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Updated S3 Guideline "Sedation for Gastrointestinal Endoscopy" of the German Society of Gastroenterology, Digestive and Metabolic Diseases (DGVS)

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Tables

1 Information on the Guideline

1.1 Publisher

1.1.1 Lead Professional Society

German Society of Gastroenterology, Digestive and Metabolic Diseases (DGVS)

1.2 Scope and Purpose

Since the introduction of the first S3 guideline on sedation in gastrointestinal endoscopy in 2008, the use of sedation in gastroenterological endoscopies, in particular of propofol, has become established. It can now be regarded as the standard in gastroenterological endoscopic practice. In several surveys, also for Germany, a proportion of more than 80 % sedated examinations has been demonstrated.

A key point is the differentiated indication: the necessity of sedation in gastroenterological endoscopy is not obligatory for all procedures but depends on the type of examination, the duration of the examination, the complexity and invasiveness of the examination, and patient characteristics. However, sedation contributes significantly to the comfort of the examination for both the patient and the endoscopist. It often creates the prerequisite for a successful and low-risk examination, especially in the case of complex therapeutic interventions. The experts considered the review and updating of the guideline to be particularly important to guarantee a successful and low-risk examination.

1.3 Goal Orientation of the Guideline

The goal of the guideline is its easy application in the practice of internal medicine, surgery, gastroenterology, anesthesiology, intensive care, and endoscopy/imaging. In addition, the guideline is intended to provide a road map for common decisions.

The target patient group is adult patients who require sedation for gastrointestinal endoscopy.

1.4 Care Areas

Outpatient and inpatient care, internal medicine, surgery, gastroenterology, anesthesiology, intensive care, and endoscopy/imaging.

1.5 User Target Group/Addressees

The guideline is aimed at the following professional groups involved in diagnosis and therapy: gastroenterologists, surgeons, anesthetists, intensive care specialists, general and visceral surgeons, and endoscopists, as well as patient representatives, patients, and relatives, and serves as information for internists and service providers (health insurance companies and pension insurance companies).

1.6 Composition of the Guideline Group: Stakeholder Participation

The guideline was developed by the German Society of Gastroenterology, Digestive and Metabolic Diseases (DGVS), which commissioned Prof. Till Wehrmann, Wiesbaden, and Prof. Andrea Riphaus, Frankfurt, as coordinators. PD Dr. Petra Lynen Jansen and Pia Lorenz, DGVS office, Berlin, were methodologically responsible. Prof. Kopp, Work Group for Scientific Medical Professional Societies e. V. (AWMF), Marburg, provided methodological advice and moderated the consensus conference as a neutral guideline expert. Mr. Torsten Karge, CGS Usergroup, Berlin, was available for the guideline portal and provided technical support for the consensus conference.

The guideline project was advertised in the *Journal of Gastroenterology* and published on the AWMF website, so that other professional societies/representatives could register for participation. The relevant professional societies and patient groups were contacted and asked to nominate their representatives.

1.7 Representatives of the Guideline Group: Participating Professional Societies

- German Society for Endoscopy Assisting Personnel (Deutsche Gesellschaft für Endoskopie-Assistenzpersonal, DEGEA)
  U. Beilenhoff (Ulm)
- German Society for Anesthesia and Intensive Care Medicine (Deutsche Gesellschaft für Anästhesiologie und Intensivmedizin

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e.V, DGAI)
P. Tonner (Leer (Ostfriesland), F. Wappler (Köln)

- German Society for General and Visceral Surgery (Deutsche Gesellschaft für Allgemein- und Viszeralchirurgie e. V., DGAV)/ Surgical Working Group for Endoscopy and Sonography (CAES) (Chirurgische Arbeitsgemeinschaft für Endoskopie und Sonographie of the DGAV)
  A. Schaible (Heidelberg)
- German Society for Endoscopy and Imaging Procedures (Deutsche Gesellschaft für Endoskopie und Bildgebende Verfahren e. V., DGE-BV)
  H. Allescher (Garmisch-Partenkirchen)
- Society for Law and Politics in Health (Gesellschaft für Recht und Politik im Gesundheitswesen, GPRG)
  H. Bitter (München)

1.8 Representatives of the Guideline Group: Participation of Patients

S. In der Smitten (Berlin) of the German Crohn's Disease/Ulcerative Colitis Association (Deutsche Morbus Crohn/Colitis ulcerosa Vereinigung, DCCV)

In addition to the steering group (▶ **Table 1**), five working groups (WGs) were formed, each headed by a leader (▶ **Table 2**). In addition to gastroenterologists, internists, surgeons, anesthesiologists, intensive care physicians, endoscopists, and patient representatives participated in the working groups.

2 Methodologic Procedure

2.1 Evidence Synthesis

2.1.1 Fundamentals of the Methodology

2.1.1.1 Scheme of Evidence Rating

For recommendations reviewed in this update for which no new relevant literature was found, the evidence levels of the associated studies were retained. If there was new relevant literature, it was assessed and added to the guideline report in the appendix. The literature review was conducted according to the Oxford Centre for Evidence-Based Medicine 2011 evidence classification (▶ **Table 4**). The details of the search, selection, and evaluation of the evidence are presented in the guideline report.

▶ **Table 1** Steering Committee.

Name	Site	Responsibility
A. Riphaus	Frankfurt	DGVS
T. Wehrmann	Wiesbaden	DGVS
A. J. Eckardt	Wiesbaden	DGVS
P. Klare	Hausham	DGVS

▶ **Table 2** Members of the Guideline Group.

WG 1: Indications/goals/known risks/ patients/quality goals	WG-head	U. Rosien, Hamburg (DGVS)
	WG-members	S. In der Smitten, Berlin (DCCV) F. Wappler, Köln (DGAI)
WG 2: Pharmacology	WG-head	P. H. Tonner, Leer (Ostfriesland) (DGAI)
	WG-members	M. Jung, Frankfurt am Main (DGVS) D. Schilling, Mannheim (DGVS) T. Voigtländer, Hannover (DGVS)
WG 3: Structure quality	WG-head	T. Wehrmann, Wiesbaden (DGVS)
	WG-members	H. Allescher, Garmisch-Partenkirchen (DGE-BV) A. Behrens, Berlin (DGVS)
WG 4: Process quality	WG-head	S. von Delius, Rosenheim (DGVS)
	WG-members	U. Beilenhoff, Ulm (DEGEA) H. Bitter, München (GRPG) H. Seifert, Oldenburg (DGVS)
WG 5: Result quality	WG-head	A. Riphaus, Frankfurt (DGVS)
	WG-members	P. Heidemann, Schwerin (DGVS, Vertreterin niedergelassene Ärztinnen/Ärzte) A. Schaible, Heidelberg (DGAV/CAES)
WG overlapping		A. J. Eckardt, Wiesbaden (DGVS) P. Klare, Hausham (DGVS)
Coordinators		A. Riphaus, Frankfurt (DGVS) T. Wehrmann, Wiesbaden (DGVS)
Methodology		I. Kopp, Marburg (AWMF)
Organization		P. Lorenz, Berlin (DGVS)

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2.1.1.2 Scheme of the Recommendation Grading

When converting the strength of evidence into the recommendation strength, the recommendation grade could be upgraded or downgraded compared to the evidence grade. Reasons for this could be, for example, the lack of consistency of the study results, the relevance of the endpoints and effect sizes, the benefit–risk ratio, patient preference, or feasibility. Grading of the recommendation was also done using the wording "we recommend", "we suggest", or "may be considered" (▶ **Table 3**; German: "*soll*", "*sollte*", or "*kann*"). The consensus strength was determined according to ▶ **Table 5**.

2.1.1.3 Statements

Statements are presentations or explanations of specific facts or issues without an immediate call for action. They are adopted in a formal consensus process, as in the case of recommendations, and can be based either on study results or on expert opinions.

2.1.1.4 Expert Consensus

Recommendations for which no systematic literature search was conducted or for which no literature was available after extensive research are referred to as expert consensus. The recommendation grading results exclusively from the wording used (we recommend/we suggest/may be considered) according to the grading in ▶ **Table 3**.

▶ **Table 3** Scheme on Grading of Recommendations.

Recommendation grade (Only S3)[1]	Description	Syntax
A	Strong recommendation	We recommend
B	Recommendation	We suggest
0	Recommendation open	May be considered

[1] The recommendation grade and the level of evidence are only specified for evidence-based recommendations. For expert consensus-based recommendations, the grading is done via we recommend/we suggest/may be considered and via the description given in the table.

2.2 External Review and Adoption

2.2.1 Adoption by the Boards of the Issuing Professional Societies/Organizations

The complete guideline was reviewed and agreed upon by the executive boards of all participating professional societies and was available as a consultation version for the professional public for four weeks from January 13 to February 12, 2023, for comments on the DGVS website and at the AWMF. Comments were solicited via the DGVS Newsletter. The proposed changes are presented in the guideline report.

2.2.2 Editorial Independence and Funding of the Guideline

The preparation of the guideline was editorially independent. The DGVS financed the use of the guideline portal and the online consensus conference. There was no financial involvement by third parties. Mandate holders and experts worked exclusively on a voluntary basis.

2.2.3 Disclosing and Handling of Conflicts of Interest

In accordance with the AWMF rules for dealing with conflicts of interest, all participants submitted their declarations on the corresponding AWMF form (Form 2018). Conflicts of interest were screened by the guideline coordinators and Prof. Kopp (AWMF). Initially, they were screened for thematic relevance to the guideline and then categorized according to the AWMF criteria as low, moderate, or high with respect to the individual recommendation. The management proposal was discussed, consented to, and implemented at the beginning of the consensus conference with all participating experts.

Paid lecturing/or training and paid authorship/or co-authorship were categorized as low conflicts of interest and had no consequences in terms of voting.

The following conflicts of interest were rated as moderate:

- Consultant or expert activity or paid participation in a scientific advisory board of a company in the healthcare industry (e. g., pharmaceutical industry or medical device industry), a commercially oriented contract institute, or an insurance company
- Participation in a scientific advisory board (advisory board)
- Research projects/conduction of clinical studies: financial contributions (third-party funds) for research projects or direct financing of institution employees by a company of the healthcare industry, a commercially oriented contract institute, or an insurance company

The following company was identified as a potential conflict of interest: Medtronic (on the topic of capnography monitoring). In addition, the company E&L medical GmbH was up for discussion as a potential conflict of interest, as this company distributes software for reporting endoscopic procedures. However, since the company itself is not involved in any way in the issue, the evaluators see no or only a minor relevant conflict of interest.

There were no conflicts of interest for Prof. Dr. Andrea Riphaus and Prof. Dr. Till Wehrmann when the 2008 guideline was prepared. In the 2014 update (published in January 2015), Prof. Dr. Andrea Riphaus and Prof. Dr. Till Wehrmann had a relevant conflict of interest regarding the vote on capnography monitoring, as they had received support from Covidien in 2011 (loan of equipment for a study). However, since this event occurred now 10 years ago, it is no longer assessed as a relevant conflict of interest for the current guideline.

Owner interests (patent, copyright, ownership of business shares, stocks, and funds with participation of healthcare companies) were rated as high conflicts of interest. High conflicts of interest related to the guideline were not identified.

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▶ **Table 4** Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence [1].

Question	Step 1 (Level 1*)	Step 2 (Level 2*)	Step 3 (Level 3*)	Step 4 (Level 4*)	Step 5 (Level 5)
How common is the problem?	Local and current random sample surveys (or censuses)	Systematic review of surveys that allow matching to local circumstances**	Local non-random sample**	Case-series**	n/a
Is this diagnostic or monitoring test accurate? (Diagnosis)	Systematic review of cross sectional studies with consistently applied reference standard and blinding	Individual cross sectional studies with consistently applied reference standard and blinding	Non-consecutive studies, or studies without consistently applied reference standards**	Case-control studies, or "poor or non-independent reference standard"**	Mechanism-based reasoning
What will happen if we do not add a therapy? (Prognosis)	Systematic review of inception cohort studies	Inception cohort studies	Cohort study or control arm of randomized trial*	Case-series or casecontrol studies, or poor quality prognostic cohort study**	n/a
Does this intervention help? (Treatment Benefits)	Systematic review of randomized trials or *n*-of-1 trials	Randomized trial or observational study with dramatic effect	Non-randomized controlled cohort/follow-up study**	Case-series, case-control studies, or historically controlled studies**	Mechanism-based reasoning
What are the COMMON harms? (Treatment Harms)	Systematic review of randomized trials, systematic review of nested case-control studies, *n*of-1 trial with the patient you are raising the question about, or observational study with dramatic effect	Individual randomized trial or (exceptionally) observational study with dramatic effect	Non-randomized controlled cohort/follow-up study (post-marketing surveillance) provided there are sufficient numbers to rule out a common harm. (For long-term harms the duration of follow-up must be sufficient.)**	Case-series, case-control, or historically controlled studies**	Mechanism-based reasoning
What are the RARE harms? (Treatment Harms)	Systematic review of randomized trials or *n*-of-1 trial	Randomized trial or (exceptionally) observational study with dramatic effect			
Is this (early detection) test worthwhile? (Screening)	Systematic review of randomized trials	Randomized trial	Non-randomized controlled cohort/follow-up study**	Case-series, case-control, or historically controlled studies**	Mechanism-based reasoning

OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence".
Oxford Centre for Evidence-Based Medicine. http://www.cebm.net/index.aspx?o=5653%22\h
* OCEBM Table of Evidence Working Group = Jeremy Howick, Iain Chalmers (James Lind Library), Paul Glasziou, Trish Greenhalgh, Carl Heneghan, Alessandro Liberati, Ivan Moschetti, Bob Phillips, Hazel Thornton, Olive Goddard and Mary Hodgkinson.
* Level may be graded down on the basis of study quality, imprecision, indirectness (study PICO does not match questions PICO), because of inconsistency between studies, or because the absolute effect size is very small; Level may be graded up if there is a large or very large effect size.
** As always, a systematic review is generally better than an individual study.

As a result, one expert was identified as having a moderate conflict of interest. Moderate conflicts of interest resulted in abstention from voting. In addition, the interdisciplinary, representative composition of the guideline group, as well as the structured consensus finding under neutral moderation, were assessed as protective factors against bias.

▶ **Table 5** Classification of Consensus Strength.

Consensus	% Approval
Strong consensus	≥ 95
Consensus	≥ 75–95
Majority agree	≥ 50–75
No consensus	< 50

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Overview of all recommendations where it was necessary to abstain because of conflicts of interest

Name	Abstentions in WG/ Recommendation	Reason
von Delius, Stefan	WG 3: Recommendation 3.4.2	Medtronic (on capnography monitoring)

The declarations of interest of all experts are presented in the guideline report.

Participants of the Consensus Conference

Guideline Experts: Hans-Dieter Allescher (DGE-BV), Angelika Behrens (DGVS), Ulrike Beilenhoff (DEGEA), Horst Bitter (GRPG), Alexander J. Eckardt (DGVS), Peggy Heidemann (DGVS), Susanne In der Smitten (DCCV), Michael Jung (DGVS), Peter Klare (DGVS), Andrea Riphaus (DGVS), Ulrich Rosien (DGVS), Anja Schaible (CAES), Dieter Schilling (DGVS), Hans Seifert (DGVS), Peter H. Tonner (DGAI), Torsten Voigtländer (DGVS), Stefan von Delius (DGVS), Frank Wappler (DGAI), and Till Wehrmann (DGVS).

Organization and Methodology: Ina Kopp (AWMF), Torsten Karge (CGS-Usergroup), and Pia Lorenz (DGVS).

The influence of conflicts of interest was further reduced by the formal two-stage consensus building and by the creation of the interdisciplinary working groups.

2.3 Distribution and Implementation

2.3.1 Concept of Distribution and Implementation

The guideline is published in the *Journal of Gastroenterology* and on the homepages of the DGVS (www.dgvs.de) and the AWMF (www.awmf.de).

2.3.2 Validity Period and Updating Procedure

The validity of the guideline is five years (April 30, 2027). The revision will be initiated by the guideline officers of the DGVS. The steering group will review the need for updating the guideline on an annual basis. For further information, please contact the DGVS office (leitlinien@dgvs.de).

3 Editorial Note

3.1 Gender-Neutral Wording

For the sole purpose of better readability, the gender-specific spelling has been omitted. All personal designations in this document are therefore to be understood as gender neutral.

3.2 Participatory Decision Making

All recommendations of the guideline are to be understood as recommendations that are made and implemented as a participatory decision-making process between physician and patient and, if applicable, the patient's relatives.

4 Special Note

Medicine is subject to a continuous development process, so that all information, in particular on diagnostic and therapeutic procedures, can only correspond to the state of knowledge at the time of the printing of the guideline. The greatest possible care has been taken regarding the recommendations on therapy and the selection and dosage of drugs. Nevertheless, users are urged to consult the manufacturers' package inserts and expert information for verification and, in case of doubt, to consult a specialist. In the general interest, any discrepancies should be reported to the DGVS. The users themselves remain responsible for any diagnostic and therapeutic application, medication, and dosage. In this guideline, registered trademarks (protected trade names) are not specially marked. It can therefore not be concluded from the absence of a corresponding reference that it is a free trade name. The work is protected by copyright in all its parts. Any use outside the provisions of copyright law without the written consent of DGVS is prohibited and punishable by law. No part of the work may be reproduced in any form without written permission. This applies to duplications, translations, microfilming, and the storage, use, and exploitation in electronic systems, intranets, and the internet.

1 Guideline – Indications/Goals/Known Risks/ Patients/Quality Goals

1.1 Recommendation on Sedation Choices

Recommendation 1.1	2022 (modified)
1.1a) We recommend that **every p**atient should be offered sedation before endoscopy.	
Evidence level 5, recommendation grade A, strong consensus	
1.1b) We recommend that patients should be informed about the advantages and disadvantages of an examination with and without sedation.	
Evidence level 5, recommendation grade A, strong consensus	
1.1. c) We recommend that, in principle, simple endoscopic examinations may be performed without sedation.	
Evidence level 5, recommendation grade A, strong consensus	

Background

Every patient has the right to an endoscopy that is as painless and stress free as possible. Therefore, it does not seem ethically justifiable to withhold sedation from patients as a matter of principle [2]. Endoscopic examinations can be unpleasant, so sedation is desired or recommended. In particular, involuntary movement by the patient should be avoided during difficult prolonged endoscopic interventions (e. g., ERCP, difficult resections, or drainage procedures). Therefore, sedation should principally be offered to every patient. Differentiated information for patients about sedation options and implementation increases examination acceptance and awareness [3, 4]. After being appropriately informed about sedation, the individual patient's wishes should, if possible, be taken into consideration.

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Simple examinations are defined as diagnostic endoscopies or interventions that are simple, brief, and not painful. A randomized controlled trial [5] and two prospective cohort studies [6, 7] substantiate this statement using colonoscopy as an example. The consent to an unsedated colonoscopy was as high as 88 %. In contrast, in another study, only 20 % of respondents agreed to colonoscopies without sedation. Male gender, higher education, and lower anxiety were positive predictors for patients to want colonoscopies without sedation [8].

1.2 Recommendation on Indications for Sedation

Recommendation 1.2	2022 (modified)

We recommend that the following aspects should be considered when deciding for or against a sedation procedure and/or analgesia:
- Patient characteristics (risk profile, comorbidities, preferences)
- Type of endoscopic intervention (indication, duration, invasiveness)
- Structural prerequisites

Evidence level 5, recommendation grade A, strong consensus

1.3 Recommendation on Examination Quality

Statement 1.3a)	2021 (unchanged)

It is not possible to make a statement on the effect of the complication rate (because of the endoscopic procedure) if sedation is not used.

Evidence level 5, strong consensus

Recommendation 1.3b)	2021 (unchanged)

Sedation may be considered for gastroscopy and colonoscopy with the aim of increasing the diagnostic value.

Evidence level 2b, recommendation grade 0, strong consensus

Background

A large Italian cohort study including more than 12,000 patients showed that sedation can increase the diagnostic value: sedated patients had a higher polyp detection rate than nonsedated patients. Also, the cecum (meaning a complete colonoscopy) was reached more frequently in this study [9]. The latter could be confirmed in other large cohort studies where sedation increased the probability of a complete colonoscopy by almost a factor of two [10].

The need for sedation in gastroenterological interventions is not obligatory in all endoscopic procedures and ultimately depends on the type, duration, complexity, and invasiveness of the examination, as well as on the patient's wish. Sedation contributes significantly to the comfort of the examination for both the patient and the examiner. It is the prerequisite for successful and low-risk examinations, especially in the case of complex therapeutic procedures.

Previous unpleasant examinations, anxiety, and the patient's ability to understand should be considered. In addition, there are often – culturally determined – major differences in handling sedation during gastrointestinal endoscopy. For example, in the United States and the United Kingdom, patients are sedated in up to 88 % [11] of endoscopic examinations. In contrast, the sedation frequency in Germany and Switzerland in the 1990 s was significantly lower at approximately 9 % [12], but is clearly increasing with the complexity of the examination. However, survey results also show a significant increase in sedation frequency for endoscopic procedures in Germany of around 90 % [13, 14]. This is presumably due on the one hand to an increased frequency of interventional examinations and on the other hand because of patient wishes (e. g., for colon carcinoma screening).

However, there are almost no studies that evaluate the safety of diagnostic and therapeutic endoscopy with or without sedation. An American study failed to meet the comparative objective because of a lack of patient acceptance (high desire for sedation) [5].

The result of a German study showed that colonoscopy can be performed without sedation in more than 90 % of cases with a low complication rate [6]. However, in general, patients wish to be sedated [6, 15, 16]. This does not seem to have a lasting effect on the complication risk during endoscopy.

For example, a prospective study by Dillon et al. [17] involving 136 children undergoing colonoscopy under general anesthesia demonstrated that the perforation rate was no higher than in adults under sedation. A meta-analysis examined the perforation rate in adults and found no increased rate under propofol sedation [18]. Thus, the claim that there are fewer colonoscopy perforations if pain is maintained cannot be confirmed.

1.4 Recommendation on Risk Assessment

1.4.1 General Considerations

Sedating and analgesic-acting drugs can induce overlapping and, sometimes, not clearly distinguishable states, ranging from minimal sedation (anxiolysis) to general anesthesia.

