicines.org.uk/emc/product/6419/smpc#grf>
- 7 Gemma M, Pennoni F, Tritto R, *et al*. Risk of adverse events in gastrointestinal endoscopy: zero-inflated Poisson regression mixture model for count data and multinomial logit model for the type of event. *PLoS One* 2021;16:e0253515.
- 8 Kitagawa E, Iida A, Kimura Y, *et al*. Responses to intravenous sedation by elderly patients at the Hokkaido University dental hospital. *Anesth Prog* 1992;39:73–8.
- 9 Rees CJ, Thomas Gibson S, Rutter MD, *et al*. UK key performance indicators and quality assurance standards for colonoscopy. *Gut* 2016;65:1923–9.
- 10 Nordt SP, Clark RF. Midazolam: a review of therapeutic uses and toxicity. *J Emerg Med* 1997;15:357–65.
- 11 Kilpatrick GJ. Remimazolam: non-clinical and clinical profile of a new sedative/ anesthetic agent. *Front Pharmacol* 2021;12:690875.
- 12 Yamamoto T, Kurabe M, Kamiya Y. Re-sleeping after reversal of remimazolam by flumazenil. *J Anesth* 2021;35:322.
- 13 Chen S-H, Yuan T-M, Zhang J, *et al*. Remimazolam tosylate in upper gastrointestinal endoscopy: a multicenter, randomized, non-inferiority, phase III trial. *J Gastroenterol Hepatol* 2021;36:474–81.
- 14 Zhu X, Wang H, Yuan S, *et al*. Efficacy and safety of remimazolam in endoscopic sedation-a systematic review and meta-analysis. *Front Med* 2021;8:655042.
- 15 Drugs.com. Fentanyl side effects\_ common, severe, long term - drugs. 2023. Available: <https://www.drugs.com/sfx/fentanyl-side-effects.html>
- 16 Mather LE, Meffin PJ. Clinical pharmacokinetics of pethidine. *Clin Pharmacokinet* 1978;3:352–68.
- 17 Robertson AR, Kennedy NA, Robertson JA, *et al*. Colonoscopy quality with Entonox(®) vs intravenous conscious sedation: 18608 colonoscopy retrospective study. *World J Gastrointest Endosc* 2017;9:471.
- 18 Ball AJ, Din S, Donnelly M, *et al*. A randomized controlled trial comparing continuous and as-required nitrous oxide use during screening colonoscopy. *Eur J Gastroenterol Hepatol* 2015;27:271–8.
- 19 Forbes GM, Collins BJ. Nitrous oxide for colonoscopy: a randomized controlled study. *Gastrointest Endosc* 2000;51:271–7.
- 20 Maslekar S, Gardiner A, Hughes M, *et al*. Randomized clinical trial of Entonox versus midazolam-fentanyl sedation for colonoscopy. *Br J Surg* 2009;96:361–8.
- 21 Maslekar S, Balaji P, Gardiner A, *et al*. Randomized controlled trial of patient-controlled sedation for colonoscopy: Entonox vs modified patient-maintained target-controlled propofol. *Colorectal Dis* 2011;13:48–57.
- 22 Everett SM, Griffiths H, Nandasoma U, *et al*. Guideline for obtaining valid consent for gastrointestinal endoscopy procedures. *Gut* 2016;65:1585–601.
- 23 Rollbusch N, Mikocka-Walus AA, Andrews JM. The experience of anxiety in colonoscopy outpatients: a mixed-method study. *Gastroenterol Nurs* 2014;37:166–75.
- 24 Neilson LJ, Patterson J, von Wagner C, *et al*. Patient experience of gastrointestinal endoscopy: informing the development of the Newcastle ENDOPREM™. *Frontline Gastroenterol* 2020;11:209–17.
- 25 Quinn L, Kelly ME, Khan A, *et al*. Sedation for gastroscopy: is it an adequately understood and informed choice? *Ir J Med Sci* 2016;185:785–9.
- 26 Yang C, Srianjan V, Abou-Setta AM, *et al*. Anxiety associated with colonoscopy and flexible sigmoidoscopy: a systematic review. *Am J Gastroenterol* 2018;113:1810–8.
- 27 Parker S, Zipursky J, Ma H, *et al*. A web-based multimedia program before colonoscopy increased knowledge and decreased anxiety, sedation requirement, and procedure time. *J Clin Gastroenterol* 2018;52:519–23.



- 28 Liu YY, Liu YQ, Petrini MA. Effect of information of patients' coping style on pregastroscopy anxiety. *Gastroenterol Nurs* 2018;41:47–58.
- 29 Shafer LA, Walker JR, Waldman C, et al. Factors associated with anxiety about colonoscopy: the preparation, the procedure, and the anticipated findings. *Dig Dis Sci* 2018;63:610–8.
- 30 NHS England. *The NHS constitution for England - GOV.UK*. 2017: 1–60. Available: <https://www.gov.uk/government/publications/the-nhs-constitution-for-england/the-nhs-constitution-for-england>
- 31 Denters MJ, Schreuder M, Depla ACTM, et al. Patients' perception of colonoscopy: patients with inflammatory bowel disease and irritable bowel syndrome experience the largest burden. *Eur J Gastroenterol Hepatol* 2013;25:964–72.
- 32 Mikocka-Walus AA, Moulds LG, Rollbusch N, et al. It's a tube up your bottom; it makes people nervous': the experience of anxiety in initial colonoscopy patients. *Gastroenterol Nurs* 2012;35:392–401.
- 33 McGoran J, Bennett A, Cooper J, et al. Acceptability to patients of screening disposable transnasal endoscopy: qualitative interview analysis. *BMJ Open* 2019;9:e030467.
- 34 Paggi S, Radaelli F, Amato A, et al. Unsedated colonoscopy: an option for some but not for all. *Gastrointest Endosc* 2012;75:392–8.
- 35 Blokzijl SJ, Lamberts KF, van der Waaij LA, et al. Short article: willingness to undergo colonoscopy with virtual reality instead of procedural sedation and analgesia. *Eur J Gastroenterol Hepatol* 2019;31:334–9.
- 36 McEntire J, Sahota J, Hydes T, et al. An evaluation of patient attitudes to colonoscopy and the importance of endoscopist interaction and the endoscopy environment to satisfaction and value. *Scand J Gastroenterol* 2013;48:366–73.
- 37 Ekkelenkamp VE, Dowler K, Valori RM, et al. Patient comfort and quality in colonoscopy. *World J Gastroenterol* 2013;19:2355–61.
- 38 Rostom A, Ross ED, Dubé C, et al. Development and validation of a nurse-assessed patient comfort score for colonoscopy. *Gastrointest Endosc* 2013;77:255–61.
- 39 Telford J, Tavakoli I, Takach O, et al. Validation of the St. Paul's Endoscopy Comfort Scale (SPECS) for colonoscopy. *J Can Assoc Gastroenterol* 2020;3:91–5.
- 40 Brown S, Bevan R, Rubin G, et al. Patient-derived measures of GI endoscopy: a meta-narrative review of the literature. *Gastrointest Endosc* 2015;81:1130–40.
- 41 Heuss LT, Sughanda SP, Degen LP. Endoscopy teams' judgment of discomfort among patients undergoing colonoscopy: 'how bad was it really' *Swiss Med Wkly* 2012;142:w13726.
- 42 Black N, Jenkinson C. Measuring patients' experiences and outcomes. *BMJ* 2009;339:b2495.
- 43 Rees CJ, Trebble TM, Von Wagner C, et al. British Society of Gastroenterology position statement on patient experience of GI endoscopy. *Gut* 2020;69:1.
- 44 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 European Gastroenterol J* 2017;5:309–34.
- 45 Neilson LJ, Sharp L, Patterson JM, et al. The Newcastle ENDOPREM™: a validated patient reported experience measure for gastrointestinal endoscopy. *BMJ Open* 2021;8:e000653.
- 46 Forbes N, Chau M, Koury HF, et al. Development and validation of a patient-reported scale for tolerability of endoscopic procedures using conscious sedation. *Gastrointest Endosc* 2021;94:103–10.
- 47 Bal BS, Crowell MD, Kohli DR, et al. What factors are associated with the difficult-to-sedate endoscopy patient? *Dig Dis Sci* 2012;57:2527–34.
- 48 Chung K-C, Juang S-E, Lee K-C, et al. The effect of pre-procedure anxiety on sedative requirements for sedation during colonoscopy. *Anaesthesia* 2013;68:253–9.
- 49 Yang M, Lu L-L, Zhao M, et al. Associations of anxiety with discomfort and tolerance in Chinese patients undergoing esophagogastroduodenoscopy. *PLoS One* 2019;14:e0212180.
- 50 Wang MC, Zhang LY, Zhang YL, et al. Effect of music in endoscopy procedures: systematic review and meta-analysis of randomized controlled trials. *Pain Med* 2014;15:1786–94.
- 51 Spagnuolo R, Corea A, Blumetti M, et al. Effects of listening to music in digestive endoscopy: a prospective intervention study led by nursing. *J Adv Nurs* 2020;76:2993–3002.
- 52 Umezawa S, Higurashi T, Uchiyama S, et al. Visual distraction alone for the improvement of colonoscopy-related pain and satisfaction. *World J Gastroenterol* 2015;21:4707–14.
- 53 Sjölander A, Jakobsson Ung E, Theorell T, et al. Hospital design with nature films reduces stress-related variables in patients undergoing colonoscopy. *HERD* 2019;12:186–96.
- 54 Liu Q, Zang Y, Zang W, et al. Implementation of virtual reality technology to decrease patients' pain and nervousness during colonoscopies: a prospective randomised controlled single-blinded trial. *Clin Med* 2022;22:clinmed.
- 55 Enestvedt BK, Eisen GM, Holub J, et al. Is the American Society of Anesthesiologists classification useful in risk stratification for endoscopic procedures? *Gastrointest Endosc* 2013;77:464–71.
- 56 Finkelmeier F, Tal A, Ajouaou M, et al. ERCP in elderly patients: increased risk of sedation adverse events but low frequency of post-ERCP pancreatitis. *Gastrointest Endosc* 2015;82:1051–9.
- 57 Kitano R, Inoue T, Ibusuki M, et al. Safety and efficacy of endoscopic retrograde cholangiopancreatography in patients with performance status 4. *Dig Dis Sci* 2021;66:1291–6.
- 58 Kim SY, Moon CM, Kim MH, et al. Impacts of age and sedation on cardiocerebrovascular adverse events after diagnostic GI endoscopy: a nationwide population-based study. *Gastrointest Endosc* 2020;92:591–602.
- 59 Kollmann CM, Schmiegell W, Brechmann T. Gastrointestinal endoscopy under sedation is associated with pneumonia in older inpatients—results of a retrospective case-control study. *United European Gastroenterol J* 2018;6:382–90.
- 60 Andrade CM, Patel B, Vellanki M, et al. Safety of gastrointestinal endoscopy with conscious sedation in obstructive sleep apnea. *World J Gastrointest Endosc* 2017;9:552–7.
- 61 Leslie K, Allen ML, Hessian EC, et al. Safety of sedation for gastrointestinal endoscopy in a group of university-affiliated hospitals: a prospective cohort study. *Br J Anaesth* 2017;118:90–9.
- 62 Mehta PP, Kochhar G, Kalra S, et al. Can a validated sleep apnea scoring system predict cardiopulmonary events using propofol sedation for routine EGD or colonoscopy? A prospective cohort study. *Gastrointest Endosc* 2014;79:436–44.
- 63 Boese ML, Ransom RK, Roadfuss RJ, et al. Utility of the Berlin questionnaire to screen for obstructive sleep apnea among patients receiving intravenous sedation for colonoscopy. *AANA J* 2014;82:38–45.
- 64 Chung F, Abdullah HR, Liao P. STOP-bang questionnaire: a practical approach to screen for obstructive sleep apnea. *Chest* 2016;149:631–8.
- 65 Liou S-C, Hsu C-M, Chen C, et al. Assessment of the Berlin questionnaire for evaluation of hypoxemia risk in subjects undergoing deep sedation for screening gastrointestinal endoscopy. *Ther Clin Risk Manag* 2018;14:1331–6.
- 66 Nay M-A, Fromont L, Eugene A, et al. High-flow nasal oxygenation or standard oxygenation for gastrointestinal endoscopy with sedation in patients at risk of hypoxaemia: a multicentre randomised controlled trial (ODEPHI trial). *Br J Anaesth* 2021;127:133–42.
- 67 Mador MJ, Nadler J, Mreyoud A, et al. Do patients at risk of sleep apnea have an increased risk of cardio-respiratory complications during endoscopy procedures? *Sleep Breath* 2012;16:609–15.
- 68 Suzuki M, Fujimoto S, Sakamoto K, et al. Clinical usefulness of end-tidal CO(2) measured using a portable capnometer in patients with respiratory disease. *Clin Respir J* 2023;17:96–104.