Sedation and/or analgesia procedures by physicians who are not anesthesiologists should not reach a planned level of sedation in which life-sustaining reflexes are impaired or abolished.

Planned general anesthesia (with loss of consciousness/protective reflexes) is reserved exclusively for anesthesiologists (exceptions exist in intensive care).

If, in individual cases, a state is reached in which life-sustaining reflexes are impaired or switched off (general anesthesia) and if the procedure is to be continued, an anesthesiologist must be consulted.

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▶ **Table 6** Modified Richmond Agitation-Sedation Score [19].

Grade	Term	Description
0	Alert and calm	
1	Sleepy	Not completely alert, but awake phases (eyes open, eye contact) lasting at least 10 s when patient is addressed
2	Mild sedation	Awake phase (eyes open, eye contact) lasting less than 10 s when patient is addressed
3	Moderate sedation	Movement or eye opening when patient is addressed (but no eye contact)
4	Deep sedation	No reaction when patient is addressed, but movement or eye opening when physically stimulated (shaking shoulder or rubbing sternum)
5	No reaction	No reaction when patient is addressed or physically stimulated

▶ **Table 7** Stages of Sedation, Modified from the American Society of Anesthesiologists [20].

	Minimal (anxiolysis)	Moderate	Deep	Anesthesia
Reaction when being addressed	Patient reacts appropriately to verbal commands	Somnolence, reaction to louder commands with additional tactile stimulation if necessary	Somnolence, hard to wake, purposeful response after repeated or painful stimulation	Patient cannot be woken, not even in response to pain stimuli
Spontaneous breathing	Not influenced	Adequate	Respiratory function may be inadequate; patients may require assistance in maintaining a patent airway	Inadequate, ITN or larynx mask necessary

Despite the fluent, not always safely controllable, sedation-level transitions, different degrees of (analgo-) sedation can be distinguished.

The degree (depth) of sedation can be determined and classified by a validated scale. While the modified Richmond Agitation-Sedation Score scale (RASS scale) [19] (▶ **Table 6**) is usually used in European anesthesia, in gastroenterology/endoscopy the classification of the different sedation stages is mainly done according to the American Society of Anesthesiologists [20] (▶ **Table 7**).

Recommendation 1.4	**2022 (modified)**
We recommend that the sedation type and depth, as well as the drug used, should be selected according to the type of intervention, as well as the patient's ASA grade and individual risk profile. There are special requirements with respect to the facilities, equipment, and qualified personnel. If the prerequisites defined under "structure quality" cannot be met, we recommend that sedation should be avoided after considering the risk-benefit, as well as the patient's wish. If sedation is indicated and/or patients want to be sedated, we recommend they should be referred to a facility that meets these requirements.	
Evidence level 5, recommendation grade A, strong consensus	

Background

The American Society of Anesthesiologists and the American Society of Gastroenterologists [20, 21] recommend carrying out a risk assessment of any cardiovascular and respiratory problems that could occur during endoscopy before the examination begins. Additionally, a physical examination should be performed that, aside from vital signs, includes auscultation of the heart and lungs.

A detailed history should include the following questions about:

- Diseases of the cardiovascular and respiratory system
- Stridor, snoring, sleep apnea syndrome
- Kidney function disorders, liver diseases
- Diabetes mellitus, obesity
- Neurologic/muscular disorders
- Age
- Previous operations which are relevant for the endoscopic access
- Complications on previous occasions when sedatives/analgesics, regional and/or general anesthesia were administered
- Drug allergies, current medication, and possible drug interactions [22]
- Tobacco, alcohol, drug consumption
- Most recent meal: when and what was eaten

In a prospective study at several hospitals in the Melbourne region, risk factors and risk assessment were confirmed by ASA classification [23].

Endoscopic examinations in patients with liver cirrhosis are safely possible under adequate surveillance. The increased sedation risk is determined by the often associated (cardiopulmonary) comorbidity.

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▶ **Table 8** ASA Classification.

ASA Grade	Definition	Selected Examples (Adults)
I	No risk	Healthy, no nicotine, no/minimal alcohol consumption
II	Mild disease	Without relevant impairment; smoker, social alcohol consumption, pregnancy, obesity (30 to under 40 kg/m^2), well controlled DM/hypertension, mild liver disease
III	Severe disease	With impairment; at least moderate to severe disease; obesity (BMI ≥ 40 kg/m^2), poorly controlled DM/hypertension, active hepatitis, alcohol addiction, pacemaker, moderate impairment of ejection fraction, stable dialysis patient, myocardial infarction/TIA/arteriosclerosis more than 3 months ago with stents
IV	Severe, constantly life-threatening disease	Myocardial infarction/TIA/arteriosclerosis less than 3 months ago with stents, persistent myocardial ischemia, severe valve dysfunction, pronounced impaired ejection fraction, shock, sepsis, acute or terminal kidney failure without established regular dialysis
V	Moribund patient, who is expected to die without the intervention	Ruptured aortic aneurysm, polytrauma, intracranial mass bleeding, ischemic bowel infarction in the presence of significant heart disease or multiple organ dysfunction
VI	Brain-dead patient directly before the organ removal for transplantation	

Under sedation, obesity (BMI greater 30 kg/m^2) is a risk factor for hypoxemia and higher age for hypotension. However, threshold values are not defined [24–28].

Previous operations (e. g., ERCP after gastrectomy or bypass OP) can increase the examination duration and, thus, the need for sedation [29].

The ASA classification [30] (▶ **Table 8**) and the structure quality are the bases for the existing guidelines [20, 31–33]. Patients with ASA grade III or higher (▶ **Table 8**) have an increased risk of complications during sedation or the endoscopic intervention.

The upgrade of the abovementioned statement to a recommendation grade A, with an evidence level of 5, is due to a 2b evidence level for ASA grade and comorbidity, as well as to patient safety considerations.

1.5 Recommendation on Anesthesia/Endotracheal Intubation

Recommendation 1.5	2022 (modified)
We recommend considering the consultation of an anesthesiologist for patients with a high-risk profile. This includes patients with a high ASA grade (III–IV) and a difficult endoscopic intervention or the presence of pathological anatomical features associated with a higher risk of airway obstruction during the intervention (e. g., craniofacial malformation; lingual, laryngeal, or hypopharyngeal tumor; severely restricted mobility of the cervical spine; severely restricted mouth opening < 3 cm; Mallampati grade 3 or 4; or a restricted hyoid-to-chin distance < 6 cm).	
Evidence level 5, recommendation grade A, consensus	

Background

A routine endoscopy under sedation seems to be safely feasible in patients with, at most, mild concomitant disease (ASA I or II) [34–36]. The most frequent adverse events are hypoxemia and hypotension. Only by properly evaluating the sedation/anesthesia risk and weighing the intervention risk can the need/type/depth of sedation be adequately planned prior to the examination. The risk profile also includes pathologic/anatomic features that may lead to respiratory problems and that would complicate any mechanical breathing support or ventilation that may be needed. In addition, existing guidelines provide further guidance on assessing the increased risk of respiratory disability in patients with pre-existing problems during anesthesia or sedation [20, 31–33].

These are:

1. Patients with stridor, snoring, and sleep apnea
2. Patients with malformation of the facial bones, e. g., Pierre-Robin syndrome or Down syndrome
3. Patients with malformation of the mouth, such as small opening (< 3 cm for adults), agomphiasis, projecting anterior teeth, missing or broken teeth, strongly curved palate with macroglossia, tonsil hypertrophy, or a uvula that is not visible
4. Patients with abnormalities of the neck, such as obesity involving the neck and face, short neck, restricted neck mobility, reduced hyoid-to-chin distance (< 6 cm for adults), neck tumors, disease or trauma of the cervical spine, tracheal alterations, or rheumatoid arthritis
5. Patients with jaw malformations such as micrognathia, retrognathia, the jaw typical of Down syndrome, or pronounced malocclusion
6. Due to their risk profile, persons with alcohol abuse, drug abuse, or patients on long-term and extensive medication, as well as patients with a high ASA grade and/or persons who are not able to cooperate, who are also expected to have higher requirements for sedation

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Data are controversial on the significance of obstructive sleep apnea (OSA). Liou et al. found a higher rate of hypoxemia under sedation in individuals at increased risk for OSA when using the Berlin Questionnaire (BQ; the BQ targets OSA and differentially asks about snoring behavior and daytime sleepiness) [37]. In contrast, Andrade et al. did not observe an increased rate of cardiopulmonary complications in patients with known OSA, and Mudambi et al. did not observe an increased rate of hospital or intensive care admissions or emergency department presentations [38, 39]. However, the studies do not distinguish between obstructive sleep apnea and obstructive sleep apnea syndrome with sequelae, which might be more critical to evaluate.

Patients with high-risk profiles and ERCP benefit from examination under intubation anesthesia [40]. However, involving or consulting an anesthesiologist in case of an increased risk profile, expected long intervention duration, or increased risk of a relevant acute complication (e. g., aspiration risk in interventions in the proximal esophagus) does not inevitably lead to an indication for intubation anesthesia [41–44].

1.6 Recommendation on Protective Endotracheal Intubation

Recommendation 1.6	2022 (modified)
Deep sedation leads to impairment of protective reflexes (swallowing reflex and coughing reflex). This increases the risk of aspiration. Thus, in special situations in emergency endoscopy with increased aspiration risk (e. g., severe upper gastrointestinal bleeding) under sedation, we recommend considering an indication for endotracheal intubation. Whether prophylactic intubation is associated with increased risk of pneumonic infiltrate has so far not been conclusively determined.	
Evidence level 4, recommendation grade A, strong consensus	

Background

It is a basic fact that deep sedation leads to impairment of the protective reflexes. For this reason, if an additional aspiration risk is present (e. g., during emergency endoscopy for upper gastrointestinal bleeding), tracheal intubation seems sensible to avoid aspiration. However, because there are no high-quality studies that prove that the advantages of this procedure outweigh the disadvantages, it is not possible to issue a general recommendation.

A retrospective case-control study by Koch et al. [45] studied a total of 62 patients, 42 of whom underwent prophylactic endotracheal intubation before the start of endoscopy for variceal hemorrhage. Subsequently, they found pneumonic infiltrates in 17 % of the intubated patients. This was not the case in the non-intubated patients. In addition, overall mortality was higher in the group that underwent prophylactic intubation (21 % vs. 5 %).

In another retrospective case-control study by Rudolph et al. [46] including 220 patients, no significant difference was seen in the frequency of pneumonic infiltrates and overall mortality between the intubated and non-intubated groups. However, deaths caused by aspiration were higher among patients who did not undergo prophylactic intubation (2 % vs. 0 %).

Because of a lack of clarity in such retrospective analyses about how patients were allocated to the groups and, thus, a possible bias (severely ill patients are more likely to undergo intubation), these studies are only of limited value.

In a population-based cohort study, Bielawska et al. analyzed retrospective data of 3 million ambulatory colonoscopies in the Ontario area [47]. They found an association of anesthesiologist-assisted examinations and aspiration pneumonia. Data on intended or achieved sedation depth and rate of primary intubation examinations are missing. Again, the retrospective approach does not allow for an evaluation of bias in the sedation choice influenced by concomitant diseases.

1.7 Recommendation on Patient Positioning

Recommendation 1.7	2022 (modified)
We recommend ensuring that sedated patients are positioned correctly to avoid position-related damage and aspiration, as well as ensuring that body temperature management be adapted to the duration of the examination.	
Evidence level 5, recommendation grade A, strong consensus	

Background

Positional damage during gastrointestinal endoscopy under sedation/anesthesia should always be avoided. There is no direct evidence of positional damage in endoscopy. The recommendation is, therefore, based on the joint recommendation of the Professional Association of German Anesthesiologists and the Professional Association of Surgeons [48] and Update BDA from 2016.

Patients may move involuntarily, especially with shallow sedation. Appropriate fall prevention must be employed by securing patients appropriately (e. g., lunge protection and safety harnesses).

For correct positioning during the use of HF-surgery, please refer to the S2k guideline on quality requirements in endoscopy.

Positional damage is usually caused by pressure and traction at anatomically exposed sites or by overstretching as a result of prolonged nonphysiological positions. The most frequently affected are brachial plexus, N. ulnaris, and N. fibularis [49].

Positional injuries are most likely to occur during procedures in the abdominal and lateral position or when transferring the patient from the examination table to the bed. The use of appropriate positioning aids is recommended. Particularly during long procedures (e. g., endoscopic submucosal dissection, retroperitoneal intervention, etc.), care should be taken to ensure correct positioning. If necessary, this should include occasional repositioning and relief of stressed regions or joints, analogous to the procedure for surgical operations.

Suitable measures must be taken to prevent patients from suffering hypothermia and their eyes from drying out. To avoid eye damage in an abdominal position, care must be taken to ensure positioning to avoid lower eye compression [48].

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2 Guideline – Sedatives/Analgesics/Adjuvant Drugs

2.1 Acceptance by the Patient and the Endoscopist

2.1.1 Patient Acceptance/Satisfaction

Recommendation 2.1	2022 (modified)
We recommend that sedation should be offered because it increases the patients' comfort and, hence, their acceptance of the endoscopic intervention. Ideally, sedation should not result in memory of unpleasant sensations, but at the same time, the duration of action should be short.	
Evidence level 1b, recommendation grade A, strong consensus	

Background

The performance of analgesia and sedation for endoscopy is dependent on several factors. The procedure is performed differently in larger clinics than in small hospitals or private practices. Regional differences, safety requirements, and reimbursement also play a role. More than 98 % of colonoscopies in the United States and more than 90 % in Canada are performed under sedation [15, 50]. Large discrepancies exist in Europe. In Italy, sedation is standard practice. In contrast, in Germany 87 % of colonoscopies and 74 % of esophagogastroduodenoscopies are performed with sedation [13, 51]. However, in Spain, less than 20 % patients are sedated during colonoscopy [52]. A recent Greek survey found that 83.3 % of patients are sedated during endoscopy [53].

Only 12 % of the endoscopists in the United States would agree to have their own colonoscopy done without sedation. The other half would prefer propofol sedation [15].

Adequate analgesia and sedation can influence the quality of the examination and the satisfaction of both the patient and endoscopist [54]. Patients primarily wish to be completely pain free, followed by the desire to wake up as soon as possible [55]. In a study by Abraham et al. [56], it was shown that gastroscopies under sedation resulted in less frequent repeat examinations and were associated with increased patient acceptance. The increase in patient acceptance with sedation for endoscopic procedures has also been demonstrated by other studies [57–64]. A large meta-analysis showed greater patient satisfaction under sedation [65]. Patient acceptance is also greater for colonoscopies under sedation with propofol [66].

However, when benzodiazepines are used during upper endoscopy (gastroscopy), patient discomfort may occur (especially vomiting and retching reflex), which may not be noticed by the endoscopist. In a study by Walmsley et al. [67], endoscopists did not notice such discomfort occurring in 12 % of patients. Even in the case of moderate sedation with midazolam, patients can sense pain [5], which may not necessarily be noticed by the endoscopist. However, patients frequently do not recall these complaints as a result of the amnestic properties of midazolam.

The variables influencing patient satisfaction were investigated in a study of 456 patients who underwent gastroscopies, colonoscopies, or a combination of both [68]. The multivariate analysis showed that especially long procedures and young patients (≤ 50 years) were factors associated with great dissatisfaction. Therefore, they require increased vigilance regarding sedation. It was demonstrated on 600 patients who had colonoscopies that propofol led to greater postprocedural satisfaction than midazolam [69]. A smaller study on 72 patients who underwent endoscopic submucosal dissections showed that satisfaction of patients sedated with propofol could be increased by premedication with 0.02 mg/kg midazolam [70]. A meta-analysis demonstrated that the sedation depth of patients undergoing colonoscopies has no effect on patient satisfaction. However, more complications arose under deeper sedation compared to mild sedation [71].

2.1.2 Endoscopist Satisfaction

Statement 2.2	2022 (unchanged)
Sedation increases the technical feasibility and the chance that the examination can be completed and, thus, improves examiner satisfaction (especially in interventional endoscopy).	
Evidence level 1b, strong consensus	

Statement 2.3	2022 (unchanged)
In interventional endoscopy, an endoscopist's satisfaction is superior for propofol over midazolam.	
Evidence level 1b, strong consensus	

Sedation can improve technical success and more complete exams, and therefore, it can increase the endoscopist's satisfaction (especially during interventions) [72, 73]. Similarly, a combination of benzodiazepines with opioids can improve examiner satisfaction. A study of 107 patients compared midazolam combined with placebo and midazolam combined with meperidine for EGD [74]. Endoscopist satisfaction was significantly better with the combination regimen ($P < 0.001$), whereas little difference was seen in patient acceptance. Sedation with benzodiazepines leads to sufficient sedation in 85 % of cases and adequate examination conditions in 71 %. However, patient satisfaction is even higher with propofol mono- or combination therapy [65].

Deep sedation may be needed to ensure that examinations can be done safely without unwanted and uncontrollable involuntary patient movement, especially for longer and more complex interventions [68, 75]. Propofol is superior to midazolam in regard to endoscopist satisfaction, particularly during interventional endoscopies [76]. Better examination conditions may be responsible for the trend of increasing propofol use. However, increasing sedation depth, achieved by raising the dose of the various substances, also increases the incidence of unexpected/unwanted side effects (see dose recommendations in the product information of various manufacturers and ▶ **Table 9**, page 38). One reason for the observed deaths during or after endoscopies could be excessive dosing of the administered medications [77, 78]. A single-center study, which involved 2 audits within 2 years, including more than 14 000 patients in England, showed that the implementation

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▶ **Table 9** Comparison of Vital Signs During Sedation with Propofol Versus Midazolam/Meperidine for ERCP.

Author	Vital sign	Propofol	Midazolam/pethidine (meperidine)	Differences
Vargo JJ [58]	SpO_2 < 90 %	21/37 (57 %)	14/38 (37 %)	ns
	BP < 75 % of baseline value	7/37 (18.9 %)	6/38 (15.8 %)	ns
	HR < 75 % of baseline value	3/37 (8.1 %)	0/38 (0.0 %)	ns
Riphaus A [121]	SpO_2 < 90 %	7/75 (9.0 %)	8/75 (11 %)	ns
	Mean decrease in SpO_2	3 % (2 %)	6 % (3 %)	< 0.01**
	BP < 90 mmHg	4/75 (5.3 %)	6/75 (8 %)	ns
	HR < 50/Min.	4/75 (5.3 %)	3/75 (4 %)	ns
Wehrmann T [115]	SpO_2 < 90 %	8/98 (8.2 %)	11/99 (11 %)	ns
	Mean decrease in SpO_2	3 % (2 %)	5 % (3 %)	< 0.01**
	BP < 90 mmHg	2/98 (2.0 %)	7/99 (7.1 %)	ns
	HR < 50/Min.	2/98 (2.0 %)	5/99 (5.1 %)	ns
Krugliak P [120]	N	14	15	
	BP < 20 % of baseline value	37.0 ± 30.1	25.2 ± 18.6	ns
	HR < 20 % of baseline value	48.2 ± 38.0	14.6 ± 25.0	< 0.01**
Jung M [66]	N	40	40	
	Decrease $Sp0_2$ (%)	–2	–4	ns
	Mean BP decrease (%)	14	17	ns
	Increase in HR (%)	+ 3.5	+ 2	ns

BP, blood pressure; HR, heart rate; ns, not significant.
** significant (P < 0.01).

of a sedation guideline for endoscopy in some cases markedly reduced dosages of sedatives and analgesics. However, the outcome (e. g., mortality) did not change significantly. At the same time, there was an increase in incomplete examinations as a result of reduced patient compliance [78]. Another study including 585 patients undergoing colonoscopies found no effect of the sedation depth (moderate vs. deep) on the examination quality regarding adenoma or polyp detection [79].

In a survey of 82 620 endoscopies, propofol sedation was used in 42 % of cases. Adverse events occurred in 0.19 %, with no reported fatalities [80]. An Italian survey showed that propofol was administered by anesthesiologists in 66 % of cases [51]. In Greece, about 70 % of endoscopists do not work with anesthesiologists [53].

A retrospective analysis of more than 230 000 patients determined sedation and analgesia to be quality indicators for endoscopy [10]. They were directly linked with the success rate of a complete exam. These results are also supported by an Italian survey [81]. In Germany, the drugs most often used for sedation during endoscopy are propofol (97 %) and midazolam (69 %). A combination of these drugs is used in 43 % of cases [14]. However, a recent survey [14] demonstrated that propofol is now being used more often than benzodiazepines. In terms of endoscopist satisfaction and quality of examination outcome, continuous administration, e. g., of propofol and remifentanil, appears to be superior to intermittent administration, although patient satisfaction was higher with intermittent sedation [82].

2.2 Monotherapies

2.2.1 Propofol

2.2.1.1 General Considerations

Propofol is a sedative with minimal analgesic effect. The sedating effect of propofol is based on the binding of the drug to GABA receptors. Propofol's exact pharmacodynamic mechanisms are still not completely understood. Propofol is extremely lipophilic and develops its effect within 30–45 seconds. As is the case with most hypnotics, the duration of action is determined by the redistribution into slow and fast compartments. The duration of action depends on the duration of its application [83]. After short-term continuous application for 30–60 minutes, patients will take 5–10 minutes to wake up. The quick onset of action with a short effect duration makes propofol a suitable sedative for gastrointestinal endoscopy [72, 84–91]. The effect of propofol is individually different depending on age [92, 93], body weight, co-morbidity, or concomitant medications. The depth of propofol sedation depends on its dose. Patients who are examined using propofol monotherapy are no more prone to pain sensation than those treated with a standard sedation regimen [66]. This is likely explained by the fact that patients cannot recall painful sensations

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that might have occurred during the procedure. Even a single bolus dose can take a patient right through several levels of sedation (▶ **Table 6, 7**) and trigger short-term apnea [94]. However, in contrast to midazolam, no antagonist exists for propofol. Therefore, all endoscopy teams that use propofol for sedation must be able to rapidly control apnea (see section 4: process quality). Administration of propofol for endoscopies requires a high degree of clinical expertise and attention to the patient. In Italy, propofol is administered by an anesthesiologist in two-thirds of all cases, in Greece in even more than 64 % of patients [51, 95].

The downsides to propofol are pain during the injection, allergic reactions, and hyperlipidemia. Besides possible hypoxia from respiratory depression, hypotension and bradycardia may occur [96] (see also ▶ **Table 9**, section 2.2.3.1). In isolated cases (intensive care settings), pancreatitis has been reported. As a rare occurrence, bacterial contamination of the lipid-based solvent of propofol can result from improper handling, which in turn has the potential for severe septic complications [97, 98]. With such improper handling (e. g., splitting of ampules), a series of infections have been described. A recent Direct Healthcare Professional Communication (DHPC) by the German Federal Institute for Drugs and Medical Devices (BfArm) in May 2023 states that propofol-containing drugs are only approved for single use in individual patients and must be taken from their container under aseptic conditions. The so-called propofol infusion syndrome (PRIS) may occur as a complication, even after short-term application (symptoms include rhabdomyolysis, cardiac arrhythmias, CK elevation, and high mortality rate) [99, 100]. However, so far, no such case has been reported during sedation for gastrointestinal endoscopy. Allergy to chicken protein, soy protein, or sulfite do not seem to be relevant because of the refining process of propofol solutions [101, 102]. However, they are still listed in the product information and should be observed. In some cases, newer propofol formulas are available [103, 104].

The use of propofol generally does not result in higher complication rates than the use of other sedation strategies, such as regimens based on benzodiazepines. An early meta-analysis showed that sedation using propofol during colonoscopies reduced the number of complications [105]. The dosage of propofol can be reduced when used in combination with other sedatives/analgesics [106, 107]. A meta-analysis of 20 studies showed that propofol was superior to other sedatives in regard to recovery or patient transfer times and resulted in higher patient satisfaction rates. However, no differences were observed regarding complications or technical success [66]. In another meta-analysis, which analyzed 36 studies with 3918 patients who were sedated for endoscopy, propofol led to a shorter recovery time and higher patient satisfaction in comparison to midazolam [65].

A meta-analysis of 22 studies with 1798 patients found that patients receiving propofol for sedation recovered faster and could be discharged sooner, with better sedation and patient cooperation and no differences in adverse events [108]. Similar results were shown in a recent meta-analysis of colonoscopies [109]. In a large multicenter study (ProSed 2) of 368,206 endoscopies, a low number of complications were found (severe complications: 0.01 %, deaths: 0.005 %, mild complications: 0.03 %). Combining propofol with other sedatives allows a significant reduction in the dose used but without a reduction in cardiopulmonary complications [110]. A recent meta-analysis of 22 studies involving 2250 patients also found no benefits of combining propofol with other sedatives other than a reduction in dose [111].

2.2.1.2 Techniques of Propofol Administration

Propofol is initially administered as a bolus to induce sedation. To maintain sedation, it is then either given as repeated boli or continuously administered using an infusion pump.

Alternative modes of administration to the intermittent bolus mode (currently the most common method for endoscopy in Germany) are administration by infusion pump (with an initial single bolus for initiation), so-called “target-controlled infusion” (TCI), “patient-controlled sedation” (PCS), and “computer-assisted personalized sedation” (CAPS). Intermittent bolus administration and administration by infusion pump are standard procedures, while the other methods are still experimental, at least regarding their use for endoscopy.

2.2.1.2.1 Intermittent Propofol Bolus Administration

With the intermittent bolus administration method, sedation is induced with an intravenous bolus adjusted to weight and, if necessary, age and any co-morbidity of the patient (e. g., 40 mg at < 70 kg body weight or 60 mg at ≥ 70 kg body weight). Thereafter, repeated boli of, for example, 20 mg according to patient needs are given to maintain the desired sedation depth [112]. If necessary, an additional benzodiazepine and/or opioid can be added for induction (see chapter 2.3, Combination Therapy). Intermittent bolus administration has been used in almost all published studies on propofol sedation efficacy during endoscopic examinations/treatments in comparison with other drugs (e. g., midazolam). In endoscopy, it is therefore currently the best-documented and most common mode of administration.

2.2.1.2.2 Continuous Propofol Administration Using Infusion Pump Systems

Also, for this mode of administration, a bolus of propofol adjusted to body weight and, if necessary, age and co-morbidity is given to induce sedation (if necessary, in combination with other drugs). Sedation is then (usually) maintained by weight-adjusted continuous propofol infusion. Dosing is performed according to the desired sedation depth and the patient’s individual risk profile. Most systems allow additional propofol boli as needed. Special infusion pump systems for anesthesia automatically calculate the maintenance dose of propofol (1 % or 2 % solution) required for a specified sedation depth once various patient parameters have been entered (e. g., weight, height, and age).

Perfusor administration of propofol has been extensively documented in anesthesia and is considered the standard of care for total intravenous anesthesia. However, only a little of the published data are available for its use in endoscopy. In a randomized comparison between perfusor application and intermittent bolus administration in interventional endoscopy, no relevant difference was found for sedation efficacy or side effects [113]. However, the authors explicitly emphasized the need for a specialist to adjust the infusion rate of the pump. A study in patients older than

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80 years demonstrated that continuous propofol administration tended to cause desaturation in geriatric patients, even though the overall complication rate was not higher in comparison to younger patients [114].

2.2.1.2.3 Non-Anesthesiologist-Administered Propofol Sedation (NAPS)

This type of propofol administration is either termed nurse-administered propofol sedation (NAPS) or, as a more general term, non-anesthesiologist-administered propofol sedation (see subheading above).

In a comparison of mild sedation administered by the endoscopist and deep sedation administered by the anesthesiologist, patients preferred the milder sedation and were more willing to repeat this procedure in the future. Again, fewer complications were noted with milder sedation [64].

A study of patients with obstructive sleep apnea compared NAPS to standard sedation with sedatives and opioids and showed that the duration of the procedure was shorter in the NAPS group, whereas the complication rate was similar between both groups [115]. Because of the favorable safety profile of propofol, the American endoscopist Douglas Rex postulated that propofol may be administered by gastroenterologists or gastroenterological nurses [116]. In an analysis (retrospective case series and meta-analysis) of more than 200 000 cases, transient mask ventilation became necessary in only 213 cases. Endotracheal intubation was not needed in any patient and all patients recovered without neurologic deficits. However, due to the methodological weaknesses of this study (retrospective analysis), these results are of limited value. Other potential morbidity parameters were not analyzed.

In another large epidemiological investigation of 27 000 patients, oxygen desaturations occurred in 2.3 % of cases. In patients older than 70 years of age, oxygen desaturations were documented in 5.5 % of patients. In most cases, other parameters, such as hemodynamics, were not analyzed [117]. Detailed data on postprocedural morbidity do not exist.

A sedation task force of the American Association for the Study of Liver Disease (AASLD), the American College of Gastroenterology (ACG), the American Gastroenterological Association (AGA), and the American Society of Gastroenterological Endoscopy (ASGE) took the position that NAPS has a safety profile comparable to standard sedation. However, insufficient experience with NAPS precludes firm conclusions regarding its application during EUS or ERCP [118]. In 2005, the AGA sent a petition to the Food and Drug Administration (FDA) to extend the privileges of propofol administration by anesthesiologists to also include non-anesthesiologists. However, this petition was finally denied in 2010 [119].

In 2010, a recommendation on sedation with propofol by non-anesthesiologists was published by three European professional societies, the European Society of Gastrointestinal Endoscopy (ESGE), the European Society of Gastroenterology and Endoscopy Nurses and Associates (ESGENA), and the European Society of Anesthesiology (ESA). Following internal discussions, support for this recommendation was withdrawn in 2015 by the ESA [120]. An updated version was published in 2015 by the ESGE and the ESGENA [33]. The current recommendations state that for most endoscopic procedures, sedation with propofol by non-anesthesiologic personnel versus traditional sedation (with comparable side effects) provides better sedation, more patient cooperation, higher patient satisfaction, shorter time to sedation, shortened postprocedural recovery times, and better post-sedation recovery scores. For advanced endoscopy procedures, NAPS is comparably safe, but with lower patient and investigator satisfaction. Significant changes compared to the previous version of the recommendation were made regarding monitoring. Capnography is recommended in special situations such as high-risk patients, deep sedation, and long procedures. Propofol should be administered as a monotherapy and as an intermittent bolus or via an infusion pump (including TCI or PCS). Patients with an ASA classification ≥ 3, a Mallampati score ≥ 3, or special risks should be sedated by an anesthesiologist. Recent studies have provided further evidence for the safety of NAPS also for special patient populations [121–125].

Recommendation 2.4	**2022 (unchanged)**
We suggest that propofol should be administered as an intermittent bolus application.	
Evidence level 1b, recommendation grade B, consensus	

2.2.1.2.4 Patient-Controlled (Analgo-) Sedation (PCS)

Patient-controlled drug administration originated from pain therapy. Today, it is standard in postoperative analgesia. With the help of programmable infusion pumps, patients can self-administer a defined dose of a drug intravenously at the press of a button. To avoid overdoses, a time-delay option is applied for repeat doses (a so-called lockout mechanism) [126]. One downside to this type of dosing is that patients often wait for a painful stimulus to administer the drug. Therefore, often the action of the applied substance occurs after the stimulus has ended [127]. This results in milder sedation but also in insufficient analgesia and lower patient satisfaction [128]. Thus, PCS may be useful for endoscopic examinations with relatively short, tolerable episodes of pain, such as is frequently the case during colonoscopy (e. g., passage of the sigmoid colon or splenic flexure). In these cases, administration of very short-acting drugs via these systems is ideal. A combination of propofol with short-acting opioids (e. g., alfentanil and remifentanil) is often used [129, 130]. In a randomized study in patients undergoing ERCP, a combined regimen of propofol and remifentanil led to more cases of respiratory depression and nausea than the combination of propofol and alfentanil [130]. All the other studied parameters, such as administered propofol dosages or patient and endoscopist satisfaction, were the same in both groups. Patients who received PCS were less deeply sedated than those who received their sedation from an anesthesiologist [129].

In a randomized study, patient satisfaction was similar with the use of a PCS system (propofol plus alfentanil) as compared to midazolam and meperidine [131] and also in two additional random-

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ized studies as compared to diazepam and meperidine (called pethidine in Germany) [132, 133]. In two other studies, patient satisfaction with PCS was even higher than for midazolam alone [134]. However, in another randomized study, a higher pain score was reported for PCS than for midazolam [131]. Fewer adverse events (oxygen desaturation or drop in blood pressure) were observed with PCS using propofol in comparison to diazepam [132, 133]. In two of these studies, 97 % and 78 % of the patients who were sedated using PCS for colonoscopy said, if necessary, they would be willing to repeat this type of sedation [135, 136]. Younger age, female sex, and lower patient satisfaction were independent factors for refusal of the PCS procedure. Recently, remifentanil has been the preferred opioid in PCS. A randomized, double-blind comparison between remifentanil and meperidine for colonoscopy showed neither a difference in patient or endoscopist satisfaction nor in terms of procedure duration or discharge time from the recovery room [137].

In a Swiss PCS study, 35 % of all patients who were approached refused to take part in the study, either because they wanted complete unconsciousness or because they did not want to take responsibility for their own drug administration [127]. However, among those patients who took part, a significantly lower propofol dose was used during colonoscopy when PCS was employed compared to intermittent bolus administration by a nurse (NAPS) [127].

A recent large single center study showed that PCS can be used safely in younger and low-risk patients and is associated with fewer cardio-respiratory adverse events [138]. In patients undergoing ERCP, PCS was better than sedation with midazolam and comparable to sedation by anesthesia staff [139]. A meta-analysis of PCS for colonoscopy found that PCS was similarly effective compared to traditional intravenous sedation [140]. However, there were advantages regarding recovery time, oxygen saturation, and incidence of hypotension.

2.2.1.2.5 Target-Controlled Infusion (TCI)

The target-controlled infusion (TCI) method allows intravenous administration of propofol (or other drugs) using an infusion pump. The dose and infusion rate are regulated by a computer [141]. The computer system calculates the individual pump infusion rate needed to maintain a preset blood drug concentration. It uses algorithms that take various patient parameters into account (e. g., age, sex, height, weight, and sedation depth). The infusion rate is adjusted during sedation after the initial dose required to reach the desired blood concentration has been calculated.

The potential advantage of the TCI method compared to continuous infusion (with fixed dose and infusion rate) is the avoidance of drug accumulation (the infusion rate is constantly adjusted). However, the current commercially available infusion pump systems calculate the dosage based on a pharmacokinetic model, which allows a deviation of 20 % from the true plasma drug concentration [142]. Nevertheless, TCI provides a more gentle initiation and a more exact titration of the sedation depth, as well as a shorter wake-up period as compared to established bolus injection and infusions based on kilograms of body weight [143].

In an evaluation of 205 patients who underwent ERCP under deep sedation (without mechanical ventilation), an open TCI system with propofol was used. The initial desired concentration was 4 µg/ml, followed by a maintenance dose in the range of 2–5 µg/ml. This was maintained during the procedure by an anesthesiologist. In addition, a bolus administration of fentanyl (50–100 µg i. v.) was allowed. The endoscopists rated the sedation as excellent in 201 of 205 cases. Only four cases of hypoxemia (pO_2 < 85 %) were seen, and one case was observed where ventilation with a mask became necessary [144].

Colonoscopies were performed in 16 patients using a TCI system in which the infusion rate was controlled by EEG (by determining the bispectral index, BIS). The goal was to reach a median propofol concentration of 2.3 µg/ml [145]. A BIS level of 80 was predominantly observed (corresponding to a mild to moderate sedation depth).

Further studies investigated the combined use of TCI and PCS, where the patient was able to modify the administration rate of the TCI pump by pushing a button. Positive sedation effects were reported during colonoscopy and ERCP. However, the case numbers were small (n = 20–40) [145–148]. In a study by Stonell et al. [148], which compared the TCI/PCS system to repetitive bolus propofol administration by an anesthesiologist during colonoscopy (n = 40), no significant differences were found in sedation efficacy or complication rates. However, the total propofol dose tended to be lower in the TCI group than in the bolus group (233 vs. 288 mg, P = 0.05).

A randomized, controlled, double-blind study on the use of TCI for gastroscopy and colonoscopy demonstrated very high patient and examiner satisfaction with TCI compared with standard sedation with fentanyl and midazolam [149]. A total of 94.3 % of patients reported wanting TCI sedation again for a future examination, compared to only 71.4 % of patients who received traditional sedation. Depending on the level of the target effect-site concentration chosen, dysphagia occurs under sedation [150]. It is more predictable under TCI because of the calculated concentrations than under non-concentration-controlled sedation. Measurement of BIS used in addition to TCI may help to adjust target concentration [151]. A study of anesthesia personnel in training showed that sedation quality and safety improved when TCI was used compared with manually administered sedation [152]. Further recent studies in different patient populations also support the safe use of TCI [153–157].

2.2.1.2.6 Computer-Assisted Personalized Sedation (CAPS)

The computer-assisted personalized sedation (CAPS) method extends TCI propofol dosing by the addition of various monitoring parameters. These include both physiological parameters (heart rate, blood pressure, O_2 saturation, and exhaled CO_2) and patient reactions to specific verbal (via headphones) and tactile stimuli (via a vibration mouse). Thus, sedation is implemented and monitored entirely by computer. A commercially available system from Ethicon only allows the regulation of moderate sedation depths; deep sedation and anesthesia are not yet provided. The system has been available in the United States since 2013 for pa-

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tients with an ASA-risk classification of I or II. It is also licensed in Canada and received CE certification in Europe in 2010 [158].

In an initial two-center evaluation in the US and Belgium, an adequate sedation effect without complications was observed in 96 patients undergoing gastroscopy or colonoscopy. Following an initial bolus administration of fentanyl (25–100 µg), 20 mg to 350 mg propofol (median 70 mg) were administered via this system [159]. The CAPS-group had fewer desaturation events than patients receiving standard sedation with midazolam and an opioid [128, 159]. Another system is currently being developed [128].

In 244 patients undergoing esophagogastroduodenoscopies or colonoscopies, higher patient and examiner satisfaction was found with comparable examination success rates and side effects compared to manual sedation with fentanyl and midazolam [160]. CAPS was also successfully used in 2677 colonoscopies performed in an outpatient setting. Compared to a historical control, the recovery time of the patients was significantly shorter [161]. Similar findings were obtained in 926 outpatient gastroscopies [162].

Due to a general trend toward deeper sedation, a commercial CAPS system could not establish itself on the market. It was discontinued only 2 years after its introduction. Approval of further systems is not foreseeable at the present time.

2.2.2 Benzodiazepines

Benzodiazepines induce anxiolysis, amnesia, and sedation. They have both anticonvulsive and muscle-relaxing effects. Respiratory depression and hypotension are also observed under benzodiazepines. They act by binding to GABA receptors. Various benzodiazepines can have different pharmacologic characteristics (e. g., a stronger sedating effect or a stronger anxiolytic effect) [163].

2.2.2.1 Diazepam

In the early days, diazepam was the only available sedative for endoscopies but is now rarely used in the Western world for these examinations. This can be attributed to its relatively long half-life compared to more recent short-acting benzodiazepines such as midazolam [164–166]. Diazepam has a markedly longer elimination half-life compared to midazolam (30–100 hours vs. 1.5–3 hours, respectively). The main side effects of diazepam are respiratory depression [167], coughing, and dyspnea. Phlebitis may occur at the injection site, especially if water-soluble forms are used [168]. The usual dose is a single injection of 5–10 mg (see also dose recommendation in the manufacturer's product information).

2.2.2.2 Midazolam

Midazolam is a short-acting benzodiazepine that for a long time was the most used sedative for endoscopy [169]. Its sedation potency is 1.5–3.5 times greater than that of diazepam [170]. The substance is effective after 1–3 minutes and reaches its maximum effect after 3–4 minutes, although the effect duration is between 15 and 80 minutes [171]. This is dependent on cofactors such as obesity, advanced age, and liver or kidney disease. It has dose-dependent hypnotic, anxiolytic, amnestic, and anticonvulsive properties like other benzodiazepines. The main pharmacologic actions are mediated by the activation of GABA receptors. All effects that are mediated by GABA receptors can be reversed by the specific antagonist flumazenil. When given in repeated or continuous doses, midazolam can have cumulative effects. Midazolam is mainly metabolized via CYP3A4 [172]. The side effect profile is equivalent to diazepam, but phlebitis occurs less commonly [173]. As is also sometimes the case with other benzodiazepines, midazolam administration can, in rare cases, lead to paradoxical reactions characterized by aggressiveness, hostility, and agitation. This phenomenon has been described in about 5 % of patients receiving midazolam by short-lasting oral administration [174]. A study by Christe et al. [175] of older patients who were sedated with midazolam (mean age 84 ± 7 years) for esophagogastroduodenoscopy showed that confusion occurred in 14 % of these patients, even on the next day. Benzodiazepine administration is regarded as an independent risk factor for the occurrence of delirious states [176].

For gastroscopies, midazolam is usually given as a bolus of 30–80 µg/kg body weight [84, 85, 175, 177]. For colonoscopies, an initial bolus between 30 and 50 µg/kg is generally given. Subsequently, lower dose boli are given until the desired sedation depth is reached [134, 177, 178]. The use of lower doses is recommended for patients older than 60 years [133, 175, 178–180]. Midazolam's duration of action is dependent on the length of its application because it tends to accumulate (context-sensitive half-life). Midazolam also increases the potency of other sedatives and hypnotics [163]. If sedation is the patient's preference, it is generally better to administer midazolam before the start of the examination rather than on an as-needed basis during the procedure [181, 182]. However, a meta-analysis of the Cochrane Database on preprocedural administration of midazolam found no clear evidence of beneficial effects [183].

2.2.2.3 Antagonistic Effect of Flumazenil on Midazolam

The effect of midazolam can be inhibited by using the benzodiazepine-specific antagonist flumazenil [184, 185]. A study by Mora et al. [186] showed that flumazenil has a stronger antagonistic effect on benzodiazepine-induced sedation and amnesia than on respiratory depression. Neutralization of the midazolam-induced respiratory depression occurs 120 seconds after intravenous flumazenil administration [187]. Flumazenil's half-life is 0.7–1.3 hours, and the average duration of the antagonizing effect is 1 hour. Patients who initially respond to flumazenil by regaining consciousness require prolonged monitoring to observe and treat a possible medication rebound.

In a study by Andrews et al. [188], 50 patients who underwent gastroscopy with midazolam sedation received either flumazenil or placebo directly after the examination and again 30 minutes later. Those who received flumazenil showed markedly improved memory, psychomotor function, and coordination after only 5 minutes ($p < 0.001$). However, re-evaluation of the same parameters 3.5 hours later showed no difference between the two groups. In contrast, the results of a study by Bartelsman et al. [189] of 69 patients who received flumazenil or placebo after midazolam administration for EGD demonstrated no re-sedation within 6 hours.

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Routine administration of flumazenil at the end of an endoscopic procedure reduces recovery time [190]. However, so far, no other benefits have been reported for either the patient or the endoscopist. Care should also be taken with patients taking carbamazepine, high doses of tricyclic antidepressants, or those suffering from chronic benzodiazepine abuse, as seizures or withdrawal symptoms may occur. Therefore, the routine use of flumazenil cannot be recommended. In patients in whom the use of flumazenil should nevertheless become necessary, an appropriately longer monitoring period should be observed.

Overall, the use of antagonists such as flumazenil seems to be rare. In a study period of 5 years, flumazenil and/or naloxone were used in only 0.03 % of cases. Reasons were a drop in oxygen saturation, respiratory changes, hypotension, and bradycardia. Compared to a matched control group, antagonists were used more frequently in the elderly, females, higher ASA class, and higher Mallampati index [191].

2.2.2.4 Remimazolam

One of the new developments in endoscopic sedation is the benzodiazepine remimazolam, which is currently in the final phase of approval. Due to the special metabolism of remimazolam, the recovery phase is significantly shorter than for midazolam (7.2 min to 15.7 min) [192]. Remimazolam acts comparably to midazolam at the GABA receptor. However, unlike midazolam but like remifentanil, it is degraded to inactive metabolites via tissue esterases. A phase IIa dose-finding study demonstrated dose-dependent, rapid, well-controlled, and safe sedation for patients undergoing gastroscopy [193]. A phase III study evaluated the use of remimazolam in 461 patients undergoing outpatient colonoscopy. With a comparable incidence of adverse events, patients receiving remimazolam had a more favorable neuropsychiatric recovery profile [194]. A protocol for a meta-analysis of existing studies on remimazolam was recently published [195].