- 69 Cook T, Woodall N, Frerk C. Major complications of airway management in the United Kingdom. In: *Report and findings. Fourth Natl Audit Proj R Coll Anaesth Difficult Airw Soc*. 2011: 1–219. Available: [https://www.nationalauditprojects.org.uk/downloads/NAP4 Full Report.pdf](https://www.nationalauditprojects.org.uk/downloads/NAP4%20Full%20Report.pdf)
- 70 Corbett G, Pugh P, Herrie J, et al. Service evaluation of the impact of capnography on the safety of procedural sedation. *Front Med* 2022;9:867536.
- 71 Parker W, Estrich CG, Abt E, et al. Benefits and harms of capnography during procedures involving moderate sedation: a rapid review and meta-analysis. *J Am Dent Assoc* 2018;149:38–50.
- 72 Mallampati SR, Gatt SP, Gugino LD, et al. A clinical sign to predict difficult tracheal intubation: a prospective study. *Can Anaesth Soc J* 1985;32:429–34.
- 73 Dossa F, Megetto O, Yakubu M, et al. Sedation practices for routine gastrointestinal endoscopy: a systematic review of recommendations. *BMC Gastroenterol* 2021;21:22.
- 74 Dunkley I, Griffiths H, Follows R, et al. UK consensus on non-medical staffing required to deliver safe, quality-assured care for adult patients undergoing gastrointestinal endoscopy. *Frontline Gastroenterol* 2019;10:24–34.
- 75 AoMRC. Safe sedation practice for healthcare procedures an update. 2021. Available: [https://www.aomrc.org.uk/wp-content/uploads/2021/0/https://www.aomrc.org.uk/wp-content/uploads/2021/02/Safe\\_sedation\\_practice\\_for\\_healthcare\\_procedures\\_update\\_0521.pdf](https://www.aomrc.org.uk/wp-content/uploads/2021/0/https://www.aomrc.org.uk/wp-content/uploads/2021/02/Safe_sedation_practice_for_healthcare_procedures_update_0521.pdf)
- 76 Hinkelbein J, Lamperti M, Akeson J, et al. European Society of Anaesthesiology and European Board of Anaesthesiology guidelines for procedural sedation and analgesia in adults. *Eur J Anaesthesiol* 2018;35:6–24.
- 77 AoMRC. Safe sedation practice for healthcare procedures an update. 2021. Available: <https://www.aomrc.org.uk/wp-content/uploads/2021/0>
- 78 Cohen LB, Deleage MH, Aisenberg J, et al. AGA Institute review of endoscopic sedation. *Gastroenterology* 2007;133:675–701.
- 79 Youn AM, Ko Y-K, Kim Y-H. Anesthesia and sedation outside of the operating room. *Korean J Anesthesiol* 2015;68:323–31.
- 80 Antonelli MT, Seaver D, Urman RD. Procedural sedation and implications for quality and risk management. *J Healthc Risk Manag* 2013;33:3–10.
- 81 Carayon P, Schoofs Hundt A, Karsh B-T, et al. Work system design for patient safety: the SEIPS model. *Qual Saf Health Care* 2006;15 Suppl 1:i50–8.
- 82 Holden RJ, Carayon P, Gurses AP, et al. SEIPS 2.0: a human factors framework for studying and improving the work of healthcare professionals and patients. *Ergonomics* 2013;56:1669–86.
- 83 Cullinane M, Gray AJG, Hargraves CMK, et al. The 2004 report of the National confidential enquiry into patient outcome and death. In: *2004 Rep Natl Confid Enq into Patient Outcome Death*. 2004: 191. Available: [https://www.ncepod.org.uk/2004report/Full\\_Report\\_2004.pdf%0Ahttp://www.ncepod.org.uk/pdf/2004/Full\\_Report\\_2004.pdf](https://www.ncepod.org.uk/2004report/Full_Report_2004.pdf%0Ahttp://www.ncepod.org.uk/pdf/2004/Full_Report_2004.pdf)



- 84 Shimizu H, Homma Y, Norii T, *et al.* Incidence of adverse events among elderly vs non-elderly patients during procedural sedation and analgesia with propofol. *Am J Emerg Med* 2021;44:411–4.
- 85 Tao Y, Sun M, Miao M, *et al.* High flow nasal cannula for patients undergoing bronchoscopy and gastrointestinal endoscopy: a systematic review and meta-analysis. *Front Surg* 2022;9:949614.
- 86 Turnbull D. High-flow nasal oxygen, procedural sedation, and clinical governance. *Minerva Anesthesiol* 2022;88:407–10.
- 87 Practice guidelines for moderate procedural sedation and analgesia 2018: a report by the American Society of Anesthesiologists task force on moderate procedural sedation and analgesia, the American Association of Oral and Maxillofacial Surgeons, American College of Radiology, American Dental Association, American Society of Dentist Anesthesiologists, and Society of Interventional Radiology. *Anesthesiology* 2018;128:437–79.
- 88 Herzog M, Rudzki M, Plöbl S, *et al.* Depth of sedation during drug induced sedation endoscopy monitored by bispectral index® and cerebral state index®. *Sleep Breath* 2021;25:1029–35.
- 89 Lin Y-J, Wang Y-C, Huang H-H, *et al.* Target-controlled propofol infusion with or without bispectral index monitoring of sedation during advanced gastrointestinal endoscopy. *J Gastroenterol Hepatol* 2020;35:1189–95.
- 90 Conway A, Ersotelos S, Sutherland J, *et al.* Forced air warming during sedation in the cardiac catheterisation laboratory: a randomised controlled trial. *Heart* 2018;104:685–90.
- 91 GMC. Good medical practice. n.d. Available: <https://www.gmc-uk.org/ethical-guidance/ethical-guidance-for-doctors/good-medical-practice><https://www.gmc-uk.org/ethical-guidance/ethical-guidance-for-doctors/good-medical-practice>
- 92 RCoSeng. Good surgical practice. n.d. Available: <https://www.rcseng.ac.uk/standards-and-research/gsp/>
- 93 World Health Organization. Global patient safety action plan 2021–2030:towards eliminating avoidable harm E ahealth care. 2021. Available: <https://www.who.int/teams/integrated-health-services/patient-safety/policy/global-patient-safety-action-plan>
- 94 Pickard S, Marshall M, Rogers A, *et al.* User involvement in clinical governance. *Health Expect* 2002;5:187–98.
- 95 Veenstra GL, Ahaas K, Welker GA, *et al.* Rethinking clinical governance: healthcare professionals' views: a Delphi study. *BMJ Open* 2017;7:e012591.
- 96 Thomas M. The evidence base for clinical governance. *J Eval Clin Pract* 2002;8:251–4.
- 97 Long DM. Competency based residency training: the next advance in graduate medical education. *Acta Neurochir Suppl* 2001;78:153–8.
- 98 Crespo J, Terán Á. Endoscopy and sedation: an inseparable binomial for the gastroenterologist. *Rev Esp Enferm Dig* 2018;110:250–2.
- 99 Bailey CR, Ahuja M, Bartholomew K, *et al.* Guidelines for day-case surgery 2019: guidelines from the Association of Anaesthetists and the British Association of Day Surgery. *Anaesthesia* 2019;74:778–92.
- 100 GMC-UK. Domain 3: communication partnership and teamwork - ethical guidance - GMC. 2012. Available: <https://www.gmc-uk.org/ethical-guidance/ethical-guidance-for-doctors/good-medical-practice/domain-3---communication-partnership-and-teamwork#paragraph-39>
- 101 NICE. British national formulary (BNF). n.d. Available: <https://bnf.nice.org.uk/>
- 102 RCoA. Caring for someone recovering from a general anaesthetic or sedation. 2021: 1–3. Available: <https://www.rcoa.ac.uk/sites/default/files/documents/2021-11/12-SedationCarer2021web.pdf>
- 103 Royal College of Anaesthetists. Sedation explained. 2021: 6–7. Available: <https://www.rcoa.ac.uk/sites/default/files/documents/2019-10/12-SedationExplainedweb.pdf>
- 104 Latto IP, Molloy MJ, Rosen M. Arterial concentrations of nitrous oxide during intermittent patient-controlled inhalation of 50 percent nitrous oxide in oxygen (Entonox) during the first stage of labour. *Br J Anaesth* 1973;45:1029–34.
- 105 The essential guide @ BOC: living healthcare. n.d. Available: [https://www.boconline.co.uk/wcsstore/UK\\_BOC\\_Industrial\\_Ntl\\_Store/pdf/downloads/Entonox-essential-guide.pdf](https://www.boconline.co.uk/wcsstore/UK_BOC_Industrial_Ntl_Store/pdf/downloads/Entonox-essential-guide.pdf)
- 106 Sebastian S, Dhar A, Baddeley R, *et al.* Green endoscopy: British Society of Gastroenterology (BSG), Joint Accreditation Group (JAG) and Centre for Sustainable Health (CSH) joint consensus on practical measures for environmental sustainability in endoscopy. *Gut* 2023;72:12–26.
- 107 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.
- 108 Qadeer MA, Vargo JJ, Khandwala F, *et al.* Propofol versus traditional sedative agents for gastrointestinal endoscopy: a meta-analysis. *Clin Gastroenterol Hepatol* 2005;3:1049–56.
- 109 Sharma VK, Nguyen CC, Crowell MD, *et al.* A national study of cardiopulmonary unplanned events after GI endoscopy. *Gastrointest Endosc* 2007;66:27–34.
- 110 Rex DK, Deenadayalu VP, Eid E, *et al.* Endoscopist-directed administration of propofol: a worldwide safety experience. *Gastroenterology* 2009;137:1229–37.
- 111 Behrens A, Labenz J, Schuler A, *et al.* How safe is sedation in gastrointestinal endoscopy? A multicentre analysis of 388,404 endoscopies and analysis of data from prospective registries of complications managed by members of the working group of leading hospital gastroenterologists (ALGK). *Z Gastroenterol* 2013;51:432–6.
- 112 Jun J, Han JI, Choi AL, *et al.* Adverse events of conscious sedation using midazolam for gastrointestinal endoscopy. *Anesth Pain Med* 2019;14:401–6.
- 113 Cashman JN, Dolin SJ. Respiratory and haemodynamic effects of acute postoperative pain management: evidence from published data. *Br J Anaesth* 2004;93:212–23.
- 114 Khanna AK, Overdyk FJ, Greening C, *et al.* Respiratory depression in low acuity hospital settings-seeking answers from the PRODIGY trial. *J Crit Care* 2018;47:80–7.
- 115 Ayad S, Khanna AK, Iqbal SU, *et al.* Characterisation and monitoring of postoperative respiratory depression: current approaches and future considerations. *Br J Anaesth* 2019;123:378–91.
- 116 Overdyk FJ, Carter R, Maddox RR, *et al.* Continuous oximetry/capnometry monitoring reveals frequent desaturation and bradypnea during patient-controlled analgesia. *Anesth Analg* 2007;105:412–8.
- 117 Overdyk F, Dahan A, Roozkrans M, *et al.* Opioid-induced respiratory depression in the acute care setting: a compendium of case reports. *Pain Manag* 2014;4:317–25.
- 118 Practice guidelines for the prevention, detection, and management of respiratory depression associated with neuraxial opioid administration: an updated report by the American Society of Anesthesiologists task force on neuraxial opioids and the American Society of Regional Anesthesia and Pain Medicine. *Anesthesiology* 2016;124:535–52.
- 119 Morse J, Bamias G. Ability to reverse deeper levels of unintended sedation. *Digestion* 2010;82:94–6.
- 120 National endoscopy database. n.d. Available: <https://nedpilot.thejag.org.uk/>
- 121 Naloxone hydrochloride \_ drugs \_ BNF \_ NICE. n.d. Available: <https://bnf.nice.org.uk/drug/naloxone-hydrochloride.html#sideEffects>
- 122 Balsells F, Wyllie R, Kay M, *et al.* Use of conscious sedation for lower and upper gastrointestinal endoscopic examinations in children, adolescents, and young adults: a twelve-year review. *Gastrointest Endosc* 1997;45:375–80.
- 123 Greenwald B. Narcan use in the endoscopy lab: an important component of patient safety. *Gastroenterol Nurs* 2004;27:20–1.
- 124 Miller DL, Wall RT. Fentanyl and diazepam for analgesia and sedation during radiologic special procedures. *Radiology* 1987;162:195–8.
- 125 American Association for Study of Liver Diseases, American College of Gastroenterology, American Gastroenterological Association Institute, *et al.* Multisociety sedation curriculum for gastrointestinal endoscopy. *Gastrointest Endosc* 2012;76:e1–25.
- 126 Mora CT, Torjman M, White PF. Sedative and ventilatory effects of midazolam infusion: effect of flumazenil reversal. *Can J Anaesth* 1995;42:677–84.
- 127 Waring JP, Baron TH, Hirota WK, *et al.* Guidelines for conscious sedation and monitoring during gastrointestinal endoscopy. *Gastrointest Endosc* 2003;58:317–22.
- 128 Flumazenil \_ drugs \_ BNF \_ NICE. n.d. Available: <https://bnf.nice.org.uk/drugs/flumazenil/>
- 129 Fassoulaki A, Theodoraki K, Melemani A. Pharmacology of sedation agents and reversal agents. *Digestion* 2010;82:80–3.