2.2.3 Propofol Versus Midazolam

Recommendation 2.5	**2022 (unchanged)**
Based on the data on action profile and complications, we suggest that propofol be preferred over midazolam.	
Evidence level 2b, recommendation grade B, strong consensus	

Data on efficacy and complications suggest that propofol should be preferred to midazolam during sedation for gastrointestinal endoscopy. Individual adjustments must be made according to the patient's situation and the type of exam, as well as to the personal, personnel, equipment, and structural requirements mentioned in this guideline.

Patients, as well as endoscopists, judge sedation with propofol as good or better than sedation with midazolam [87, 88, 132, 196, 197]. Therefore, in recent years, propofol has gained importance as a sedative for gastrointestinal endoscopy. Some have termed this a paradigm shift in endoscopy, if nothing else, because of explicit requests for propofol sedation by some patients [72].

Randomized studies suggest that propofol is preferable for EGD, colonoscopy, and ERCP [72, 84–91, 197–201]. The advantages of propofol sedation compared to benzodiazepines are a shorter time of onset [87], significantly better patient cooperation (especially in interventional endoscopy such as ERCP) [198, 202], and a shorter recovery time [200], including recovery of psychomotor function [86]. In patients undergoing ESD, a comparison of propofol versus midazolam showed markedly better endoscopist-satisfaction with the exam conditions in the propofol group [203].

Propofol facilitates the performance of colonoscopy [204], and moderate sedation ("conscious sedation") is usually sufficient [205].

The in-depth analysis shows no influence of propofol on patient satisfaction for upper GI-endoscopy [84, 85, 197, 206] but an advantage for propofol during colonoscopies [86, 87, 196].

A comparative meta-analysis of five publications including 552 patients showed that endoscopist satisfaction was higher for propofol than for midazolam. Patient satisfaction and transfer criteria did not differ. However, hypotension occurred more often under propofol than midazolam [207].

A recently published double-blind study on outpatient colonoscopies showed clear advantages of propofol compared to a midazolam bolus or titrated midazolam regarding examination duration and induction time, as well as recovery and transfer time [208].

In a study of 1000 patients who underwent endosonographic procedures, a complication rate of 0.6 % was noted with propofol as compared to 1 % in historical controls who received midazolam and meperidine [72]. However, in the propofol group, one case of aspiration pneumonia occurred and three patients required endotracheal intubation [72]. Endoscopist satisfaction was higher in the propofol group and examination times were significantly shorter. Apnea was a frequent complication with potentially severe consequences.

Propofol also has advantages over midazolam for more complex procedures, such as endoscopic submucosal dissection [209]. Body movements occurred less frequently in patients sedated with propofol than with midazolam [210]. Apart from hypotonias, which occurred more frequently under propofol, side effects were comparable in both groups. A comparative study of 90 patients showed that propofol is also preferable to midazolam in patients with liver disease (such as liver cirrhosis) [211].

2.2.3.1 Cardiorespiratory Complications

Comparative data on complications from 12 randomized studies were compiled in a meta-analysis by Qadeer et al. [105] that describes the relative risk of sedation with propofol compared to benzodiazepines. The use of propofol for colonoscopy was associated with significantly fewer side effects. For other endoscopic interventions (EGD and ERCP), no significant difference was seen. A more recent meta-analysis included 20 studies and found higher satisfaction rates with propofol but no increase in complication rates [66].

When propofol is used for ERCP, there is in some cases a significantly higher risk of arterial hypotension compared to midazolam/meperidine [197–199, 212, 213]. There is also a tendency

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for oxygen saturation to drop below 90 % with propofol sedation, although this was not statistically significant (▶ **Table 9**).

In a risk factor analysis by Wehrmann and Riphaus [214] in 9547 patients who received propofol sedation for interventional upper endoscopy over a period of 6 years (EGD, n = 5374, ERCP, n = 3937, EUS, n = 236), 3151 patients had monosedation with propofol and 6396 patients sedation with a combination of propofol and midazolam. A total of 135 severe complications was reported (1.4 %), leading to discontinuation of the intervention. Short-term mask ventilation was necessary in 40 (0.4 %) and endotracheal intubation in 9 patients (0.09 %). Eight patients needed additional observation in the intensive care unit (0.3 %) and four patients died, three of whom had adverse events that could have been sedation related (mortality rate 0.03 %). After multivariate analysis of the data, emergency interventions and higher propofol doses were independent risk factors for cardiorespiratory complications [214]. In a comparative study of i. v. propofol monosedation versus i. v. propofol combined with oral midazolam in patients undergoing ERCP, fewer episodes of oxygen desaturation, lower propofol doses required, and less anxiety levels of the patients prior to the procedure were noted in the propofol/midazolam combination group [215].

In a large multicenter study of 177 944 patients in ASA classes I and II who underwent esophagogastroduodenoscopies or colonoscopies, 64.4 % of patients received propofol alone and 22.4 % a combination of propofol and midazolam. Sedation was provided by endoscopy personnel in 56.5 %. No severe adverse events occurred, and milder adverse events were more common in patients receiving midazolam and an opioid [216]. In contrast, an analysis of 73 029 procedures recorded 39 life-threatening events, such as cardiorespiratory arrest or significant hypoxia. Patients in all ASA classes were included. The authors note that there was an increase in complications, particularly in patients sedated with propofol. This was mainly attributed to patients with comorbidities, as well as a tendency toward deeper sedations [217]. However, a meta-analysis on the incidence of the cardiorespiratory side effects of propofol found no significant differences compared to traditional sedatives such as midazolam [218].

2.2.3.2 Amnesia

2.2.3.3 Diazepam Versus Midazolam

Recommendation 2.6	2022 (modified)
If benzodiazepines are to be used for sedation in justified individual cases, we recommend that midazolam should be preferred over diazepam because of its shorter half-life.	
Evidence level 2b, recommendation grade A, consensus	

Amnesia following the use of midazolam has been well studied [219] and has been shown to be significant. If amnesia is not desired, midazolam should not be used. An alternative benzodiazepine is diazepam [165, 166]. The longer half-life of diazepam has not been reported as a disadvantage compared to midazolam [166, 170, 220]. However, in some studies, patient comfort was lower after diazepam than after midazolam. Of all sedation concepts, midazolam has the highest potency of amnesia as a side effect. Examples of justified use of benzodiazepines can be found in [107, 215].

2.2.4 Other Drugs as Monotherapeutics

2.2.4.1 Introduction

Other drugs are either sedating/hypnotic or analgesically active substances that do not fall under the usual substance classes. These include opioids and ketamine (as monotherapeutics), inhalation anesthetics, nonsteroidal anti-inflammatory drugs (NSAIDs), and neuroleptanalgesics. There are only a few older studies on these substances, which show, at a moderate level of evidence, that these drugs are basically suitable for sedation. Evaluating the existing literature, the following points stand out:

1. The frequency of adverse events is much higher than for the usual sedation methods.
2. Some of these methods (such as neuroleptanalgesia) no longer have a role in modern anesthesia.
3. Scientific evidence is lacking for ketamine; specific side effects make this drug unsuitable for use as a monosubstance. Only a few studies with small patient numbers exist on the use of ketamine in combination therapy (e. g., in combination with midazolam or propofol); they suggest a positive effect. However, further evaluation in randomized studies with larger patient numbers is required.
4. Inhalation anesthetics require special equipment, monitoring procedures, and standards of safety in the workplace. It is impossible to adhere to MAC values (maximum allowable concentrations) of the substances used because open inhalation systems are almost always used in endoscopy, and routine protection of the airways (intubation and airtight laryngeal mask) is not the usual practice.
5. Based on the current data, there is not enough evidence for the routine use of NSAIDs for endoscopic interventions.

Recommendation 2.7	2022 (unchanged)
We suggest that opioids, ketamines, inhalation anesthetics, and neuroleptics should not be used as monotherapeutics for sedation in endoscopy.	
Evidence level 5, recommendation grade B, strong consensus	

2.2.4.2 Opioids as Monotherapeutics

2.2.4.2.1 Fentanyl

2.2.4.2.1.1 General Considerations

Fentanyl is a lipophilic synthetic morphine derivative that is chemically related to meperidine. It is about 600 times more potent than meperidine and 100 times more potent than morphine. The effect starts only about 20 seconds after intravenous administration, as the substance binds to specific opiate receptors in the brain and spinal cord. The maximum effect is expected after 6 minutes, and the duration of effect is 20–30 minutes. The initial

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dose is usually 50–100 µg. In older patients, the dose should be reduced. The most common adverse effect is respiratory depression, which may be expected with a dose of as little as 100 µg (for adults) because of the strong potency of the drug. In addition, thoracic rigidity may occur, which can make it more difficult for the patients to breathe spontaneously or to ventilate the patient, should this prove necessary. The effects on blood pressure and heart rate are mild, usually causing a drop in these parameters because of the central inhibition of the sympathetic nervous system. Smooth muscle spasms of the bile duct and pancreas and constipation can also occur. Nausea and vomiting under fentanyl are comparable to other opioids. Although fentanyl is usually used for general anesthesia (often in combination with other drugs) or for chronic pain (usually transdermal), there are few studies with small patient numbers on its use as an analgesic for endoscopy.

Studies that compared the use of fentanyl during EGD and sigmoidoscopy to unsedated procedures showed better patient acceptance and tolerance with fentanyl. Cardiorespiratory complications were not observed [221, 222]. A study comparing fentanyl and meperidine during endoscopic procedures showed shorter examination times when fentanyl was used. A more rapid patient recovery was reached with its use. However, meperidine showed a better analgesic effect in postprocedural pain scores [223]. In contrast, in 180 patients who received deeper sedation for analgesia, the fentanyl group showed a better postprocedural pain score than remifentanil [224].

2.2.4.2.2 Remifentanil

2.2.4.2.2.1 General Considerations

Data on the routine use of remifentanil, a highly potent synthetically synthesized opioid with an extremely short half-life (2–3 min), are scarce. Remifentanil is predominantly used in combination with midazolam or propofol to reduce the dose applied. Within a few minutes after intravenous injection, remifentanil is hydrolytically cleaved in blood and tissue by nonspecific esterases, regardless of liver and kidney function. There is no accumulation even after prolonged continuous use [225]. As with other opioids, the use of remifentanil can lead to respiratory depression. Muscle rigidity, especially of the respiratory muscles, is also observed. These side effects occur primarily with bolus administrations. Therefore, the substance should be applied only as a continuous infusion in spontaneously breathing patients. Use is restricted to a site that is fully equipped to monitor and support respiratory and cardiovascular functions (according to the product information).

In a randomized study by Akcaboy et al. [226], 100 patients received a continuous infusion of remifentanil (bolus 0.5 µg/kg, then 0.05 µg/kg per minute continuously) or propofol (bolus 0.5 mg/kg, followed by 50 µg/kg per minute) for colonoscopy. After bolus administration, the duration of the examination was longer, and the oxygen saturation was lower after remifentanil than after propofol. Although the recovery time was shorter for remifentanil, the time to hospital discharge was comparable. Nausea and vomiting were observed much more frequently in the remifentanil group. Fanti et al. performed a randomized, double-blind comparison of remifentanil and meperidine for sedation during colonoscopy. After an initial bolus, remifentanil was administered by patient-controlled application. Patients in the meperidine group received a bolus and a pump with normal saline for self-administration. Satisfaction scores of patients and endoscopists were similar in both groups. In addition, no differences were observed regarding procedure duration and the required times for discharge of the patients from the recovery area [137]. In another study, remifentanil was compared to a combination of midazolam and meperidine for colonoscopies. It showed a more rapid recovery and better hemodynamic stability of patients receiving remifentanil as compared to the control group [227].

Comparing remifentanil alone and pethidine with midazolam in colonoscopies, similar adverse event frequency was found with shorter recovery time and better intraprocedural communication with patients [228]. Another study also found adequate analgesia, faster recovery, and greater investigator satisfaction with remifentanil alone compared with remifentanil and midazolam, as well as pethidine and midazolam [229].

Using the up-and-down method, a pharmacokinetic model for dosing remifentanil with propofol was designed [230]. With the goal of suppressing gag reflexes upon insertion of the endoscope into the pharynx in 50 % to 90 % of cases, a target concentration of 1 ng/ml (equivalent to approximately 0.05 $mg^{*}kg^{-1*}min^{-1}$ without TCI) for remifentanil combined with a propofol bolus of 1 mg/kg or a target concentration of 2 ng/ml (equivalent to approximately 0.1 $mg^{*}kg^{-1*}min^{-1}$ without TCI) for remifentanil combined with a propofol bolus of 0.75 mg/kg was found. Remifentanil target concentrations are reached approximately 5 minutes after the start of the infusion [230].

The very good controllability, as well as the fast recovery times under remifentanil, make these substances a promising analgesic in combination with a well-controllable sedative in gastrointestinal endoscopic procedures.

2.2.4.2.3 Sufentanil

Sufentanil has a spectrum of activity favorable for analgo-sedation with potent analgesia and less respiratory depression compared with other opioids [231]. Greater hemodynamic stability and a shorter context-sensitive half-life have been described compared to the other opioids [232]. Sufentanil appears superior to fentanyl as an analgesic for procedural sedation because of lower risk of accumulation, greater therapeutic range, and spectrum of action. Due to its stronger sedative properties, sufentanil can be used in combination with sedatives and as a monotherapeutic. Compared with the partial opioid agonist nalbuphine, sufentanil produces equally good analgesia in colonoscopy patients [233]. However, respiratory depression occurred more frequently. Overall, the data on sufentanil for procedural sedation are still too limited to make an assessment.

2.2.4.3 Ketamines as Monotherapeutics

2.2.4.3.1 General Considerations

Ketamine is an intravenously or intramuscularly injectable general anesthetic with strong analgesic effects. It is mainly used as a "monoanesthetic" for short diagnostic and therapeutic interventions in children and for special situations in adults. After intrave-

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nous bolus administration, ketamine has a rapid onset of action (< 1 min) and an effect duration of about 10–15 minutes [234]. It causes a so-called dissociative anesthesia without cardiorespiratory depression [235]. The analgesic effect starts at sub-hypnotic doses and lasts longer than its anesthetic effect. The sedative and hypnotic properties of ketamine, however, are much less pronounced. Muscle tone is maintained or increased under ketamine anesthesia, so that the protective reflexes are generally not affected. Because of its sympathoexcitation, ketamine leads to a rise in blood pressure and heart rate, which in turn cause an increase in myocardial oxygen consumption and concomitantly increased coronary perfusion. Myocardial ischemia may occur [236]. Ketamine displays a negative inotropic and antiarrhythmic effect on the heart itself. Moderate hyperventilation is observed after ketamine administration. It has a relaxing effect on the bronchial muscles. Contraindications for ketamine use include insufficiently treated or untreated arterial hypertension (systolic/diastolic blood pressure above 180/100 mmHg at rest) and patients for whom a rise in blood pressure would be a substantial risk (e. g., history of cerebrovascular insult).

Relative contraindications include unstable angina pectoris or myocardial infarction in the preceding 6 months. Since, in general, the pharyngeal reflexes are maintained, mechanical irritation of the pharynx should be avoided when ketamine is employed as a monoanesthetic. Hallucinations, nightmares, and delirious states are frequent adverse events (in about 10 %–30 % of cases). These reactions can be reduced by also giving midazolam [235, 237]. In Germany, in addition to racemic ketamine, the levorotatory isomer S+-ketamine is also commercially available. S+-ketamine is approximately two times more potent than ketamine and is said to have fewer side effects [237, 238]. However, the literature on this subject so far is inconclusive.

For the reasons given above, ketamine is not recommended as a routine monotherapeutic for endoscopic examinations.

Most studies on the use of ketamine relate to its use in combination therapies (mainly with midazolam) for endoscopic interventions in children [239, 240]. It was shown that adequate sedation can be achieved without cardiorespiratory complications. Although the data on the use of ketamine in adults are limited, there are some indications that adjunctive use of ketamine (in combination with midazolam) can be beneficial for certain patients (all contraindications considered). A double-blind, placebo-controlled study by Rosing et al. [241] that compared midazolam/placebo with midazolam/ketamine for colonoscopy in 129 patients showed that patients receiving the combination therapy needed fewer repeat injections (40 % vs. 27 %), had better sedation and analgesia, and were more willing to agree to undergo another similar procedure. A randomized study by Ong et al. [242], which compared ketamine combination sedation (ketamine plus midazolam, pentazocine, and propofol) with propofol monosedation for ERCP, demonstrated, especially in younger patients, a better patient tolerance of the combination sedation. However, patient satisfaction was similar in both groups. In addition, hypoxia occurred more frequently when the combination therapy was used.

A recent study in colonoscopy patients showed better hemodynamic stability and fewer respiratory complications in the ketamine/propofol group than the propofol group with similar patient and endoscopist satisfaction [243]. Further studies also demonstrated advantages of a combination of ketamines with other sedatives/analgesics [244–246].

2.2.4.3.2 Etomidate

In recent years, the use of etomidate for sedation during endoscopic procedures has been increasingly studied. Like propofol and the benzodiazepines, the imidazole derivative etomidate is an agonist at the GABA receptor. It has a short onset and half-life comparable to propofol. Hypotension is less pronounced after bolus injection than after propofol [247]. Due to suppression of the adrenal cortex via inhibition of 11ß-hydroxylase with a drop in serum cortisol, etomidate is unsuitable for prolonged sedation without adequate cortisol substitution. Clinically relevant inhibition of cortisol synthesis may also occur after bolus administration of etomidate (e. g., for intubation) especially in patients with comorbidities. For this reason, the administration of etomidate should be critically considered in the context of sedation for endoscopy [248–251].

A meta-analysis comparing sedation with propofol and etomidate found no differences in sedative effects, cardiovascular side effects, and recovery time [252]. In contrast to propofol, etomidate caused fewer respiratory complications and injection pain, but patients had more frequent myoclonias. In a study comparing etomidate with midazolam, myoclonias were observed in 12.1 % of patients [253]. Patient satisfaction was higher with midazolam. Better hemodynamic stability was observed with a combination of etomidate and midazolam than with propofol and midazolam [253].

Due to the still relatively poor data situation and the potential side effects such as myoclonia and suppression of the adrenal cortex, especially in patients with comorbidities, no recommendation for etomidate in gastrointestinal endoscopy can be made at present.

2.2.4.3.3 Dexmedetomidine

Dexmedetomidine is a specific α2-adrenoceptor agonist characterized by sedative and low analgesic properties. Unlike other sedatives/hypnotics, dexmedetomidine does not cause respiratory depression. The substance has been approved in Germany since 2011 for sedation of adult patients in the intensive care unit up to a sedation level of RASS –3. Since the publication of the previous version of this guideline, it has also been approved for the sedation of adult, non-intubated patients before and/or during diagnostic or surgical procedures (source: product information preparation Dexdor, as of January 2020).

When rapidly administered intravenously, α2 agonists such as dexmedetomidine exhibit a typical hemodynamic profile. Initially, there is an increase in blood pressure followed by a mild hypotensive phase [254]. Therefore, because of the pronounced hemodynamic effects, dexmedetomidine should not be administered as a rapid intravenous infusion or even as a bolus [255]. Alpha 2 agonists should not be used in patients with bradycardic arrhythmias or in patients who are dependent on adequate mean pressure [256]. In case of volume deficiency, pronounced hypotensive phases may occur. Accordingly, the volume status should be assessed and compensated before administration of α2 agonists. The drug should only be administered by experienced users, and continuous monitoring must be

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ensured. The dose should be adjusted in patients with hepatic and/or renal function limitations and in elderly patients.

Since the publication of the last version of this guideline, the number of studies on the use of dexmedetomidine for sedation during endoscopic procedures has multiplied [257]. In 2015, a meta-analysis of nine studies comparing dexmedetomidine with midazolam was published by Nishizawa et al. [257]. Dexmedetomidine achieved deeper sedation on the Ramsay scale and therefore appears particularly suitable for ERCP and ESD. No differences were found with respect to cardiovascular parameters. It was speculated by the authors that the use of butylscopolamine under dexmedetomidine masks increased bradycardias [257]. There were no differences between dexmedetomidine and midazolam in terms of recovery time. In a meta-analysis of six studies by Zhang et al., dexmedetomidine had fewer side effects (especially respiratory depression) with better sedation quality [258]. A meta-analysis of six studies comparing dexmedetomidine with propofol was published by Nishizawa's group in 2017 [259]. Dexmedetomidine resulted in more bradycardia with otherwise comparable frequencies of adverse events. Patient satisfaction was significantly better with propofol sedation. No differences were found in recovery time.

Recommendation 2.8	**2022 (new)**
The use of dexmedetomidine may be considered for endoscopic procedures.	
Evidence level 1b, recommendation grade 0, strong consensus	

2.2.4.4 Inhalation Anesthetics as Monotherapeutics

2.2.4.4.1 Nitrous Oxide (Laughing Gas)

Recommendation 2.9	**2022 (modified)**
Nitrous oxide (laughing gas) may be considered for analgesia and sedation during colonoscopy only if the structural requirements are met.	
Evidence level 1b, recommendation grade 0, strong consensus	

2.2.4.4.1.1 General Considerations

Nitrous oxide (N_2O), the so-called "laughing gas", is a stable, slow-reacting, colorless, and odorless gas. It has strongly analgesic and mildly narcotic properties. Nitrous oxide has a rapid onset of action and a short recovery time. Mixed with oxygen, it is normally used to initiate or maintain anesthesia. In Germany, a fixed mixture of 50 % nitrous oxide and 50 % oxygen has been commercially available since 2008 (Livopan; in Great Britain available as Entonox since 1965, in other countries available as Emono or Meopa). Nitrous oxide is a gas at room temperature and must only be applied using suitable inhalation and anesthesia equipment. It has a mild sedative and a strong analgesic effect. Although normally, the circulation is only slightly affected, a drop in blood pressure, decreased stroke volume, and increased pulmonary vascular resistance may occur. Possible adverse side effects are nausea and vomiting. The occurrence of euphoria, dreams, and fantasies has been described. The methionine, folic acid, and vitamin B12 metabolisms can be affected [260]. If the dose is too high, hypoxia, circulatory depression, agitation, or somnolence and even unconsciousness may occur. Occupational safety measures must be enforced. In addition, its oxidizing capacity must be considered (see statement of the BDA and the German Society for Anesthesiology and Intensive Care Medicine; DGAI) [261].