- 130 Spivey WH. Flumazenil and seizures: analysis of 43 cases. *Clin Ther* 1992;14:292–305.
- 131 Mordel A, Winkler E, Almog S, *et al.* Seizures after flumazenil administration in a case of combined benzodiazepine and tricyclic antidepressant overdose. *Crit Care Med* 1992;20:1733–4.
- 132 Kankaria A, Lewis JH, Ginsberg G, *et al.* Flumazenil reversal of psychomotor impairment due to midazolam or diazepam for conscious sedation for upper endoscopy. *Gastrointest Endosc* 1996;44:416–21.
- 133 Spinelli P, Pacilli P, Scignano A. Clinical use of flumazenil (Ro 15-1788) after endoscopic procedures. *Endoscopy* 1988;20:86.
- 134 Mathus-Vliegen EMH, de Jong L, Kos-Foekema HA. Significant and safe shortening of the recovery time after flumazenil-reversed midazolam sedation. *Dig Dis Sci* 2014;59:1717–25.
- 135 Alarcón Fernández O, Baudet Arteaga JS, Sánchez del Río A, *et al.* Utility of routine use of reversion after sedation in outpatient colonoscopy. *Gastroenterol Hepatol* 2005;28:10–4.
- 136 Lee SP, Sung I-K, Kim JH, *et al.* Efficacy and safety of flumazenil injection for the reversal of midazolam sedation after elective outpatient endoscopy. *J Dig Dis* 2018;19:93–101.
- 137 Penninga EI, Graudal N, Ladekarl MB, *et al.* Adverse events associated with flumazenil treatment for the management of suspected benzodiazepine intoxication-a systematic review with meta-analyses of randomised trials. *Basic Clin Pharmacol Toxicol* 2016;118:37–44.
- 138 Lamont T, Matthew L, Cousins D, *et al.* Avoiding midazolam overdose: summary of a safety report from the National Patient Safety Agency. *BMJ* 2009;339:b4459.
- 139 NHS Improvement. Never events list 2018 (revised in 2021). 2021: 1–22. Available: [https://improvement.nhs.uk/documents/2266/Never\\_Events\\_list\\_2018\\_FINAL\\_v5.pdf](https://improvement.nhs.uk/documents/2266/Never_Events_list_2018_FINAL_v5.pdf)

- 140 Turnbull D, Krovvidi H, Gannon J. Chapter 7 guidelines for the provision of anaesthesia services (GPAS) in the non-theatre environment. 2020. Available: <https://www.rcoa.ac.uk/sites/default/files/documents/2020-02/GPAS-2020-07-ANTE.pdf>
- 141 Flood C, Matthew L, Marsh R, *et al.* Reducing risk of overdose with midazolam injection in adults: an evaluation of change in clinical practice to improve patient safety in England. *J Eval Clin Pract* 2015;21:57–66.
- 142 Ravindran S, Bassett P, Shaw T, *et al.* Improving safety and reducing error in endoscopy (ISREE): a survey of UK services. *Frontline Gastroenterol* 2021;12:593–600.
- 143 Gralnek IM, Stanley AJ, Morris AJ, *et al.* Endoscopic diagnosis and management of nonvariceal upper gastrointestinal hemorrhage (NVUGIH): European Society of Gastrointestinal Endoscopy (ESGE) guideline - update 2021. *Endoscopy* 2021;53:300–32.
- 144 Kim JS, Kim B-W, Kim DH, *et al.* Guidelines for nonvariceal upper gastrointestinal bleeding. *Gut Liver* 2020;14:560–70.
- 145 Lekharaju VPK, Iqbal J, Noorullah O, *et al.* Emergency endoscopic retrograde cholangiopancreatography in critically ill patients is a safe and effective procedure. *Frontline Gastroenterol* 2013;4:138–42.
- 146 Lipper B, Simon D, Cerrone F. Pulmonary aspiration during emergency endoscopy in patients with upper gastrointestinal hemorrhage. *Crit Care Med* 1991;19:330–3.
- 147 Goudra B, Nuzat A, Singh P, *et al.* Cardiac arrests in patients undergoing gastrointestinal endoscopy: a retrospective analysis of 73,029 procedures. *Saudi J Gastroenterol* 2015;21:400.
- 148 Rehman A, Iscimen R, Yilmaz M, *et al.* Prophylactic endotracheal intubation in critically ill patients undergoing endoscopy for upper GI hemorrhage. *Gastrointest Endosc* 2009;69:e55–9.
- 149 Wayne JD. Intubation and sedation in patients who have emergency upper GI endoscopy for GI bleeding. *Gastrointestinal Endosc* 2000;51:768–71.
- 150 Griesdale DEG, Bosma TL, Kurth T, *et al.* Complications of endotracheal intubation in the critically ill. *Intensive Care Med* 2008;34:1835–42.
- 151 Hayat U, Lee PJ, Ullah H, *et al.* Association of prophylactic endotracheal intubation in critically ill patients with upper GI bleeding and cardiopulmonary unplanned events. *Gastrointest Endosc* 2017;86:500–9.
- 152 Beg S, Ragunath 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.
- 153 Basturk A, Artan R, Yilmaz A. Investigation of efficacy of lidocaine spray for sedated esophagogastroduodenoscopy in children. *Pediatr Gastroenterol Hepatol Nutr* 2017;20:87–93.
- 154 Campo R, Brullet E, Montserrat A, *et al.* Topical pharyngeal anesthesia improves tolerance of upper gastrointestinal endoscopy: a randomized double-blind study. *Endoscopy* 1995;27:659–64.
- 155 Evans LT, Saberi S, Kim HM, *et al.* Pharyngeal anesthesia during sedated EGDs: is 'the spray' beneficial? A meta-analysis and systematic review. *Gastrointest Endosc* 2006;63:761–6.
- 156 Heuss LT, Hanhart A, Dell-Kuster S, *et al.* Propofol sedation alone or in combination with pharyngeal lidocaine anesthesia for routine upper GI endoscopy: a randomized, double-blind, placebo-controlled, non-inferiority trial. *Gastrointest Endosc* 2011;74:1207–14.
- 157 Quine MA, Bell GD, McCloy RF, *et al.* Prospective audit of upper gastrointestinal endoscopy in two regions of England: safety, staffing, and sedation methods. *Gut* 1995;36:462–7.
- 158 Prout BJ, Metreweli C. Pulmonary aspiration after fibre-endoscopy of the upper gastrointestinal tract. *BMJ* 1972;4:269–71.
- 159 Green SM, Mason KP, Krauss BS. Pulmonary aspiration during procedural sedation: a comprehensive systematic review. *Br J Anaesth* 2017;118:344–54.
- 160 Khan KJ, Fergani H, Ganguli SC, *et al.* The benefit of fentanyl in effective sedation and quality of upper endoscopy: a double-blinded randomized trial of fentanyl added to midazolam versus midazolam alone for sedation. *J Can Assoc Gastroenterol* 2019;2:86–90.
- 161 Rong Q-H, Zhao G-L, Xie J-P, *et al.* Feasibility and safety of endoscopic submucosal dissection of esophageal or gastric carcinomas under general anesthesia. *Med Princ Pract* 2013;22:280–4.
- 162 Nonaka S, Kawaguchi Y, Oda I, *et al.* Safety and effectiveness of propofol-based monitored anesthesia care without intubation during endoscopic submucosal dissection for early gastric and esophageal cancers. *Dig Endosc* 2015;27:665–73.
- 163 Yoo YC, Park CH, Shin S, *et al.* A comparison of sedation protocols for gastric endoscopic submucosal dissection: moderate sedation with analgesic supplementation vs analgesia targeted light sedation. *Br J Anaesth* 2015;115:84–8.
- 164 Park CH, Shin S, Lee SK, *et al.* Assessing the stability and safety of procedure during endoscopic submucosal dissection according to sedation methods: a randomized trial. *PLoS One* 2015;10:e0120529.
- 165 Kim SH, Choi YS, Lee SK, *et al.* Comparison of general anesthesia and conscious sedation in procedure-related complications during esophageal endoscopic submucosal dissection. *Surg Endosc* 2020;34:3560–6.
- 166 Cha M-H, Sandooja R, Khalid S, *et al.* Complication rates in emergent endoscopy for foreign bodies under different sedation modalities: a large single-center retrospective review. *World J Gastrointest Endosc* 2021;13:45–55.
- 167 Jirapinyo P, Abu Dayyeh BK, Thompson CC. Conscious sedation for upper endoscopy in the gastric bypass patient: prevalence of cardiopulmonary adverse events and predictors of sedation requirement. *Dig Dis Sci* 2014;59:2173–7.
- 168 Triantafyllidis JK, Merikas E, Nikolakis D, *et al.* Sedation in gastrointestinal endoscopy: current issues. *World J Gastroenterol* 2013;19:463–81.
- 169 Akhter A, Patel R, Nelsen E, *et al.* Prospective comparison of moderate conscious sedation and anesthesia assistance for the performance of endoscopic retrograde cholangiopancreatography (ERCP). *Can J Gastroenterol Hepatol* 2021;2021:8892085.
- 170 Dhaliwal A, Dhindsa BS, Saghir SM. Choice of sedation in endoscopic retrograde cholangiopancreatography: is monitored anesthesia care as safe as general anesthesia? A systematic review and meta-analysis. *Ann Gastroenterol* 2021;34:879–87.
- 171 Kongkam P, Rerknimitr R, Punyathavorn S, *et al.* Propofol infusion versus intermittent meperidine and midazolam injection for conscious sedation in ERCP. *J Gastrointest Liver Dis* 2008;17:291–7.
- 172 Vargo JJ, Zuccaro G Jr, Dumot JA, *et al.* Gastroenterologist-administered propofol versus meperidine and midazolam for advanced upper endoscopy: a prospective, randomized trial. *Gastroenterology* 2002;123:8–16.
- 173 Garewal D, Powell S, Milan SJ, *et al.* Sedative techniques for endoscopic retrograde cholangiopancreatography. *Cochrane Database Syst Rev* 2012:CD007274.
- 174 Redondo-Cerezo E, Sánchez-Robaina A, Martínez Cara JG, *et al.* Gastroenterologist-guided sedation with propofol for endoscopic ultrasonography in average-risk and high-risk patients: a prospective series. *Eur J Gastroenterol Hepatol* 2012;24:506–12.
- 175 Campbell JA, Irvine AJ, Hopper AD. Endoscopic ultrasound sedation in the United Kingdom: is life without propofol tolerable? *World J Gastroenterol* 2017;23:560.
- 176 Möschler O, May A, Müller M, *et al.* Complications in and performance of double-balloon enteroscopy (DBE): results from a large prospective DBE database in Germany. *Endoscopy* 2011;43:484–9.
- 177 Byeon J-S, Jung KW, Song H-S, *et al.* A pilot study about tolerability to double balloon endoscopy: comparison to esophagogastroduodenoscopy and colonoscopy. *Dig Dis Sci* 2009;54:2434–40.
- 178 Sidhu R, Sanders DS. Double-balloon enteroscopy in the elderly with obscure gastrointestinal bleeding: safety and feasibility. *Eur J Gastroenterol Hepatol* 2013;25:1230–4.
- 179 Chetcuti Zammit S, Sanders DS, Sidhu R. Device assisted enteroscopy in the elderly - a systematic review and meta-analysis. *Dig Liver Dis* 2019;51:1249–56.
- 180 Tanaka S, Mitsui K, Tatsuguchi A, *et al.* Current status of double balloon endoscopy - indications, insertion route, sedation, complications, technical matters. *Gastrointest Endosc* 2007;66:S30–3.
- 181 Nishizawa T, Suzuki H, Fujimoto A, *et al.* Effects of carbon dioxide insufflation in balloon-assisted enteroscopy: a systematic review and meta-analysis. *United European Gastroenterol J* 2016;4:11–7.
- 182 Lin Y, Zhang X, Li L, *et al.* High-flow nasal cannula oxygen therapy and hypoxia during gastroscopy with propofol sedation: a randomized multicenter clinical trial. *Gastrointest Endosc* 2019;90:591–601.
- 183 Arantes V, Albuquerque W, Salles JMP, *et al.* Effectiveness of unsedated transnasal endoscopy with white-light, flexible spectral imaging color enhancement, and lugol staining for esophageal cancer screening in high-risk patients. *J Clin Gastroenterol* 2013;47:314–21.
- 184 Kawai T, Takagi Y, Yamamoto K, *et al.* Narrow-band imaging on screening of esophageal lesions using an ultrathin transnasal endoscopy. *J Gastroenterol Hepatol* 2012;27 Suppl 3:34–9.
- 185 Shariff MK, Varghese S, O'Donovan M, *et al.* Pilot randomized crossover study comparing the efficacy of transnasal disposable endosheath with standard endoscopy to detect Barrett's esophagus. *Endoscopy* 2016;48:110–6.
- 186 Ai Z-L, Lan C-H, Fan L-L, *et al.* Unsedated transnasal upper gastrointestinal endoscopy has favorable diagnostic effectiveness, cardiopulmonary safety, and patient satisfaction compared with conventional or sedated endoscopy. *Surg Endosc* 2012;26:3565–72.