In a meta-analysis of 11 studies including 623 patients who had a sigmoidoscopy or colonoscopy, nitrous oxide was compared to procedures that avoided the use of an analgesic [262]. There were no differences with regards to pain during exams that avoided analgesics but also no differences regarding colonoscopies with intravenous sedation. The use of nitrous oxide led to a more rapid discharge, as compared to intravenous sedation. A Cochrane meta-analysis analyzed the use of nitrous oxide during colonoscopy [263]. A total of 16 studies with 547 patients were included. Four studies showed that nitrous oxide has similar analgesic effects as conventional sedation. One study showed superiority of conventional sedation, and one study showed an advantage of nitrous oxide. Two studies showed a more rapid recovery of the patients with nitrous oxide, and one showed no difference. Finally, two studies showed improved safety with the use of nitrous oxide, whereas one study showed improved safety with sedation [263]. The authors concluded that nitrous oxide appears to have the same efficacy as conventional sedation for colonoscopy and a better safety profile, but that more data are required. In one recent study, it was found that nitrous oxide leads to more rapid recovery, as well as better pain control and patient satisfaction. However, in another study, no difference was observed between nitrous oxide and i. v. sedation when both were applied on demand [264, 265]. Few new studies indicate that nitrous oxide's sedation quality is comparable to an i. v. sedation [266–268].

The data situation still appears to be too weak to allow a clear assessment of the significance of nitrous oxide for the performance of endoscopy. It should be noted, however, that occupational safety regulations must be observed when using nitrous oxide.

2.3 Combination Therapies

2.3.1 General Considerations

Combination therapies are usually comprised of a sedative and an analgesic or a combination of different sedatives. As a general principle, opioids and sedatives mutually potentiate their action, leading to an increased risk of possible side effects [269–271]. By combining different substances, dose reductions can lead to more rapid recovery after the procedure [87, 196, 272, 273]. Although combination therapy causes hypotension and oxygen desaturation more frequently than monotherapies [274–276], the occurrence of accidental overdosing is reduced [112, 116] (see also section 2.3.3). In recent years, combinations of sedatives with i. v.-applied lidocaine have also been described [277–280].

Because of the synergistic effects of propofol, midazolam, and opioids, the dosage of propofol can generally be reduced when combining these substances (mainly shown in studies of general anesthesia), and side effects can therefore be reduced [281, 282]. In addition, the combination appears to provide improved

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safety in achieving moderate sedation rather than deep sedation [201, 281, 283, 284]. In elderly patients with comorbidities, the combination of midazolam and propofol leads to a shorter recovery time and better patient satisfaction than midazolam monotherapy [285]. These results are confirmed by a meta-analysis from 2010 that showed more occurrences of deep sedation with propofol monotherapy as compared to benzodiazepine monotherapy. However, propofol in combination with other substances showed no difference in sedation level as compared to benzodiazepines alone [66]. Anesthesiologists voice concerns of overdosing with the use of combination therapies [286].

Both midazolam and propofol are sedatives/hypnotics, which primarily act by binding to GABA receptors. For this reason, they have additive effects. The dosages of propofol and midazolam can be reduced when used in combination. However, their effect on GABA receptors remains similar. Propofol and midazolam have synergistic effects, at least regarding cardiorespiratory function. These can lead to corresponding hemodynamic changes. Midazolam has a longer half-life and a longer duration of action than propofol. Therefore, a prolonged recovery time must be expected as compared to propofol monotherapy. Increasingly, propofol, midazolam, and/or ketamine are also combined with dexmedetomidine [246, 287–293]. The different mechanisms of action, lower respiratory depression, and an effect enhancement by dexmedetomidine can be exploited.

2.3.2 Specific Combinations

2.3.2.1 Combination of Benzodiazepine Plus Opioids

A study by Milligan et al. [272], comparing a combination of alfentanil/midazolam with midazolam alone for upper endoscopy, showed an improvement in examination conditions for the endoscopist, increased patient acceptance, and a shorter recovery time. Another randomized, double-blind study by Radaelli et al. [294], which compared midazolam to midazolam/meperidine for colonoscopy in 253 patients, reported significantly less pain and a higher rate of willingness to repeat the intervention under combination therapy. The recovery time and the fall in oxygen saturation were comparable in both groups. A study comparing midazolam alone to a combination of midazolam and meperidine in 74 patients showed no difference in the quality of analgesia, recovery time, or procedure time [295]. The combination of midazolam and fentanyl, however, had a similar analgesic effect but a shorter recovery time than midazolam plus meperidine [296].

2.3.2.2 Combination of Propofol Plus Opioids

In a randomized, controlled study by Van Natta et al. [106], 200 patients undergoing colonoscopy were given propofol alone to reach deep sedation or a combination treatment with propofol/fentanyl, propofol/midazolam, or propofol/midazolam/fentanyl to reach moderate sedation. Recovery time, patient satisfaction, and vital signs were compared. Patients with propofol sedation alone needed significantly higher doses and showed deeper sedation stages than those given the other combination treatments ($P < 0.001$). The time to discharge was significantly shorter after the combination treatments than after propofol alone (median 13.0–14.7 min versus 18.1 min, $P < 0.01$). A large study of 222 patients undergoing complex endoscopic procedures demonstrated no difference in vital signs between the study groups, and there was no significant difference in patient satisfaction [297]. The combination of propofol and opioid showed no difference in safety between propofol and standard sedation. In addition, Lee's study showed that the use of propofol was associated with significantly increased patient satisfaction.

2.3.2.3 Combination of Sedative Plus Propofol

A total of 64 patients underwent two long (> 30 min) consecutive endoscopic examinations and initially received propofol and then a combination of midazolam and propofol. The advantage of combined sedation was that a significantly lower dose of propofol (–59 %) was required. However, the postinterventional recovery time was twice as long for the combination regimen (4 vs. 8 min) [298]. Furthermore, it was demonstrated in 239 consecutive patients undergoing therapeutic endoscopy (EGD and endoscopic ultrasonography) that the combination of propofol and midazolam led to a lower dose of propofol compared to monotherapy (0.20 ± 0.09 mg/min per kilogram body weight vs. 0.25 ± 0.13 mg/min per kilogram, respectively, $P < 0.01$) with otherwise comparable efficacy [273]. However, the combination regimen was also associated with a longer recovery time (25 ± 8 min vs. 19 ± 7 min, respectively, $P < 0.05$). Another study showed a similar effect of dose reduction and a shorter postinterventional recovery time with the use of a combination of propofol with midazolam as compared to propofol monotherapy (13.0–14.7 versus 18.1 min, $P < 0.01$, respectively) [106].

Recommendation 2.10	**2022 (unchanged)**
We suggest that a combination of propofol and midazolam should not be used.	
Evidence level 1b, recommendation grade B, consensus	

2.3.2.4 Combination of Sedatives Plus Spasmolytics

A prospective, double-blind, placebo-controlled study by Mui et al. [299] investigated the use of the spasmolytic hyoscine N-butylbromide (Buscopan) for sedation in patient-controlled sedation with propofol/alfentanil for colonoscopy. The study demonstrated a longer cecal intubation time, significantly lower endoscopist satisfaction, a significantly higher dose of sedative/analgesic, and significant hemodynamic instability.

The combination of spasmolytics with sedatives increases the rate of cardiovascular side effects and reduces both patient satisfaction and the endoscopist's evaluation of the examination. The use of spasmolytics in sedation for endoscopy should therefore be carefully considered. Since the focus of this guideline is sedation and not spasmolysis, no firm recommendation is given.

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2.3.3 Side Effects of Combination Therapies

2.3.3.1 General Considerations

Even if the recommended dose reduction for combination therapy is followed, respiratory function is compromised more frequently than under monotherapy [274–276]. Based on the existing studies, it cannot be stated whether life-threatening situations occur more often under combination therapy.

In a randomized, double-blind, placebo-controlled study, 71 patients were sedated with diazepam or a combination of diazepam plus meperidine. Patient satisfaction was similar in both groups, but the endoscopists preferred the combination therapy because of better patient tolerance. However, with combination therapy, oxygen saturation dropped twice as often as with diazepam monotherapy ($P = 0.008$) [276]. Another study randomized 35 patients to either a combination of alfentanil/midazolam or midazolam alone [274]. Again, a fall in oxygen saturation resulting in a need for oxygen administration was more common with the combination treatment. Patient tolerance, patient satisfaction, recovery time, and blood pressure were comparable in both groups.

A randomized, double-blind study investigated the addition of remifentanil to sedation with propofol in 50 relatively healthy patients (ASA grades I and II) undergoing colonoscopy. Blood pressure and oxygen saturation dropped significantly more often in the remifentanil/propofol group. Although the addition of remifentanil allowed for a propofol dose reduction, recovery time was significantly shorter ($P < 0.01$) and patient satisfaction significantly higher ($P < 0.01$) with propofol monotherapy [275].

2.4 Influence of Comorbidities

2.4.1 General Considerations

A higher ASA classification is assigned to patients according to the severity of their comorbidities. Patients with comorbidities have a higher rate of adverse events compared with healthy subjects [92, 300, 301]. Older patients and patients with pre-existing coronary or pulmonary diseases are at higher risk of complications during endoscopy with sedation [92, 302, 303]. Hepatobiliary diseases (in which drug elimination is reduced) or age-related slower metabolism can also potentiate side effects [172, 304, 305].

A multiplicity of physiological processes contribute to increased sensitivity toward the various drugs, leading to a correspondingly increased sedation risk [306]. Age-related diseases and rapid or excessive doses contribute more strongly to cardiorespiratory complications than age per se [306].

2.4.2 High-Risk Patients

Recommendation 2.11	**2022 (unchanged)**
Patients with a higher ASA grade and/or older patients are at higher risk of sedation-related side effects (cardio-respiratory depression). We suggest that the dose of the sedative/analgesic used should be adjusted/reduced accordingly.	
Evidence level 2b, recommendation grade B, strong consensus	

2.4.3 Substance Type

In accordance with the modified recommendations of the American Society of Gastroenterology for elderly patients undergoing gastrointestinal endoscopy [307], fewer substances should be administered more slowly and at a lower cumulative dose [307, 308]. In many cases, midazolam and/or opioids are used to sedate elderly patients. Since there is an increased risk of hypoxemia with the use of benzodiazepines in elderly patients, patients with obesity, and anemic patients, a reduction in dose seems advisable [309]. Postintervention hypoxemia risk is also increased, especially in elderly patients [213].

Since propofol has a limited therapeutic range, it can lead to more cardiorespiratory complications in older high-risk patients than in younger patients [92, 310]. Low initial doses of propofol (in general half the recommended dose for adults), slow, gradual titration, and careful monitoring are recommended for sedation of older patients [311–313]. If special care is taken in sedating elderly patients, it has been shown that propofol can be safely used in this patient group [213, 310, 313]. In a study of elderly patients receiving propofol for endoscopic examination, it was shown that patients over 70 years of age required lower doses of propofol than patients under 70 years of age. The incidence of major and minor complications was the same in both patient groups [313]. Based on 27 000 patients, it was demonstrated that under sedation with propofol, there was a drop in oxygen saturation in 2.3 % of patients, even though 2 L of oxygen were administered during the procedure. In elderly patients over 70 years of age, it was even more than 5 % [117]. In these patients, hemodynamic parameters were only recorded in a few cases, so it can only be guessed whether further complications would occur. There was also no monitoring of ventilation, so hypoventilation and hypercapnia can also only be speculated on. Continuous administration of propofol in patients over 80 years of age led to a clear tendency of increased decreases in oxygen saturation, even though there were not more complications overall compared to younger patients [114]. A cohort study by Vargo et al. [300] analyzed risk factors for cardiopulmonary events during propofol sedation for upper and lower endoscopy. The overall risk of a cardiopulmonary event during 528 gastroscopies and 1683 colonoscopies was 11.7 per 1000 cases. A higher risk was found in patients with an increasing ASA grade who were undergoing colonoscopy.

In a randomized study by Riphaus et al. [314], 60 patients with known liver cirrhosis and portal hypertension were sedated with either propofol or midazolam. Before and 2 hours after the examination, all patients took a number connection test (ZVT-A) and a portosystemic encephalopathy syndrome test (PSE). Twenty patients without liver cirrhosis who did not undergo gastroscopy were the control group. Recovery time and the recovery score were also determined. Compared to sedation with midazolam, patients sedated with propofol had a significantly shorter recovery time (18.4 ± 6.7 min vs. 7.8 ± 2.9 min, respectively). Propofol also affected the PSE score less than midazolam, the use of which led to transient exacerbation of the existing subclinical hepatic encephalopathy. Hence, sedation with propofol tends not to cause exacerbation of subclinical hepatic encephalopathy in patients with liver cirrhosis and is therefore an alternative sedative for use in

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these patients. Likewise, another study compared a combination of propofol with midazolam or fentanyl in patients undergoing upper gastrointestinal endoscopy and found propofol-based sedation to be more effective with a more rapid recovery as compared to midazolam [315]. Because of its shorter duration of action, better controllability, and fewer complications regarding hepatic encephalopathy in cirrhotic patients, propofol should be preferred over benzodiazepines and/or opioids in such cases [314–318].

Recommendation 2.12	2022 (unchanged)
We recommend that propofol should be used for sedation of patients with hepatic encephalopathy. Benzodiazepines should not be used in patients with hepatic encephalopathy.	
Evidence level 1b, recommendation grade A, strong consensus	

2.4.4 Obesity

Data on the effect of obesity on sedation for endoscopy are still limited. Morbid obesity can result in several comorbidities such as obstructive sleep apnea, restrictive lung disease, and pulmonary hypertension. Diseases of the lung or upper airways increase the risk of complications during sedation. In a study in obese patients who received propofol sedation for upper gastrointestinal endoscopy, 2 of 69 patients had to be treated for hypoxemia [319]. In another study, a multivariate analysis of 799 patients identified a direct association between BMI and sedation problems in patients who were sedated with propofol [320]. An analysis of 799 patients identified BMI and higher ASA classification as predictors for respiratory and cardiac complications [321]. A multivariate analysis identified ASA class III or greater and an elevated BMI as independent risk factors for mechanical, respiratory support [322].

2.4.5 Elderly Patients

As in obese patients, data on sedation for endoscopy in geriatric patients is sparse. Generally, aging leads to a reduction in organ function. Impaired hepatic or renal function are of particular importance for the metabolization and elimination of sedatives and analgesics [323]. In addition, as a result of existing comorbidities, polypharmacy is common in the elderly. This can lead to drug interactions with the substances used for sedation. One study showed that patients older than 70 years required less propofol than those younger than 70 years [313]. In patients older than 90 years of age, only minimal doses of propofol are required to reach adequate examination conditions [324]. Furthermore, patients older than 80 years have a higher risk of oxygen desaturation [114]. A study in more than 10 000 patients showed a general increase in the rate of complications with age [325]. A German study of patients older than 80 years showed only a slightly increased risk when mild sedation was used [213]. Required doses for adequate sedation were 10–20 % lower in high-risk patients than in those with an ASA classification of I and II [310]. Meticulous monitoring is therefore required in high-risk, elderly patients. Also, several recent studies showed that sedation can be safely performed in the elderly if careful attention is paid to sedative/analgesic dosing and adequate monitoring [156, 326–330]. Postprocedural pneumonias can occur more often in sedated patients [27].

Recommendation 2.13	2022 (unchanged)
Propofol may be considered for sedation in elderly patients.	
Evidence level 1b, recommendation grade 0, strong consensus	

2.4.6 Comorbidities

An increased risk can also be found in younger patients with comorbidities who undergo sedation. As a result, higher ASA classification appears to predict more frequent complications [322, 331–334]. A study of propofol sedation for endosonography included patients of all ASA classes. It found no correlation between ASA class and risk of complications. However, sedation was performed by an anesthesiologist [72]. It should be considered that patients with multiple comorbidities and high-risk patients have special staffing requirements (see chapter 3.3).

A meta-analysis on the sedation of patients with liver cirrhosis showed that propofol has similar side effects and a shorter recovery and discharge time than midazolam (296). Another meta-analysis came to the same conclusion that the frequency of side effects under midazolam and propofol is similar [335]. However, the efficacy of the propofol sedation was significantly better. Therefore, propofol sedation should be preferred in patients with liver cirrhosis. Patients undergoing variceal ligation experienced more frequent desaturations (23.2 % vs. 7.7 %), bradycardia (22.5 % vs. 17.2 %), and hepatic encephalopathy (6.6 % vs. 0.6 %) in the midazolam group compared to patients who were not sedated with midazolam, respectively [336].

2.4.7 Antagonists

Recommendation 2.14	2022 (modified)
We recommend that specific antagonists for benzodiazepines and opioids should be immediately available in the endoscopy suite. *Adapted from the ASGE, 2008*	
Evidence level 5, recommendation grade A, strong consensus	

Recommendation 2.15	2022 (unchanged)
Offering music to the patient may be considered to reduce the dose of the sedative used.	
Evidence level 1b, recommendation grade 0, strong consensus	

Several studies found a positive effect of music regarding the reduction in sedative and analgesic doses. These results were also confirmed by meta-analyses.

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A recent randomized controlled trial also found the benefit of music during colonoscopies. In the music group, patients had less pain, were more satisfied, and the examination was easier to perform. In addition, the need for midazolam and pethidine was less than in the control group [337]. The anxiety level was also favorably influenced by music during endoscopy. In 180 patients, no difference in anxiety level was found depending on age or type of examination. However, music significantly reduced anxiety [338]. In contrast, a study of 307 patients showed that music had no effect on pain perception during endoscopic procedures [339].

A meta-analysis by Rudin et al. [312] evaluated six randomized controlled studies with a total of 641 patients. In three studies, endoscopy was done with music alone. This reduced the patients' anxiety levels in comparison to the control group by 8.6 % (P = 0.004). In the remaining three studies, patients received music in addition to drug therapy (midazolam, meperidine, or propofol/alfentanil). This significantly reduced the need for analgesics by 29.7 % (P = 0.001) and for sedatives by 15 % (P = 0.055). Another meta-analysis of eight studies included a total of 722 patients undergoing colonoscopy. A reduction in examination time was found, whereas other parameters, such as pain, blood pressure, and recovery time, were only minimally influenced by music. However, no unfavorable effects of music were noted, aside from the acoustic isolation of the patient from the endoscopy personnel [340]. A third meta-analysis of eight studies included 712 patients. No difference was found regarding various endpoints regardless of whether music was used or not. However, overall satisfaction scores were significantly higher in the music group [341]. In a recent study of patients undergoing colonoscopy, an EMG of the facial musculature was used to objectify stress levels. It was found that patients who listened to music during the procedure had significantly lower stress levels than the control group [342]. While patient satisfaction showed no differences, endoscopists were significantly more satisfied with the course of colonoscopy.

Overall, the data suggest that music during an endoscopic procedure may lead to a shorter examination time with possible reduction in sedative doses. Since the use of music entails little effort and does not lead to relevant side effects, its use can be recommended in patients who wish to have it.

Acupuncture/Hypnosis

Although there has been increasing interest in alternative medicine in recent years, data on the use of acupuncture during endoscopic procedures are still scarce. While there is evidence of a reduced need for sedatives/analgesics in patients with acupuncture [342], other results show no effect on sedation [343]. Further studies must be done before the value of acupuncture for sedation in endoscopic gastrointestinal procedures can be assessed. The same is true for hypnosis.

3 Guideline – Structure Quality

Since there are currently only limited prospective studies on the topic of structure quality, almost all recommendations are based on previous guidelines and recommendations of other professional societies [21, 81, 117, 344–373], as well as the current S2k guideline, "Quality-Requirements for Gastrointestinal Endoscopy" (AWMF register no. 021–022).

3.1 Personal Requirements

The endoscopic examination and/or treatment and the sedation procedure are distinct medical procedures. If physicians perform the diagnostic or therapeutic intervention and, at the same time, also carry out the sedation, they take full responsibility not only for the intervention but also for the sedation and/or analgesia. This includes monitoring and, if required, restoration of vital functions.

Special theoretical and practical knowledge on sedation and/or analgesia is necessary not just for physicians, but also for supporting nurses and other assisting staff. A physician cannot perform the invasive intervention and at the same time monitor the sedation and/or analgesia procedures.

Therefore, all personnel involved in sedation and monitoring should be familiar and trained with the sedation technique used, as well as its monitoring and complication management (see point 3.3.1).

Whether, in individual cases, physicians performing the sedation can be substituted by qualified, specially trained, nonphysician personnel must be decided on a case-by-case basis by physicians who perform the diagnostic or therapeutic intervention. These physicians take responsibility, and they must perform an on-site assessment with consideration of the structure of the working place, the patient's overall condition, and the complexity of the procedure (also see point 3.3.3.1). The examining physician (endoscopist) must ensure that such a substituting person is sufficiently qualified and capable of carrying out their tasks appropriately.

The problem of the organization/transfer of liability is regulated by general legal principles based on civil, criminal, and occupational law. The detailed manufacturer's product information for the used drug(s), especially regarding structure quality (e. g., equipment and personnel requirements), must be followed.

Recommendation 3.1	**2022 (modified)**
We recommend that physicians who are responsible for the sedation should be experienced in intensive care medicine. They should be trained and proficient in the use of sedatives and analgesics. This involves knowledge, recognition, and treatment of expected side effects including cardiopulmonary resuscitation, maintaining upper airway patency, intubation, and assisted ventilation.	
Evidence level 5, recommendation grade A, strong consensus	

As in the guidelines of other professional societies [21, 311, 361–372, 374–380], personal prerequisites for carrying out analgo-sedation include knowing how to deal with an emergency situation (including correcting circulation problems) and being proficient in endotracheal intubation.

This has not changed, even in the new versions of various international guidelines [373, 381–384].