- 187 Alexandridis E, Inglis S, McAvoy NC, *et al.* Randomised clinical study: comparison of acceptability, patient tolerance, cardiac stress and endoscopic views in transnasal and transoral endoscopy under local anaesthetic. *Aliment Pharmacol Ther* 2014;40:467–76.
- 188 Kadayifci A, Atar M, Parlar S, *et al.* Transnasal endoscopy is preferred by transoral endoscopy experienced patients. *J Gastrointest Liver Dis* 2014;23:27–31.
- 189 Knuth J, Kunze DE, Benz C, *et al.* Is the transnasal access for esophagogastroduodenoscopy in routine use equal to the transoral route? A prospective, randomized trial. *Z Gastroenterol* 2013;51:1369–76.
- 190 Miyake K, Kusunoki M, Ueki N, *et al.* Classification of patients who experience a higher distress level to transoral esophagogastroduodenoscopy than to transnasal esophagogastroduodenoscopy. *Dig Endosc* 2013;25:397–405.

- 191 Kadayifci A, Parlar S, Aydinli M, *et al.* Unsedated transnasal versus conventional oral endoscopy in endoscopy naïve patients. *Acta Gastroenterol Belg* 2014;77:224–8.
- 192 Sami SS, Dunagan KT, Johnson ML, *et al.* A randomized comparative effectiveness trial of novel endoscopic techniques and approaches for Barrett's esophagus screening in the community. *Am J Gastroenterol* 2015;110:148–58.
- 193 Castro Filho EC, Perazzo H, Guimaraes RAP, *et al.* Reliability and safety of transnasal compared to conventional endoscopy for detecting oesophageal varices in cirrhotic patients. *Liver Int* 2018;38:1418–26.
- 194 Uchiyama K, Ishikawa T, Sakamoto N, *et al.* Analysis of cardiopulmonary stress during endoscopy: is unsedated transnasal esophagogastroduodenoscopy appropriate for elderly patients? *Can J Gastroenterol Hepatol* 2014;28:31–4.
- 195 Mori A, Ohashi N, Tatebe H, *et al.* Autonomic nervous function in upper gastrointestinal endoscopy: a prospective randomized comparison between transnasal and oral procedures. *J Gastroenterol* 2008;43:38–44.
- 196 Parker C, Alexandridis E, Plevris J, *et al.* Transnasal endoscopy: no gagging no panic! *Frontline Gastroenterol* 2016;7:246–56.
- 197 Bugajski M, Wieszczy P, Hoff G, *et al.* Modifiable factors associated with patient-reported pain during and after screening colonoscopy. *Gut* 2018;67:1958–64.
- 198 Aljebreen AM, Almadi MA, Leung FW. Sedated vs unsedated colonoscopy: a prospective study. *World J Gastroenterol* 2014;20:5113–8.
- 199 Aboumarzouk OM, Agarwal T, Syed Nong Chek SAH, *et al.* Nitrous oxide for colonoscopy. *Cochrane Database Syst Rev* 2011:CD008506.
- 200 Cadoni S, Falt P, Gallittu P, *et al.* Impact of carbon dioxide insufflation and water exchange on postcolonoscopy outcomes in patients receiving on-demand sedation: a randomized controlled trial. *Gastrointest Endosc* 2017;85:210–8.
- 201 Nicolai MPJ, Keller JJ, de Vries L, *et al.* The impact of sexual abuse in patients undergoing colonoscopy. *PLoS One* 2014;9:e85034.
- 202 Holme O, Bretthauer M, de Lange T, *et al.* Risk stratification to predict pain during unsedated colonoscopy: results of a multicenter cohort study. *Endoscopy* 2013;45:691–6.
- 203 Singh H, Poluha W, Cheung M, *et al.* Propofol for sedation during colonoscopy. *Cochrane Database Syst Rev* 2008; :CD006268.
- 204 Adeyemo A, Bannazadeh M, Riggs T, *et al.* Does sedation type affect colonoscopy perforation rates *Dis Colon Rectum* 2014;57:110–4.
- 205 Cooper GS, Kou TD, Rex DK. Complications following colonoscopy with anesthesia assistance: a population-based analysis. *JAMA Intern Med* 2013;173:551–6.
- 206 Bielawska B, Day AG, Lieberman DA, *et al.* Risk factors for early colonoscopic perforation include non-gastroenterologist endoscopists: a multivariable analysis. *Clin Gastroenterol Hepatol* 2014;12:85–92.
- 207 Bielawska B, Hooke LC, Sutradhar R, *et al.* Anesthesia assistance in outpatient colonoscopy and risk of aspiration pneumonia, bowel perforation, and splenic injury. *Gastroenterology* 2018;154:77–85.
- 208 Wernli KJ, Brenner AT, Rutter CM, *et al.* Risks associated with anesthesia services during colonoscopy. *Gastroenterology* 2016;150:888–94.
- 209 Cullinane M, Gray AJG, Hargraves CMK, *et al.* The 2004 report of the National confidential enquiry into patient outcome and death. In: *2004 Rep Natl Confid Enq into Patient Outcome Death*. 2004: 191.
- 210 Bowles CJA, Leicester R, Romaya C, *et al.* A prospective study of colonoscopy practice in the UK today: are we adequately prepared for national colorectal cancer screening tomorrow *Gut* 2004;53:277–83.
- 211 Gavin DR, Valori RM, Anderson JT, *et al.* The National Colonoscopy Audit: a nationwide assessment of the quality and safety of colonoscopy in the UK. *Gut* 2013;62:242–9.
- 212 ASGE Standards of Practice Committee, Chandrasekhara V, Early DS, *et al.* Modifications in endoscopic practice for the elderly. *Gastrointest Endosc* 2013;78:1–7.
- 213 Lord D, Bell G, Gray A, *et al.* Sedation for gastrointestinal endoscopic procedures in the elderly: getting safer but still not nearly safe enough. *BSG* 2006:1–14.
- 214 Hung A, Marshall J, Barnett S, *et al.* Risk factors and outcomes of reversal agent use in moderate sedation during endoscopy and colonoscopy. *J Clin Gastroenterol* 2016;50:e25–9.
- 215 ASGE Standards of Practice Committee, Ben-Menachem T, Decker GA, *et al.* Adverse events of upper GI endoscopy. *Gastrointest Endosc* 2012;76:707–18.
- 216 Clarke GA, Jacobson BC, Hammett RJ, *et al.* The indications, utilization and safety of gastrointestinal endoscopy in an extremely elderly patient cohort. *Endoscopy* 2001;33:580–4.
- 217 Gangi S, Saidi F, Patel K, *et al.* Cardiovascular complications after GI endoscopy: occurrence and risks in a large hospital system. *Gastrointest Endosc* 2004;60:679–85.