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3.2 Education and Training Courses

Recommendation 3.2	2022 (modified)

As part of quality assurance, we recommend physicians and nonphysician assisting personnel should participate in specifically designed sedation training. The knowledge of the nonphysician personnel should be certified.

Evidence level 5, recommendation grade A, strong consensus

So far, only isolated special training guidelines exist on sedation and management of emergency situations. However, they show that specific training courses, such as those using simulators, improve physicians' confidence in handling emergency situations [385, 386].

A much broader training program for nonphysician assisting personnel (nurses) was the subject of several studies using propofol [94, 334]. The DGVS has developed a structured curriculum for a joint one-day team training for physicians and nurses [387]. For training of qualified, nonphysician assisting personnel (nurses or physician's assistants) a 3-day curriculum is offered by the DEGEA and accredited by the DGVS [387]. In addition, since 2012, a training curriculum of the ESGE and ESGENA exists [388], which was developed in accordance with the German recommendations. All curricula rely on the use of simulator-based training.

Recently, there have been positive recommendations from numerous international guidelines on this subject [373, 381–384, 389, 390]. High safety in the use of NAPS by trained teams has also been documented in mostly retrospective studies [391–393]. For sedation with midazolam plus opiates (moderate sedation), a reduction in the number of hypoxias by trained compared with untrained endoscopists was reported [386].

Recommendation 3.3	2022 (modified)

We recommend that the qualification of physicians and nonphysician assisting personnel who are involved in sedation, monitoring, and follow-up should be ensured by periodical participation in structured education curricula.
In addition to theoretical knowledge, these curricula should transmit practical competencies including complication management (e. g., simulation training).
Note: It is generally preferable for the whole endoscopy team (physicians and nonphysician assisting personnel) to do the training together.

Evidence level 2, recommendation grade A, strong consensus

Background

Annual training courses in cardiopulmonary resuscitation (e. g., "megacode" training) for all hospital nurses is still generally recommended. The training curriculum for sedation is no substitute for these annual courses. How often such sedation training curricula must be held differs greatly and depends on the individual prerequisites of hospitals or practices (experience/training of physicians and nurses, number of sedations performed, experience in complication management, etc.). Therefore, no definite statement about the required frequency of repeating such training curricula can be made in this guideline. The individual frequency (e. g., every 3 years) should be determined in each endoscopy unit as part of the quality management process. Ideally, this should be done as a peer-reviewed process, and the results should be documented in writing. The DGEA recommends repeated training for nurses every 3 years. Several retrospective studies have also documented a high degree of safety in the use of NAPS by trained teams [391–393]. For sedation with midazolam plus opiates (moderate sedation), a reduction in the number of hypoxias by trained compared to untrained endoscopists was reported [386].

In principle, team training of physicians and nonmedical staff is recommended, but in Germany participation of physicians, especially in refresher courses, has often in the past not been the case.

3.3 Personnel Requirements

Recommendation 3.4	2022 (modified)

For every endoscopy under sedation, we recommend that one person is solely responsible for the performance, monitoring, and documentation of the sedation. This person should have verifiable specific training and be experienced in the monitoring of patients who have received medication (sedatives, hypnotics, and/or analgesics).
In all cases, if an increased patient risk (e. g., ASA class ≥ III and procedural special risk factors for cardiopulmonary events), anatomical peculiarities of the airways, or severe neurologic diseases are expected, we recommend that a second physician (qualified in resuscitation and intensive care) be present whose only task is the sedation and the monitoring of the patient.

Evidence level 5, recommendation grade A, consensus

The guideline of the DGAI [376] states: "Since the examiner is usually unable to watch the patient's vital signs with sufficient care while doing an endoscopy, it is necessary for a second, specially trained, and qualified person to reliably take over the patient monitoring."

It was shown in several studies that patients with greater comorbidities (ASA class ≥ III) have an increased sedation risk during emergency and long lasting (> 60 min) endoscopies [220, 394–396]. Questions regarding the composition of endoscopy teams or persons involved in endoscopic procedures or interventions are addressed in the DGVS guideline, "Quality Requirements for Gastrointestinal Endoscopy" (AWMF register no. 021–022). There is adherence to the initial statement that one person should be exclusively responsible for the performance and monitoring of the sedation.

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Requirements for training are outlined in the training curricula of the European Society of Gastrointestinal Endoscopy (ESGE) and German Society for Endoscopy Assisting Personnel (DEGEA) [387, 388]. In principle, as a prerequisite of training in sedation and emergency management, assistants should have formal training in a medical profession (nurses, physician's assistants, etc.).

The recommendation also corresponds to most of the current international guidelines [373, 381–384, 390]. In a new ASGE guideline, which focusses on this topic ("Staffing requirements") [397], a differentiated procedure between the performance of unsedated endoscopies (not the subject of the current guideline), the administration of moderate sedation (by benzodiazepines and other substances excluding propofol), and of deep sedation (with propofol) is recommended. The sole focus of the sedating person on the sedation procedure ("sole task") is only required for deep sedation with propofol. Furthermore, the German "Pro-Sed" studies [34, 398] indicate that for low-risk patients and interventions, a "sole task" approach, also for propofol, is not mandatory. However, definite proof, based on hard endpoints, has not yet been provided for this strategy. Based on "primacy of patient safety", the previous recommendation remains valid. The ASA classification (as an excellent factor) proves difficult to classify the risk of patients who should have a second physician present, as the definition of this group is very diverse. For example, decompensated heart failure or severe COPD is certainly an indication for physician-guided sedation rather than NAPS sedation, but poorly controlled diabetes mellitus or chronic, rate-controlled atrial fibrillation are mostly not. However, most of the guideline group voted in favor of maintaining the 2014 recommendation.

A recent retrospective Scandinavian study [392] showed that for ASA I-II patients, complex endoscopic examinations (ERCP, EUS, balloon enteroscopies, and also those with high procedural risk) are also safely possible in a "NAPS setting". The evidence of a single retrospective study is currently not sufficient to change the recommendation.

3.4 Monitoring During and After the Endoscopic Procedure

Recommendation 3.5	**2022 (unchanged)**
We recommend that monitoring measures should be based on the patient's health status, the invasiveness of the endoscopic procedure to be performed, and the type of sedation/analgesia used.	
Evidence level 5, recommendation grade A, strong consensus	

Several prospective complication registers [220, 394–396] showed an increased complication rate in patients ASA class III and higher, both for interventional endoscopy and emergency examinations. In a single-center, prospective-case series of patients undergoing interventional endoscopies (majority upper GI tract hemostasis and ERCP) [214], an increased morbidity and mortality was found, and patients with higher ASA class and those who underwent emergency interventions were at highest risk. This is also confirmed in recent German publications [34, 398]. The recommendation is in consensus with all international guidelines dealing with this topic [373, 381–384, 390].

Recommendation 3.6	**2022 (modified)**
We recommend that sedation should be initiated by an appropriately qualified physician (see Recommendation 3.1).	
Evidence level 5, recommendation grade A, strong consensus	

The delegation of medical services, such as the delegation of monitoring to assistants, requires the presence of a physician who is personally responsible for delegating this activity.

In Germany, the indication for sedation and the choice of special medication must be made by a physician who is qualified to do so (a requirement of pharmaceutical law).

Recommendation 3.7	**2022 (modified)**
Subsequent monitoring and continuation by an experienced person with appropriate training (physician, nurse/physician assistant) may be considered.	
Evidence level 1, recommendation grade 0, strong consensus	

The safety of NAPS sedation has been documented in numerous international, mostly prospective, studies [34, 125, 398–406].

The previous Recommendation 3.3.3.1c is redundant to Recommendation 3.4 (previously 3.3.2.1) and was left in the previous guideline versions of 2008 and 2014 to emphasize the importance of this passage ("the sedating person is solely responsible for the administration, monitoring, and documentation of sedation") under the primacy of patient safety. Because of redundancy, this recommendation has now been deleted. The adoption of the resolution was only by simple majority (no consensus reached) because, to many members of the guideline group, this statement is still important. However, there are modifications of this recommendation in the literature.

The European guideline is more open regarding the requirement that no relevant restriction of the activities of the person monitoring the sedation is allowed [362] and this applies equally to the ASGE guideline [367]. It is stated that short activities, which can be interrupted at any time without danger, can be additionally assumed by this person [362, 367]. A possible example would be the handing of biopsy forceps, e. g., for taking Helicobacter samples during gastroscopy. A precise definition of these "short interruptible tasks" [367] is not given. However, the German guideline group remained stringent in this regard because of the legal requirements underlying the expert opinion from 2006 on the ability to delegate intravenous sedation in endoscopy by Prof. Dr. Dr. A. Ehlers (see DGVS homepage at www.dgvs.de).

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Recommendation 3.8	2022 (modified)
Administration of drugs necessary to maintain sedation or control complications during the procedure by properly trained and experienced persons, who are exclusively assigned to this task as ordered by a physician, may be considered.	
Evidence level 1, recommendation grade 0, strong consensus	

Under appropriate conditions, NAPS is safe and efficient [334, 407–409] in patients with ASA classification I–III (▶ **Table 8**). NAPS should not be performed in ASA IV patients [334, 407–409]. NAPS should be performed by an appropriately trained person supervising only this task. To date, only one prospective case series exists in diagnostic OED and colonoscopy. In 27 000 patients, it showed that even when supervised by the assisting endoscopy nurse ("2-person procedure"), NAPS appears to be safe [117]. However, randomized studies on this issue are not available to date, and most of the studies on NAPS (> 95 %) were conducted in a "3-person setting". The fact that in Germany, as shown in a survey by A. Behrens et al. [410], a "third person" is only involved in a maximum of 50 % of cases makes it irrelevant for the guideline recommendation (which must primarily be based on published evidence and safety of use). Directly comparative, randomized studies on the frequency of complications in procedures using a "2-person vs. 3-person procedure" in the context of sedation during GI endoscopy are lacking to date. A first study implementing such a setting has only recently been completed ("Pro-Sed 3" study), but the results have not yet been published in full.

Recommendation 3.9	2022 (modified)
We recommend that after completion of the procedure, the sedated patients should be monitored.	
Evidence level 5, recommendation grade A, strong consensus	

Postinterventional monitoring is necessary to detect any sedation sequelae. The duration of the postinterventional monitoring phase depends on the expected risk [270]. The duration of action and the half-life of the substance used should be considered.

Close monitoring of the patient by qualified personnel should be continued until the patient has completely recovered. This should be done irrespective of the substance used and, if appropriate, with the use of a pulse oximeter. Patients can be released from the monitoring area when their vital signs are stable and they are alert [376]. The vital signs and level of alertness of the patient must be documented upon discharge from the recovery area. Please refer to topic V of this guideline for details regarding the outpatient and inpatient setting.

Since follow-up should also include follow-up of problems not caused by sedation (e. g., perforation, nausea, etc.), a change in the wording of the 2014 recommendation (although without any evidence) seemed appropriate. Almost all international guidelines recommend patient monitoring independent of whether the focus is on sedation or not [373, 381–384, 390]. In sedated patients, detection of even non-sedation-related problems (e. g., perforation or other technical complications) may be delayed.

Recommendation 3.10	2022 (unchanged)
We recommend that patient monitoring in the recovery phase should be performed by appropriately trained and qualified personnel.	
Evidence level 5, recommendation grade A, strong consensus	

Monitoring persons must always be present in the recovery area or have the recovery unit in view (telemetric monitoring via cameras, etc. is not recommended).

However, they may, for example, use the telephone or file reports (i. e., perform tasks that can immediately be terminated). For safety reasons, patients who are awake should remain in the monitoring area until they are discharged. This prevents patients from leaving the area on their own while still under the influence of the sedation (see verdict of the German Supreme Court (Bundesgerichtshof), reference no. VI ZR 265/02).

This recommendation corresponds to all recommendations of other professional societies [373, 381–384, 390].

3.5 Facility and Equipment Requirements

Recommendation 3.11	2022 (modified)
We recommend that sedation should only be carried out in an environment adequately equipped to monitor and support respiratory and cardiovascular function. There should be an additional, separate recovery area. This recovery area should also allow the monitoring of vital signs and treatment of cardio-pulmonary complications and should be supervised by persons qualified for this purpose.	
Evidence level 5, recommendation grade A, consensus	

According to the DGAI guideline [376], "the spatial conditions and the equipment of the treatment and monitoring rooms must be designed to the requirements of patients with relevant concomitant diseases (ASA III and higher). The treatment room should be equipped with monitoring equipment (pulse oximetry, RR, ECG), drugs, oxygen connection, suctioning, and the tools and equipment needed to perform resuscitation. In the event of a serious complication, a suitable means of transport to a qualified treatment facility (intensive care unit) must be ensured (e. g., elevator with the possibility of transporting the patient lying down)." Currently, there is no evidence-based data available for the valid recommendations and standards. For further details, please refer to the guideline on "Quality Requirements for Gastrointestinal Endoscopy" (AWMF register no. 021–022). This guideline also describes the criteria for the structural and personnel requirements of the recovery area, which have been included in the current version of the sedation guideline since 2014.

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Recommendation 3.12	2022 (unchanged)
We recommend that mandatory monitoring during endoscopy should include pulse oximetry and blood pressure measurement.	
Evidence level 5, recommendation grade A, strong consensus	
We suggest that continuous ECG monitoring be done for those patients who have severe heart disease or expected arrhythmic problems.	
Evidence level 5, recommendation grade B, strong consensus	

The person in charge of the clinical monitoring checks breathing by observation, palpation of thorax, and abdominal wall movement and possibly by auscultation of the expiratory airstream. The endoscopy personnel must have appropriate emergency training and must be proficient in cardiopulmonary resuscitation.

According to the recommendations of various national and international professional societies, pulse oximetry is required for monitoring during all examinations [5, 361, 372]. For sedated and high-risk patients, continuous blood pressure and ECG monitoring are also demanded.

In addition to clinical monitoring, pulse oximetry is now a prerequisite for sedation (especially after the introduction of the quality assurance agreement for colonoscopy in accordance with § 135 SGB V). Here, oxygen saturation and heart rate are measured continuously. In Switzerland, according to a survey from 2012, 100 % of all endoscopies with propofol sedation were monitored by pulse oximetry [411]. Similar studies from other countries, as well as from Germany [13, 14, 50, 51], show comparable figures with a monitoring rate of 96 % to 97 %. Sedation with propofol also requires monitoring of blood pressure. Monitoring devices in which oxygen saturation, heart rate, and automatic blood pressure measurements are displayed on a monitor mounted directly next to the endoscopy monitor are best because the examiner can view everything at once. Documentation of the measurement parameters is also preferable. In Germany, the frequency of blood pressure monitoring almost doubled within 3 years after implementation of the first national care guideline in 2008 [14].

Almost all current international guidelines support this recommendation [373, 381–384]. In some guidelines, the assessment of the patient's level of consciousness (e. g., using the MOAA/S score) is additionally required [382, 384]. In the opinion of the guideline group, there is no hard evidence for this. The partial tactile measures on the patient, which are necessary to determine the MOAS/S score, interfere with the course of endoscopic procedures. This is especially true for those of short duration. If anything, such measures may only be useful for longer-lasting procedures. Since the recommendation essentially refers to technical monitoring, it does not make sense to include the above-mentioned aspect. The fact that the consciousness of the sedated patient must be monitored is already included in the recommendations of WG II. Whether the MOAA/S score system makes sense here appears at least debatable.

3.5.1 Extended Monitoring

Recommendation 3.13	2022 (modified)
Capnography may be used for early detection of apnea. The additional use of capnography may be considered for multi-morbid or highly obese patients who have a high procedural risk for cardiopulmonary complications.	
Evidence level 1, recommendation grade 0, strong consensus	

Capnography records the concentration of CO_2 in the breath. Breathing activity can be graphically displayed. By observing the continuous display of the expiratory CO_2 concentration on a monitor, apnea can be detected earlier than with pulse oximetry. The time difference of detection between these methods lies in the range of up to 1 minute [412–417]. Measurement of the absolute CO_2 tissue concentration (e. g., using transcutaneous measurement) or in the exhaled air is less important as compared to capnometric measurements in patients receiving general anesthesia (the focus should be on continuous capnographic monitoring).

Three recent international guidelines recommend the use of capnography in high-risk patients, deep sedation, and long-duration procedures, without a clear, definite recommendation ("recommended") [373, 381, 383]. A Cochrane analysis evaluated the effect of capnography on the performance of painful procedures in an emergency unit (no endoscopic examinations). Three randomized controlled studies were found, but a reduction in complications could not be shown [418].

Regarding the use of capnography in endoscopic examinations/interventions, a retrospective analysis of billing data from 258 000 patients was presented by Joplink et al. [419]. The setting of capnography alone, pulse oximetry alone, or the combination of both monitoring methods was analyzed. Retrospective analysis showed that the use of capnography (alone or in combination) significantly reduced the need for pharmacological interventions. The number of recorded deaths was also lower with the use of capnography but did not reach significance (odds ratio 0.18, $P = 0.16$) [419].

Regarding a possible cost–benefit analysis, a literature-based study was conducted in the United States. It showed that a reduction in side effects could be expected in 27.2 % of cases with deep sedation and in 18 % of cases with moderate sedation. Thus, it was determined (for the United States setting) that the use of capnography was cost effective [420].

In a meta-analysis of the literature of randomized controlled trials regarding the achievement of a lower hypoxemia rate by the use of capnography, nine studies were evaluated [421]. It was shown that the simple hypoxemia frequency ($pO_2 < 90$ %) was significantly decreased, with an odds ratio of 0.61, as was the occurrence of severe hypoxemia ($pO_2 < 85$ %), with an odds ratio of 0.53. However, the frequency of need for assisted ventilation or increased oxygen delivery was not different with the use of capnography compared with standard monitoring [421].

In addition, several randomized controlled trials can be found in the current literature:

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In a single-center study by Slagelse et al. involving 540 patients sedated with NAPS, the number of adverse events (especially hypoxemia) with or without the use of capnography (in addition to standard monitoring) was evaluated. The number and duration of hypoxemia episodes were reduced by 40 % (mild hypoxemia pO_2 < 90 %) and 21 % (severe hypoxemia, pO_2 < 85 %) by capnography (however, both effects were not significant). Overall, the study demonstrates only a very limited clinical benefit of capnography [422].

The results were somewhat more favorable in an RCT by Friedrich-Rust et al. in two centers on 533 patients undergoing colonoscopy under NAPS or MAC sedation with or without additional capnography. Hypoxemia (pO_2 < 90 %) was observed in only 18 % of patients monitored with capnography but in 32 % under standard monitoring (significant effect). Additional risk factors for the occurrence of hypoxemia were age, BMI, the presence of sleep apnea syndrome, and the use of anesthesia-guided sedation (MAC) [423].

In contrast, in another RCT performed at a single center in 452 patients undergoing gastroscopy or colonoscopy (ASA class I and II), the hypoxia rate was not significantly different without or with capnography (54 % vs. 50 % of patients, respectively) [424].

In two further RCT from the Frankfurt working group on capnography during PEG insertion, the frequency of hypoxemia was significantly reduced in 150 patients (odds ratio 0.29 for hypoxia < 90 % and odds ratio 0.35 for severe hypoxia < 85 %) [425]. In another 147 patients, the significance of a parameter calculated from capnography, the so-called integrated pulmonary index (IPI), was evaluated. Here, no relevant advantage of this method over the standard evaluation of capnography was shown [426].

In two prospective uncontrolled studies, capnography was considered useful in severely obese patients (BMI 46.4) [427] or when used during ERCP (N = 11 patients) [428].

Another study compared capnography via conventional determination of CO_2 concentration from nasal respiratory flow to a newer method, which determines CO_2 content via a special mouthpiece, thus orally. In 104 patients who underwent gastroscopy (ASA I and II patients), a more accurate detection of CO_2 concentration was shown with oral capnography (100 % accuracy) versus nasal capnography (47 % accuracy) [429].

All published studies (not only those included in the meta-analysis) showed a significant reduction in the number of observed hypoxemias with the additional use of capnography (see above). Evidence of a significant reduction in robust endpoints, such as mortality or permanent damage, or even a reduction in the frequency of endotracheal intubations, was not reported. Therefore, only a “may be considered” recommendation seems possible. Especially the use of capnography, in addition to standard monitoring, in multi-morbid or severely obese patients and complex procedures may well be useful.

Statement 3.14	2022 (unchanged)
A benefit of EEG monitoring with respect to relevant parameters in gastrointestinal endoscopy has not been demonstrated.	
Evidence level 1b, strong consensus	

The electric activity of the human brain correlates with the level of alertness and cerebral perfusion. Therefore, measurement of the electrical activity of the brain via EEG can be useful during general anesthesia or deep sedation. Bispectral (BIS) monitoring is used to evaluate sedation depth in intensive care medicine and in surgical patients.

An anesthesiology group investigated the correlation of sleep depth under propofol sedation using the BIS index and a complementary topographic EEG in patients sedated with propofol during endoscopy. Changes in the different brain regions between the natural sleep depth and under propofol sedation were shown [430].

A German working group evaluated the correlation between the clinical assessment of consciousness and various EEG parameters during frontotemporal EEG using a Neuroline 720 device from Ambu during gastroenterological and bronchoscopic examinations under propofol sedation. A total of 171 patients (ASA I and II) were evaluated. Only a weak correlation between the clinically determined level of consciousness and the EEG parameters, in particular the BIS index, was found. Therefore, due to the numerous artifacts, it was concluded, especially for the BIS monitoring, that the application of this method during endoscopy is not meaningful [431].

Most of the many other studies [432–441], however, showed no significant reduction in the required propofol dose in mostly interventional endoscopies. The use of BIS monitoring also did not lead to a reduction in surrogate patient safety parameters (hypoxemia and RR drop) [436]. In addition, some studies reported an inadequate or too slowly correlated assessment of the patient’s sedation depth in comparison to clinical observation of sedation depth and evaluation using BIS monitoring [438].

A meta-analysis on BIS monitoring included 12 studies, 6 of which were judged to be of poor quality [442]. Overall, the evidence quality from all studies was considered “low”. As a result, there was no significant effect of BIS monitoring on the duration of endoscopic examination, on the duration of awakening after sedation, and ultimately on clinically relevant adverse events. Only hypoxemia frequency and the number of blood pressure drops were significantly reduced. Overall, it was concluded that the validity of the existing studies is very limited [442].

In a randomized controlled trial of 115 patients undergoing colonoscopy under propofol sedation, there was only a moderate correlation between clinical assessment of sedation depth (MOAA/s) and BIS score [443].

In a randomized trial on the use of BIS monitoring in gastric ESD procedures in 90 patients, the need for interventions (e. g., chin-lift maneuver or increasing oxygen delivery) was required in 47.8 % of patients without compared to 30 % of patients with BIS monitoring [444]. However, again, no difference was found in the incidence of sedation-assisted complications. The conclusion was that BIS monitoring is not clinically relevant [444].

Another randomized study investigated BIS monitoring in 280 patients undergoing screening colonoscopies. The only finding was that the required propofol dose was higher in the group receiving BIS monitoring. Overall, BIS monitoring was again not considered helpful for clinical use [445]. In contrast, a randomized study of 50 patients undergoing outpatient colonoscopy conduct-

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ed in 2019 found that the required propofol dose was lower under BIS monitoring. In addition, cognitive status was evaluated before and after sedation in both groups (MMSE, Trieger test, and clock pointer test), with a more favorable outcome under BIS monitoring [446].

In a comparative study [447] with another EEG-monitoring method, which detects acoustic-evoked potentials, BIS monitoring was superior (on the assessment of sedation depth under propofol).

In a randomized controlled trial by Wehrmann et al. [199], a significant reduction in the required propofol dose during ERCP was demonstrated when using another alternative EEG-monitoring procedure, the Narcotrend system. However, this was not demonstrated using the same Narcotrend procedure, in a more recent randomized study investigating the control of propofol sedation during ERCP [448]. However, a lower rate of hypoxemia and drop in blood pressure was found under Narcotrend monitoring.

In summary, no significant relevant advantages for the use of EEG monitoring in gastrointestinal endoscopy could be documented when considering current and older studies. Therefore, the use of such procedures can still not be recommended.

3.5.2 Addendum: Newer Monitoring Procedures (Without Recommendation)

Two studies employed bio-impedance monitoring to assess respiratory minute volume (RMV). This method involves placing three adhesive electrodes on the sternum, the xiphoid, and the right axillary line of the patient. By analyzing the wall movement of the chest, the respiratory minute volume is estimated [449]. An initial randomized study of 51 patients undergoing upper gastrointestinal endoscopies showed a better assessment of patients' respiratory function using this method to determine respiratory minute volume than using respiratory rate alone [449].

In a second study of 73 patients undergoing upper gastrointestinal interventions, a decrease in minute volume was observed in 15.3 % of patients undergoing standard monitoring compared to only 7.2 % of patients studied with the new RVM monitoring (bioimpedance technique) (a decrease in minute volume < 40 % from baseline was considered relevant). This effect was even more pronounced in the 10 % of patients in whom the anesthesiologist determined respiratory minute volume in advance as clinically meaningful [450].

In one study, photoplethysmography was used to detect respiratory rate (the Nellcor system, which is attached to the finger). A feasibility study on 26 patients described no increased sensitivity using this monitoring method for the detection of apnea episodes [451].

In another study, by Parisian anesthesiologists, a photoplethysmography method was used for blood pressure monitoring. In this feasibility study of 20 patients undergoing gastroscopy and colonoscopy, a decrease in mean arterial pressure to < 65 mmHg was demonstrated in 91 % of patients undergoing standard monitoring but only in 30 % of patients additionally examined with the photoplethysmographic method [452].

Another study describes the use of acoustic monitoring to detect respiratory activity compared to capnography [453]. Here, a sensor is attached to the neck of the patient. Forty-nine patients undergoing MAC sedation during gastroscopy with ESD were evaluated. A higher technical failure rate was found for capnography (40 %) compared with the acoustic monitor (22 %), and vital signs were not different in the two groups [453].

In another feasibility study in 12 patients by the Cleveland Group, exhaled air temperature was measured and evaluated to determine respiratory rate. This initial evaluation found the device to be practicable. The so-called "Linsham Respiratory Monitor" is incorporated into a face mask, through which an endoscope can also be orally inserted [454].

However, all the newer abovementioned methods have so far only been evaluated in feasibility studies. A definite assessment of their clinical value is not possible at present, and therefore, no recommendations can be made.

4 Guideline – Informed Consent/Prerequisites for Performance of Sedation/Preservation of Vital Functions/Clinical Monitoring/ Emergency Management

4.1 Informed Consent

Recommendation 4.1	**2022 (unchanged)**
When patients are given information about the endoscopy, we recommend that they should also be told about sedation side effects, especially anterograde amnesia, and the possibility of restricted psychomotor capability after the sedation.	
Evidence level 5, recommendation grade A, strong consensus	

4.1.1 General and Legal Aspects

The law on medical interventions, the physician's duty to inform, and patient information are very complex. According to constant jurisdiction of the German Federal Supreme Court, every medical intervention constitutes a personal injury offense according to paragraph 223 ff. StGB, 823 I BGB (German Civil Code). A medical intervention includes not only the performance of diagnostic procedures but also therapeutic measures such as surgery or drug administration [455]. The consent ("informed consent") that is necessary for these procedures is only valid if the patients have been given sufficient information and are able to exercise their right to self-determination. If patients are not competent to give their consent (e. g., children and severely mentally retarded persons), the physician must inform their representative (guardian, agent for healthcare matters, or other responsible persons) [456]. To be able to give their consent, patients must also understand the implications of the intervention. Aside from the legal aspects, a well-performed informed consent process increases patient satisfaction [457]. Patients should receive information even if they have already undergone a similar endoscopic intervention and they feel sufficiently informed. Many patients are not good judges of their own level of information and understanding. Moreover, in-

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formation received earlier may have been forgotten or details might remain misunderstood. The informed consent must be given for the currently intended examination.

4.1.2 Informing Person

Recommendation 4.2	2022 (unchanged)
We recommend that a competent and experienced physician should inform patients about the procedure in a form they can understand.	
Evidence level 5, recommendation grade A, strong consensus	

Background

The physician must be competent and experienced in sedation. Informing the patient, who is usually uneducated in medicine, must be done gently and comprehensibly. It is important that the patient understands the impact and implications of the intervention. The physician must make sure that the patient has this understanding. Delegation (e. g., to a nurse) is impermissible by law in Germany.

4.1.3 Informed Consent Procedure

Statement 4.3	2022 (modified)
The foundation of the consent procedure should be a discussion between the physician and patient. The content and range of the discussion should be documented. The patients should receive copies of the information and consent that they signed (according to paragraph 630e BGB (German Civil Code)).	
Evidence level 5, strong consensus	

Recommendation 4.4	2022 (modified)
We recommend that information should be provided in a timely manner so that the patient can make a well-founded decision about consent (according to paragraph 630e BGB (German Civil Code)).	
Evidence level 5, recommendation grade A, strong consensus	

Background

The discussion must be patient centered, i. e., dependent on the patient's comprehension and scope of information needs. In addition, standardized patient information sheets can be used, but they only support the transfer of information and documentation and are no substitute for the personal patient information session. Under civil law, the physician has the burden of proof that the patient was properly informed [455]. Therefore, written documentation is essential. A waiver should not be offered to the patient and certainly not suggested. If, however, patients refuse to be informed of their own accord, the waiver must be documented and signed by the patient [456]. The importance of the patient's right to self-determination also requires that the declaration of consent is offered in a timely manner [458] to ensure that patients can decide without time pressure. The correct timing of informed consent depends on the circumstances of the individual case. Even in emergencies, responsive patients should be informed as soon as time permits before giving consent [458]. In principle, the information should be provided to the patients as early as possible. It is recommended that informed consent be performed together with the information about the endoscopic procedure.

4.1.4 Content of the Patient Information Interview

Recommendation 4.5	2022 (unchanged)
We recommend that the discussion should include information on the preparation for sedation, various sedation methods, and their possible complications. It should also include informing patients that it is possible to perform the intervention without sedation.	
Evidence level 5, recommendation grade A, strong consensus	

Background

In almost all types of endoscopic interventions, adverse effects of sedation are responsible for at least 50 % of complications [459]. Complications of sedation (aspiration, arterial hypotension, bradycardia, apnea, etc.) are therefore typical complications and must be discussed in detail with the patient. The patient should be informed about the typical sedation risks irrespective of complication rates. Severe atypical risks must also be discussed. The physician should advise the patient on the "if and how" of sedation. In addition to sex and age, it is wise to take the patient's level of anxiety/fear into account when setting the sedation dose. These three factors have been shown to predict the patients' cooperation during the intervention and their satisfaction afterward [460–462]. Overall, the tendency should be to offer sedation to younger and more anxious patients, as well as to women [5, 8, 55, 460]. During long examinations and difficult interventions (e. g., ERCP or a difficult polypectomy), sedation is necessary to avoid unwanted involuntary patient movement [165, 463]. This too should be explained to the patient. If the patient is injured after refusing to consent to a necessary examination on the basis of factually incorrect and/or unobjective information, the physician may be responsible [464]. Sedation can be refused if either the patient has a very high ASA risk class [465, 466] or if the hospital and personnel are not adequately equipped to perform sedation according to the required standards. The physician must then explain to the patient why sedation is impossible.

Whether patients should be informed of the possibility of dying because of the intervention is debated. In two verdicts of the Regional Appeal Court Stuttgart, Germany [464, 467], and one of the Regional Appeal Court Zweibrücken, Germany [468], the courts demanded that patients be gently informed before colonoscopy of the possibility of dying as a result of perforation. In another case, it was decided that patients must be informed that they could die because of an ERCP. In the case of very urgent or emergent procedures, the extent of information may be adjusted to the situation.

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4.1.5 Safety Information (Behavior After Sedation)

Recommendation 4.6	2022 (unchanged)
We recommend that patients should be informed about what is safe to do and not to do after sedation and discharge from outpatient care. They should be given an information leaflet.	
Evidence level 5, recommendation grade A, strong consensus	

Background

Postprocedural conduct (management of discharge, see point 5.2): patients undergoing endoscopy as an outpatient procedure should be told that they need to bring someone who will accompany them home safely. All patients who are sedated must be told that they must not actively participate in road traffic, operate complicated machinery, drink alcohol, or make important or legally binding decisions. Due to the propofol's half-life, a period of rest and abstinence from the above-mentioned activities on the day of the procedure is sufficient for monosedation. When other drugs are used, also in combination with propofol, this period may be longer (e. g., 24 hours when using midazolam). Patients should always be given a telephone number to contact the physician or hospital if they feel unwell or have complications or bleeding after the endoscopy [456]. Information on the do's and don'ts for the period after the examination should be given to the patient in written form and in person [456]. For critical procedures or patients with severe comorbidities, targeted questioning by a nurse via telephone calls the next day was more effective than a written reminder [469].

4.2 Requirements for Carrying Out Sedations

Recommendation 4.7	2022 (unchanged)
A permanent intravenous access is a prerequisite for sedation and/or analgesia.	
Evidence level 2b, strong consensus	

Background

Peripheral venous access is a fundamental requirement for the administration of sedatives. A comparative study by Smith et al. [470] investigated the functionality of a butterfly versus indwelling catheter 1 hour after endoscopy, a time when most benzodiazepines and opioids have not even reached their half-life. Only 44 % of the butterflies but 98 % of the indwelling catheters were still functional.

4.3 Protection of Vital Functions

Recommendation 4.8	2022 (unchanged)
We recommend that sedated patients should prophylactically receive oxygen via a nasal cannula.	
Evidence level 2b, recommendation grade A, strong consensus	

Background

Incidents caused by sedation are usually cardiopulmonary events [459]. They make up about half of all complications in endoscopy and, depending on the patient's risk level, can also occur during gastroscopy without sedation [471]. Earlier publications reported a 5 % incidence of cardiopulmonary events with benzodiazepine use [220], and recent studies with propofol report an incidence of 0.1 % [394]. Older patients, in particular, are at risk of hypoxia under sedation [127, 178]. Prophylactic oxygen administration via a nasal cannula can significantly reduce the frequency of hypoxemic events [472–477]. However, there are also indications that prophylactic oxygen administration can delay the early detection of hypoxemic events using pulse oximetry [270, 465]. Despite this fact, the guideline authors consider the "safety-buffer" effect of prophylactic oxygen administration to be more important than its possible disadvantage of delayed hypoxemia detection.

Recent studies have investigated the use of nasal high flow during sedation for gastrointestinal endoscopy [478]. Nasal-high-flow therapy uses special large lumen nasal cannulae that allow a high gas flow of up to 60 liters per minute with variable oxygen content. This results in a low positive pressure in the airways. Data for use in gastrointestinal endoscopy is sparse, so its use outside of studies is not reasonable. The same applies for nasally applied PEEP (especially in patients with obstructive sleep apnea and/or significant obesity). So far, only feasibility studies are available. A randomized German study (Th. Rösch et al. at the University Hospital Hamburg-Eppendorf) will start soon [479].

4.4 Management of Sedation-Related Emergencies

4.4.1 Hypoxemia

Hypoxia is present if oxygen saturation declines below 90 % as measured with a pulse oximeter. Most pulse oximeters indicate the level of oxygen saturation by the impulse pitch level. Thus, if the tone frequency becomes lower or the digitally visible oxygen saturation drops continuously, counteractive measures must be taken. Initially, this means asking patients in a loud voice and stimulating them by touch to breathe deeper. If the patients are on their backs or sides, their chins can be pulled up using an Esmarch grip (also called jaw-thrust maneuver). This allows them to breathe freely again through the mouth. Placement of a Güdel or Wendl tube may be of help. In addition, the oxygen flow should be increased (e. g., from 2 to 4–5 L/min) and the application of sedatives should be interrupted. If patients fail to develop spontaneous breathing with these measures, ventilatory support must be performed using a bag mask. Finally, if necessary, the airways should be secured instrumentally (e. g., endotracheal intubation). If the patient was sedated with benzodiazepines, the antagonist flumazenil may be given in addition intravenously (naloxone is used as an antagonist for opioids). This often makes ventilation unnecessary. Otherwise, the procedure for hypoxia under benzodiazepines is the same as for propofol.

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4.4.2 Cardiac Arrhythmias

4.4.2.1 General Considerations

Endoscopic intubation of the colon is enough to cause excessive activation of the sympathetic autoregulative nervous system in unsedated patients [480], thus increasing the probability of cardiovascular events. Heartrate variability is enhanced further by sedation [481]. However, cardiopulmonary events can also be observed in unsedated patients during gastroscopy [482, 483].

4.4.2.2 Tachyarrhythmias

There are only a few reports of supraventricular or ventricular tachyarrhythmias during endoscopic procedures [484–487]. In emergencies, antiarrhythmics and a defibrillator should be kept at hand [488, 489].

4.4.2.3 Bradyarrhythmias

Occasionally, bradycardia occurs, especially during colonoscopy with or without sedation. The incidence is reported to be 0.5 % [490]. However, drug intervention was only necessary in one-third of the patients. The intervention consists of administering 0.5 mg atropine intravenously. This can be repeated if necessary up to a dose of 3 mg, and/or adrenaline (2–10 µg/min) can be given intravenously. In life-threatening situations, cardiopulmonary resuscitation should be done [491].

4.4.3 Arterial Hypotension

The incidence of arterial hypotension during colonoscopy varies between 0.3 % [490] and 3 %–19 % [480] depending on the definition. In the case of arterial hypotension, volume resuscitation with crystalloid infusion should be done. If hypotension persists, vasoactive substances should be given. Prophylactic infusion during all colonoscopies is not recommended [492], but it may be a good choice in older dehydrated patients. Prophylactic intravenous administration of crystalloid fluids can also be useful for long procedures carried out under propofol sedation because of its pronounced blood-pressure-reducing properties.

4.4.4 Myocardial Ischemia

Myocardial ischemia may occur during endoscopy with or without sedation. In a prospective study, ST-segment depression was described in 7 % of patients undergoing colonoscopy. However, three-quarters of these events occurred before the actual endoscopy [493]. ST depression can be significantly reduced by oxygen supplementation during endoscopy [473]. There is one published report of a case of myocardial infarction during colonoscopy [303].

4.4.5 Rare Events During Sedation

Allergic reactions are rarely observed in patients who are sedated for endoscopy. In 80 000 colonoscopies, one allergic reaction to midazolam was observed [459]. Localized pain at the injection site, especially in small-caliber peripheral veins, is a more common phenomenon after propofol administration. This type of “injection pain” can be largely avoided by intravenous injection of a local anesthetic before propofol application or by its injection on an “as-needed” basis [494–497].

5 Guideline – Quality Goals: Internal Quality Assurance/Discharge Criteria/Fitness for Road Traffic/Ability to Work/Documentation/Benchmarking

5.1 Internal Quality Assurance

Recommendation 5.1	2022 (unchanged)
We recommend that there should be a written and easily understandable procedure plan for performing sedation and/or analgesia, for monitoring the patient after sedation, for the criteria for discharge to the outpatient or general inpatient area, and for the management of any complications. The respective responsibilities should be clearly defined.	
Evidence level 5, recommendation grade A, strong consensus	

5.2 Discharge Criteria

5.2.1 Patient Instructions

Recommendation 5.2	2022 (modified)
We recommend that patients should be accompanied when they are being discharged. They should also receive written instructions, including a 24-hour emergency telephone number in case of examination-related complications (sedation or intervention).	
Evidence level 5, recommendation grade A, consensus	

5.2.2 Minimum Criteria for Discharge

Recommendation 5.3	2022 (unchanged)
The use of minimal discharge criteria after sedation and/or analgesia from the recovery area is wise. We recommend the use of a standardized discharge checklist.	
Evidence level 5, recommendation grade A, strong consensus	

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Recommendation 5.4	2022 (unchanged)

▶ **Table 10** Transfer After Outpatient Endoscopy.

Minimal criteria for discharge after outpatient endoscopy with sedation/analgesia (modified according to Ead H. [498])
Stable vital signs for at least 1 hour
Alert and oriented to time, place, and person (for patients with initially reduced mental state, the initial state be reached)
Complete (or near-complete) resolution of pain
Ability to get dressed independently and to walk with assistance (for patients with initially reduced functional/mental state, the initial state be reached)
Discharge accompanied by a responsible adult
Written and verbal instructions, regarding diet, activities, medications, participation in traffic, judgement ability, typical signs of complications, follow-up appointments, and a phone number to be called in case of complications
Evidence level 5, recommendation grade A, consensus

Recommendation 5.5	2022 (unchanged)

▶ **Table 11** Transfer After Inpatient Endoscopy.

Minimal criteria for transfer from the recovery room to the hospital ward after endoscopy with sedation/analgesia (according to DGAI, 2009 [499])
Level of alertness: awake or same as prior to the endoscopic procedure
Protective reflexes present or same as prior the endoscopic procedure
Sufficient spontaneous breathing without treatment or same as prior to endoscopic procedure
Stable cardiac circulation without therapy or same as prior to endoscopic procedure
Evidence level 5, recommendation grade A, strong consensus

5.2.3. Use of Scoring Systems for Discharge

Recommendation 5.6	2022 (unchanged)
We recommend that scoring systems (e. g., the Aldrete score) should not be the sole basis for deciding whether patients can be discharged because they do not evaluate psychomotor function.	
Evidence level 1b, recommendation grade A, strong consensus	

Background

Various scoring systems to assess postsurgical recovery have been used after sedation for endoscopy. The most popular systems are the modified Aldrete score (for early or phase I recovery) and the postanesthetic discharge scoring system (PADSS, for intermediate or phase II recovery) [500, 501]. Despite limitations of the PADSS, inherent to its focus on surgical procedures (e. g., one of the five criteria in this system is "surgical bleeding"), safe discharge after gastrointestinal endoscopy was reported in a relatively small prospective study [502]. A checklist (▶ **Table 10**) is recommended that assesses the ability of the patient to be discharged from the outpatient area (modified according to Ead et al. [498]). At a minimum, criteria proposed by the American Society of Anesthesiology should be met [20]. Commonly used tests to evaluate psychomotor functions are the coherent response to questions, the ability to stand on one foot, and the ability to walk in a straight line for 5 m without instability.

The use of the modified Aldrete score [503] only allows statements about patients' vital signs but not about their psychomotor performance. The latter may be considerably impaired even when a maximum score is reached [504]. Even if patients have stable vital signs and seem sufficiently awake after sedation, it is known that, after the use of intermediate-acting substances (e. g., midazolam and meperidine), patients have a prolonged phase of amnesia and impaired reflexes and judgement.

Patients undergoing colonoscopy, who are sedated with a frequently employed combination of midazolam plus an opiate, show impairment of reaction time, fine motor skills, and perception for at least 30 minutes after the procedure. Study data show that the remaining aftereffects of midazolam impair various psychomotor functions for at least 1 hour after administration [504, 505]. In these cases, midazolam seems to be the main reason for the persistent impairment of psychomotor function after sedation [506]. A study by Thapar et al. [506] comparing the effect of midazolam with fentanyl and propofol gave similar results. A current study by Watkins et al. also showed that sedation with propofol alone compared to a combination of propofol plus fentanyl or fentanyl plus midazolam has the least effect on cognitive function after the intervention [507].

5.3 "Street Fitness"

5.3.1 Roadworthiness

Recommendation 5.7	2022 (modified)
Even after reaching the required discharge criteria, psychomotor function can still be significantly impaired. Therefore, the time to active and passive participation in road traffic should be determined individually depending on the drugs used and the individual patient's risk profile at the time of discharge.	
Evidence level 1b, recommendation grade A, strong consensus	

Recommendation 5.8	2022 (unchanged)
We recommend that upon discharge, patients should refrain from driving, operating heavy machinery, or engaging in legally binding decisions for at least 12 hours if sedation with propofol alone was administered.	
Evidence level 1b, recommendation grade A, strong consensus	

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Recommendation 5.9	2022 (unchanged)
We recommend that patients should refrain from such activities for 24 hours if benzodiazepines are used for sedation.	
Evidence level 1b, recommendation grade A, strong consensus	

Background

Until 2008, the recommendations of various professional societies stated that patients should not participate actively or passively in road traffic for 24 hours [376, 377, 508] after sedation for gastrointestinal endoscopy. However, due to a lack of evidence, this time frame appears to be too broadly defined, especially with the use of ultra-short-acting substances, such as propofol or remifentanil.