- 218 Amornyotin S. Sedation-related complications in gastrointestinal endoscopy. *World J Gastrointest Endosc* 2013;5:527–33.
- 219 Bamji N, Cohen LB. Endoscopic sedation of patients with chronic liver disease. *Clin Liver Dis* 2010;14:185–94.
- 220 Haq MM, Faisal N, Khalil A, *et al.* Midazolam for sedation during diagnostic or therapeutic upper gastrointestinal endoscopy in cirrhotic patients. *Eur J Gastroenterol Hepatol* 2012;24:1214–8.
- 221 Edelson J, Suarez AL, Zhang J, *et al.* Sedation during endoscopy in patients with cirrhosis: safety and predictors of adverse events. *Dig Dis Sci* 2020;65:1258–65.
- 222 Steed H, Barrett D, Emm C, *et al.* Unsedated percutaneous endoscopic gastrostomy insertion: a safe, effective, and well-tolerated method. *JPEN J Parenter Enteral Nutr* 2012;36:231–4.
- 223 Sato Y, Goshi S, Kawauchi Y, *et al.* Safety of unsedated PEG placement using transoral ultrathin endoscopy in patients with amyotrophic lateral sclerosis. *Nutritional Neuroscience* 2017;20:71–5.
- 224 Thompson AG, Blackwell V, Marsden R, *et al.* A risk stratifying tool to facilitate safe late-stage percutaneous endoscopic gastrostomy in ALS. *Amyotroph Lateral Scler Frontotemporal Degener* 2017;18:243–8.
- 225 Pieri M, Landoni G, Cabrin L. Noninvasive ventilation during endoscopic procedures: rationale, clinical use, and devices. *J Cardiothorac Vasc Anesth* 2018;32:928–34.
- 226 Wikman-Jorgensen P, Llenas-García J, Hobbins M, *et al.* Microscopic observation drug susceptibility assay for the diagnosis of TB and MDR-TB in HIV-infected patients: a systematic review and meta-analysis. *Eur Respir J* 2014;44:973–84.
- 227 Gaspar R, Ramalho R, Coelho R, *et al.* Percutaneous endoscopic gastrostomy placement under NIV in amyotrophic lateral sclerosis with severe ventilatory dysfunction: a safe and effective procedure. *GE Port J Gastroenterol* 2023;30:61–7.
- 228 Kawanishi K, Kato J, Toda N, *et al.* Risk factors for aspiration pneumonia after endoscopic hemostasis. *Dig Dis Sci* 2016;61:835–40.
- 229 Fujimura M, Ishiura Y, Myou S, *et al.* Cardiopulmonary complications during gastroscopy in patients with chronic respiratory failure undergoing long-term home oxygen therapy. *Endoscopy* 2000;32:33–6.
- 230 Baron TH, Ramirez B, Richter JE. Gastrointestinal motility disorders during pregnancy. *Ann Intern Med* 1993;118:366.
- 231 Bruno JM, Kroser J. Efficacy and safety of upper endoscopy procedures during pregnancy. *Gastrointest Endosc Clin N Am* 2006;16:33–40.
- 232 Dolovich LR, Addis A, Vaillancourt JMR, *et al.* Benzodiazepine use in pregnancy and major malformations or oral cleft: meta-analysis of cohort and case-control studies. *BMJ* 1998;317:839–43.
- 233 Mitchell J, Jones W, Winkley E, *et al.* Guideline on anaesthesia and sedation in breastfeeding women 2020: guideline from the Association of Anaesthetists. *Anaesthesia* 2020;75:1482–93.
- 234 Matheson I, Lunde PK, Bredeken JE. Midazolam and nitrazepam in the maternity ward: milk concentrations and clinical effects. *Br J Clin Pharmacol* 1990;30:787–93.
- 235 Nitsun M, Szokol JW, Saleh HJ, *et al.* Pharmacokinetics of midazolam, propofol, and fentanyl transfer to human breast milk. *Clin Pharmacol Ther* 2006;79:549–57.
- 236 ASGE Standard of Practice Committee, Shergill AK, Ben-Menachem T, *et al.* Guidelines for endoscopy in pregnant and lactating women. *Gastrointest Endosc* 2012;76:18–24.
- 237 Borgatta L, Jenny RW, Gruss L, *et al.* Clinical significance of methohexital, meperidine, and diazepam in breast milk. *J Clin Pharmacol* 1997;37:186–92.
- 238 Brooks AJ, Smith PJ, Cohen R, *et al.* UK guideline on transition of adolescent and young persons with chronic digestive diseases from paediatric to adult care. *Gut* 2017;66:988–1000.
- 239 NICE. Sedation in under 19s: using sedation for diagnostic and therapeutic procedures. 2019. Available: [www.nice.org.uk/guidance/cg112](https://www.nice.org.uk/guidance/cg112)
- 240 Mental capacity act 2005. n.d. Available: <https://www.legislation.gov.uk/ukpga/2005/9/contents>
- 241 Legislation.co.uk. Adults with incapacity (Scotland) act 2000. n.d. Available: <https://www.legislation.gov.uk/asp/2000/4/section/1>
- 242 Department Of Health. Consent for examination, treatment or care. 2016. Available: <https://www.health-ni.gov.uk/articles/consent-examination-treatment-or-care>
- 243 Mohanaruban A, Bryce K, Radhakrishnan A, *et al.* Safe sedation practices among gastroenterology registrars: do we need more training *Frontline Gastroenterol* 2015;6:223–8.
- 244 Dumonceau J-M, Riphaut A, Beilenhoff U, *et al.* European curriculum for sedation training in gastrointestinal endoscopy: position statement of the European Society of Gastrointestinal Endoscopy (ESGE) and European Society of Gastroenterology and Endoscopy Nurses and Associates (ESGENA). *Endoscopy* 2013;45:496–504.
- 245 Schilling D, Leicht K, Beilenhoff U, *et al.* Impact of S3 training courses 'sedation and emergency management in endoscopy for endoscopy nurses and assisting personnel' on the process and structure quality in gastroenterological endoscopy in practices and clinics - results of a nationwide survey. *Z Gastroenterol* 2013;51:619–27.
- 246 Joint Advisory Group on Gastrointestinal Endoscopy. JETS course overview. 2014. Available: [https://www.thejag.org.uk/downloads/JAG\\_approved\\_training\\_courses/JETS\\_course\\_overview\\_v3.0.pdf](https://www.thejag.org.uk/downloads/JAG_approved_training_courses/JETS_course_overview_v3.0.pdf)
- 247 National safe sedation - home. n.d. Available: <https://nationalsafesedation.com/>