A whole series of studies by Kortilla et al. [509–511] dating back to the 1970 s already investigated psychomotor function after sedation with various drugs. These showed that even when benzodiazepines were used at higher doses (diazepam 0.45 mg/kg body weight), psychomotor functions were restored after 10 hours [510]. Psychomotor functions were impaired for up to 12 hours only when meperidine 75 mg i. m. was used. In this case, the recommendation not to drive for 24 hours seems justifiable – but meperidine 75 mg i. m. is no longer routinely used in endoscopy [509].

Normalization of psychomotor function on the day of the examination is primarily dependent on the half-life of the substance used, whereby short-acting substances have an advantage. In a prospective study by Riphaus et al. [86] involving 98 patients sedated during gastroscopy and colonoscopy using either propofol or midazolam/pethidine, there was no impairment of psychomotor abilities two hours after sedation with propofol compared with midazolam/pethidine (using a driving simulator).

These results were confirmed for propofol in a similar study by Horiuchi et al. [512]. However, a very low medium propofol dose (around 40 mg) was used, which is not routinely employed for propofol sedation in Germany [13, 14].

In another study by Horiuchi et al. [513], 92 % of 400 patients drove themselves home after low-dose propofol sedation (dose usually < 50 mg in Asian patients) for gastroscopy without causing traffic accidents.

A current study by Sato et al. [125] investigated the safety and efficacy of propofol sedation administered by assistants at a mean dosage of 105 mg during outpatient gastroscopy and colonoscopy in a total of 117,661 ASA I and II patients. A questionnaire-based postintervention evaluation (2 weeks after the examination) included questions about whether patients “drove themselves home or to the office after the medical checkup?” and “had an accident shortly after the medical checkup?” It was found that many of at least 66,250 people were able to drive themselves home or to work after the procedure without being involved in a traffic accident. Which mode of transport they used was not specified in the study. Likewise, due to the query by questionnaire instead of, for example, a telephone follow-up, any serious accidents that made it impossible for the patient to answer the questionnaire were not recorded.

Overall, after the use of short-acting hypnotics (e. g., propofol) as a monosubstance, roadworthiness seems to be restored quickly considering the drug’s half-life. Nevertheless, on the basis of the results obtained in the present prospective study by Riphaus et al. [86] of 98 subjects and also by Horiuchi et al. [514] with a sample size of 48 subjects (and thus a very small number of cases), the use of public transportation (even without an escort) may be considered, at the most. For driving a motor vehicle/bicycle, further large, prospective field studies are needed, which have not yet been presented by any working group worldwide.

In accordance with the low evidence of the currently available data on roadworthiness after propofol sedation and the primary consideration of patient safety, the guideline group has once again adopted the recommendations of the current evidence- and consensus-based guideline of the European Society of Gastrointestinal Endoscopy (ESGE) on propofol sedation by non-anesthesiologists [362] (see *Recommendation 5.8* and *5.9*).

This is also in the light of a study by Brechmann et al. [515] in which, with the aid of a multi-dimensional questionnaire, 82 patients completed a questionnaire 1 hour before and after, as well as 1 week after, propofol monosedation. It was shown that a clear euphoric effect was detectable in 36 of these patients (44 %). Thus, it is not only a sedating effect that may have an impact on driving capability.

First, data from Riphaus et al. [516] suggest that gender differences influence recovery time after propofol monosedation during colonoscopy. The aim of this study was to investigate whether and to what extent gender differences in recovery time can be detected using EEG monitoring to maintain a constant sedation level. As a result, women woke up significantly faster than men, with time to eye opening of 7.3 ± 3.7 versus 8.4 ± 3.4 min ($P = 0.005$) and time to full orientation of 9.1 ± 3.9 versus 10.4 ± 13.7 min ($P = 0.008$), respectively. Propofol dosage was not significantly different, with a trend toward more propofol per kg body weight in women (3.98 ± 1.81 mg versus 3.72 ± 1.75 mg, $P = 0.232$, respectively). The results are best explained by gender-related differences in the pharmacokinetics and pharmacodynamics of opioids, muscle relaxants, and intravenous anesthetics. The faster recovery time may be related to a possible lower plasma concentration of propofol in women, as well as to differences in the concentration of glucuronidated degradation products in women and men. Also, CYP2B6 (a propofol degradation enzyme belonging to the cytochrome P450 enzymes responsible for oxidative metabolism of drugs) concentration was 1.9 times higher in the liver of women than in men [517].

Thus, the influence of gender should be considered when propofol is used as sedation for gastrointestinal endoscopy. This includes appropriate dosing for females and caution regarding possible overdose in male patients.

Based on the most recent data, focusing solely on the half-life of the drug used does not appear to be sufficient for determining wake-up time and subsequent “street fitness”. Further data regarding gender-sensitive pharmacokinetics and dynamics are necessary to allow personalized medicine to ensure the greatest possible patient safety in sedation during gastrointestinal endoscopy.

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5.4 Documentation

Recommendation 5.10	2022 (unchanged)

We recommend that the patient file or the documentation form should contain time-dependent documentation of the vital signs (heart rate, blood pressure, and oxygen saturation), the drugs used including name and dose, as well as the administration of intravenous fluids, and the flow rate of oxygen. Complications and their management should be documented as well.

Evidence level 5, recommendation grade A, strong consensus

5.4.1 General Considerations

Structured documentation is part of a quality process and may help to improve compliance with sedation guidelines [518]. Documentation is an essential part of patient care and should be done in all phases of the intervention (it may also provide a record of correct sedation administration and monitoring in the event of legal issues).

This includes:

- Pre-interventional evaluation of the patient
- Informed consent
- Monitoring during the intervention
- Patient recovery
- Patient discharge

Ideally, a standardized form should be used to improve documentation [518].

5.4.2 Inability to Work

Recommendation 5.11	2022 (unchanged)

We recommend that the duration of the inability to work should be assessed individually, specific to the workplace, taking into account the effect profile of the used drugs.

Evidence level 5, recommendation grade A, strong consensus

Background

A general or precise recommendation cannot be given on how long a patient is unable to work after the use of sedatives and analgesics for gastrointestinal endoscopy. As a general guide, an interval of 24 hours is recommended [376, 377, 508]. However, this interval is not based on evidence. For persons with a hazardous working place (e. g., crane operators), a longer absence from work (e. g., 48 hours) is recommended after sedation.

5.5 Benchmarking

Recommendation 5.12	2022 (modified)

We recommend that all complications that occur during endoscopy with or without sedation should be documented. These include, in particular:

- Blood pressure changes requiring intervention
- Cardiac arrhythmia requiring intervention
- Hypoxemia
- Aspiration
- Mask ventilations
- Unplanned intubations
- Neurological deficits
- Unplanned intensive care monitoring
- Resuscitations
- Deaths

Evidence level 5, recommendation grade A, strong consensus

Recommendation 5.13	2022 (modified)

As part of internal quality management, we recommend that a team meeting should be held regularly (at least every 3 months). Documentation of this team meeting should at least include information on the complications given under 5.12.

Evidence level 5, recommendation grade A, strong consensus

Background

A “benchmark” is a standard or reference point (metric) for a relative evaluation of a product, service, or organization unit.

The most important benchmark for sedation during gastrointestinal endoscopy should be complication rates that are as low as possible. A nationwide survey of all endoscopic examinations and associated complications with and without sedation is desirable. The complications mentioned above should be centrally recorded and evaluated so that subsequent procedures can be optimized. Some projects of this kind have already been launched (e. g., a study of the German Association of Gastroenterologists in Private Practice, complication registry of Helios-hospitals in Germany, etc.).

Conflict of Interest

The overview of the authors’ conflicts of interest are published in the guideline report (german version).

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References

[1] OCEBM Levels of Evidence Working Group = Jeremy Howick ICJLL, Paul Glasziou, Trish Greenhalgh, Carl Heneghan, Alessandro Liberati, Ivan Moschetti, Bob Phillips, Hazel Thornton, Olive Goddard and Mary Hodgkinson. OCEBM Levels of Evidence Working Group*. "The Oxford Levels of Evidence 2". 2011

[2] Probert CSJ, Jayanthi V, Quinn J et al. Information Requirements and Sedation Preferences of Patients Undergoing Endoscopy of the Upper Gastrointestinal Tract. Endoscopy 1991; 23: 218–219

[3] 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: 519–523

[4] Lauriola M, Tomai M, Palma R et al. Intolerance of Uncertainty and Anxiety-Related Dispositions Predict Pain During Upper Endoscopy. Front Psychol 2019; 10: 1112

[5] Rex DK, Imperiale TF, Portish V. Patients willing to try colonoscopy without sedation: associated clinical factors and results of a randomized controlled trial. Gastrointest Endosc 1999; 49: 554–559

[6] Eckardt VF, Kanzler G, Schmitt T et al. Complications and adverse effects of colonoscopy with selective sedation. Gastrointestinal endoscopy 1999; 49: 560–565

[7] Yörük G, Aksöz K, Unsal B et al. Colonoscopy without sedation. The Turkish journal of gastroenterology: the official journal of Turkish Society of Gastroenterology 2003; 14: 59–63

[8] Early DS, Saifuddin T, Johnson JC et al. Patient attitudes toward undergoing colonoscopy without sedation. The American journal of gastroenterology 1999; 94: 1862–1865

[9] Radaelli F, Meucci G, Sgroi G et al. Technical performance of colonoscopy: the key role of sedation/analgesia and other quality indicators. The American journal of gastroenterology 2008; 103: 1122–1130

[10] Crispin A, Birkner B, Munte A et al. Process quality and incidence of acute complications in a series of more than 230,000 outpatient colonoscopies. Endoscopy 2009; 41: 1018–1025

[11] Daneshmend TK, Bell GD, Logan RF. Sedation for upper gastrointestinal endoscopy: results of a nationwide survey. Gut 1991; 32: 12–15

[12] Froehlich F, Gonvers JJ, Fried M. Conscious sedation, clinically relevant complications and monitoring of endoscopy: results of a nationwide survey in Switzerland. Endoscopy 1994; 26: 231–234

[13] Riphaus A, Rabofski M, Wehrmann T. Endoscopic sedation and monitoring practice in Germany: results from the first nationwide survey. Zeitschrift fur Gastroenterologie 2010; 48: 392–397

[14] Riphaus A, Geist F, Wehrmann T. Endoscopic sedation and monitoring practice in Germany: re-evaluation from the first nationwide survey 3 years after the implementation of an evidence and consent based national guideline. Zeitschrift fur Gastroenterologie 2013; 51: 1082–1088

[15] Cohen LB, Wecsler JS, Gaetano JN et al. Endoscopic sedation in the United States: results from a nationwide survey. The American journal of gastroenterology 2006; 101: 967–974

[16] Thompson DG, Lennard-Jones JE, Evans SJ et al. Patients appreciate premedication for endoscopy. Lancet (London, England) 1980; 2: 469–470

[17] Dillon M, Brown S, Casey W et al. Colonoscopy under general anesthesia in children. Pediatrics 1998; 102: 381–383

[18] Xue M, Tian J, Zhang J et al. No increased risk of perforation during colonoscopy in patients undergoing propofol versus traditional sedation: A meta-analysis. Indian J Gastroenterol 2018; 37: 86–91

[19] Ely EW, Truman B, Shintani A et al. Monitoring sedation status over time in ICU patients: reliability and validity of the Richmond Agitation-Sedation Scale (RASS). JAMA 2003; 289: 2983–2991

[20] Practice guidelines for sedation and analgesia by non-anesthesiologists. Anesthesiology 2002; 96: 1004–1017

[21] Cohen LB, Delegge MH, Aisenberg J et al. AGA Institute review of endoscopic sedation. Gastroenterology 2007; 133: 675–701

[22] McCain JD, Stancampiano FF, Bouras EP et al. Creation of a score to predict risk of high conscious sedation requirements in patients undergoing endoscopy. Gastrointest Endosc 2020; 91: 595–605.e3

[23] 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: 90–99

[24] Laffin AE, Kendale SM, Huncke TK. Severity and duration of hypoxemia during outpatient endoscopy in obese patients: a retrospective cohort study. Can J Anaesth 2020; 67: 1182–1189

[25] Khoi C-S, Wong J-J, Wang H-C et al. Age correlates with hypotension during propofol-based anesthesia for endoscopic retrograde cholangiopancreatography. Acta Anaesthesiologica Taiwanica 2015; 53: 131–134

[26] 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. Gastrointestinal Endoscopy 2020; 92: 591–602.e16

[27] Kollmann CM, Schmiegel 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: 382–390

[28] Lieber SR, Heller BJ, Howard CW et al. Complications Associated with Anesthesia Services in Endoscopic Procedures Among Patients with Cirrhosis. Hepatology 2020. doi:10.1002/hep.31224

[29] Jirapinyo P, Kumar N, Thompson CC. Patients With Roux-en-Y Gastric Bypass Require Increased Sedation During Upper Endoscopy. Clin Gastroenterol Hepatol 2015; 13: 1432–1436

[30] Doyle DJ, Goyal A, Bansal P et al. American Society of Anesthesiologists Classification. StatPearls. Treasure Island (FL): StatPearls Publishing; 2022

[31] Waring JP, Baron TH, Hirota WK et al. Guidelines for conscious sedation and monitoring during gastrointestinal endoscopy. Gastrointestinal endoscopy 2003; 58: 317–322

[32] SGNA position statement. Statement on the use of sedation and analgesia in the gastrointestinal endoscopy setting. Gastroenterology nursing: the official journal of the Society of Gastroenterology Nurses and Associates 2004; 27: 142–144

[33] Dumonceau J-M, Riphaus A, Schreiber F et al. Non-anesthesiologist administration of propofol for gastrointestinal endoscopy: European Society of Gastrointestinal Endoscopy, European Society of Gastroenterology and Endoscopy Nurses and Associates Guideline – Updated June 2015. Endoscopy 2015; 47: 1175–1189

[34] Behrens A, Ell C, Studiengruppe A-P. Sicherheit der Sedierung der Gastroskopie und Koloskopie bei Niedrigrisikopatienten – Retrospektive Subgruppenanalyse der Ergebnisse einer Registerstudie von über 170000 Endoskopien. Zeitschrift für Gastroenterologie 2016; 54: 733–739

[35] Borgaonkar MR, Pace D, Lougheed M et al. Canadian Association of Gastroenterology Indicators of Safety Compromise following Colonoscopy in Clinical Practice. Can J Gastroenterol Hepatol 2016; 2016: 2729871

[36] Daza JF, Tan CM, Fielding RJ et al. Propofol administration by endoscopists versus anesthesiologists in gastrointestinal endoscopy: a systematic review and meta-analysis of patient safety outcomes. Can J Surg 2018; 61: 226–236

[37] 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. Therapeutics and Clinical Risk Management 2018; 14: 1331–1336

[38] Andrade CM, Patel B, Gill J et al. Safety of Gastrointestinal Endoscopy With Conscious Sedation in Patients With and Without Obstructive Sleep Apnea. J Clin Gastroenterol 2016; 50: 198–201

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

[39] Mudambi L, Spiegelman A, Geron D et al. Obstructive Sleep Apnea Is Not Associated with Higher Health Care Use after Colonoscopy under Conscious Sedation. Ann Am Thorac Soc 2016; 13: 419–424

[40] Smith ZL, Mullady DK, Lang GD et al. A randomized controlled trial evaluating general endotracheal anesthesia versus monitored anesthesia care and the incidence of sedation-related adverse events during ERCP in high-risk patients. Gastrointest Endosc 2019; 89: 855–862

[41] Buxbaum J, Roth N, Motamedi N et al. Anesthetist-Directed Sedation Favors Success of Advanced Endoscopic Procedures. Am J Gastroenterol 2017; 112: 290–296

[42] Yurtlu DA, Aslan F, Ayvat P et al. Propofol-Based Sedation Versus General Anesthesia for Endoscopic Submucosal Dissection. Medicine (Baltimore) 2016; 95: e3680

[43] van de Ven S, Leliveld L, Klimek M et al. Propofol sedation without endotracheal intubation is safe for endoscopic submucosal dissection in the esophagus and stomach. United European Gastroenterol J 2019; 7: 405–411

[44] 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: 665–673

[45] Koch DG, Arguedas MR, Fallon MB. Risk of aspiration pneumonia in suspected variceal hemorrhage: the value of prophylactic endotracheal intubation prior to endoscopy. Digestive diseases and sciences 2007; 52: 2225–2228

[46] Rudolph SJ, Landsverk BK, Freeman ML. Endotracheal intubation for airway protection during endoscopy for severe upper GI hemorrhage. Gastrointestinal endoscopy 2003; 57: 58–61

[47] Bielawska B, Hookey 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.e3

[48] Shmygalev S, Heller AR. Perioperative visual loss after nonocular surgery. Der Anaesthesist 2011; 60: 683–694

[49] Müller-Vahl H. Positioning injuries to peripheral nerves – Pathogenesis, clinical presentation, differential diagnosis and medicolegal aspects. Anästhesie und Intensivmedizin 2010; 51: 664–678

[50] Porostocky P, Chiba N, Colacino P et al. A survey of sedation practices for colonoscopy in Canada. Can J Gastroenterol 2011; 25: 255–260

[51] Fanti L, Agostoni M, Gemma M et al. Sedation and monitoring for gastrointestinal endoscopy: A nationwide web survey in Italy. Dig Liver Dis 2011; 43: 726–730

[52] Baudet JS, Borque P, Borja E et al. Use of sedation in gastrointestinal endoscopy: a nationwide survey in Spain. Eur J Gastroenterol Hepatol 2009; 21: 882–888

[53] Protopapas A. Endoscopic sedation practices of Greek gastroenterologists: a nationwide survey. Annals of Gastroenterology 2020. doi:10.20524/aog.2020.0494

[54] Bell GD. Preparation, Premedication, and Surveillance. Endoscopy 2004; 36: 23–31

[55] Subramanian S, Liangpunsakul S, Rex DK. Preprocedure patient values regarding sedation for colonoscopy. J Clin Gastroenterol 2005; 39: 516–519

[56] Abraham N, Barkun A, Larocque M et al. Predicting which patients can undergo upper endoscopy comfortably without conscious sedation. Gastrointest Endosc 2002; 56: 180–189

[57] Hedenbro JL, Ekelund M, Aberg T et al. Oral sedation for diagnostic upper endoscopy. Endoscopy 1991; 23: 8–10

[58] Kinoshita Y, Ishido S, Nishiyama K et al. Arterial oxygen saturation, blood pressure, and pulse rate during upper gastrointestinal endoscopy—influence of sedation and age. J Clin Gastroenterol 1991; 13: 656–660

[59] Yuno K, Iishi H, Tatsuta M et al. Intravenous midazolam as a sedative for colonoscopy: a randomized, double-blind clinical trial. Aliment Pharmacol Ther 1996; 10: 981–984

[60] Marriott P, Laasch HU, Wilbraham L et al. Conscious sedation for endoscopic and non-endoscopic interventional gastrointestinal procedures: meeting patients' expectations, missing the standard. Clin Radiol 2004; 59: 180–185

[61] Ristikankare M, Hartikainen J, Heikkinen M et al. Is routinely given conscious sedation of benefit during colonoscopy? Gastrointest Endosc 1999; 49: 566–572

[62] Hsieh YH, Chou AL, Lai YY et al. Propofol alone versus propofol in combination with meperidine for sedation during colonoscopy. J Clin Gastroenterol 2009; 43: 753–757

[63] Amornyotin S, Srikureja W, Chalayonnavin W et al. Dose requirement and complications of diluted and undiluted propofol for deep sedation in endoscopic retrograde cholangiopancreatography. Hepatobiliary & pancreatic diseases international: HBPD INT 2011; 10: 313–318

[64] Poincloux L, Laquière A, Bazin JE et al. A randomized controlled trial of endoscopist vs. anaesthetist-administered sedation for colonoscopy. Dig Liver Dis 2011; 43: 553–558

[65] 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: 910–923

[66] Singh H, Poluha W, Cheung M et al. Propofol for sedation during colonoscopy. Cochrane Database Syst Rev 2008; 2008: Cd006268

[67] Walmsley RS, Montgomery SM. Factors affecting patient tolerance of upper gastrointestinal endoscopy. J Clin Gastroenterol 1998; 26: 253–255

[68] Jin EH, Hong KS, Lee Y et al. How to improve patient satisfaction during midazolam sedation for gastrointestinal endoscopy? World J Gastroenterol 2017; 23: 1098–1105

[69] Padmanabhan A, Frangopoulos C, Shaffer LET. Patient Satisfaction With Propofol for Outpatient Colonoscopy: A Prospective, Randomized, Double-Blind Study. Dis Colon Rectum 2017; 60: 1102–1108

[70] Shin S, Park CH, Kim HJ et al. Patient satisfaction after endoscopic submucosal dissection under propofol-based sedation: a small premedication makes all the difference. Surg Endosc 2017; 31: 2636–2644

[71] Lim S, Lee OH, Yoon IJ et al. Moderate versus deep sedation in adults undergoing colonoscopy: systematic review and meta-analysis. Curr Med Res Opin 2019; 35: 879–885

[72] Nayar DS, Guthrie WG, Goodman A et al. Comparison of propofol deep sedation versus moderate sedation during endosonography. Dig Dis Sci 2010; 55: 2537–2544

[73] Meining A, Semmler V, Kassem AM et al. The effect of sedation on the quality of upper gastrointestinal endoscopy: an investigator-blinded, randomized study comparing propofol with midazolam. Endoscopy 2007; 39: 345–349

[74] Laluna L, Allen ML, Dimarino AJ et al. The comparison of midazolam and topical lidocaine spray versus the combination of midazolam, meperidine, and topical lidocaine spray to sedate patients for upper endoscopy. Gastrointest Endosc 2001; 53: 289–293

[75] Patel S, Vargo JJ, Khandwala F et al. Deep sedation occurs frequently during elective endoscopy with meperidine and midazolam. Am J Gastroenterol 2005; 100: 2689–2695

[76] Cohen LB. Redefining quality in endoscopic sedation. Dig Dis Sci 2010; 55: 2425–2427

[77] Cullinane M et al. Scoping our practice, in National Confidential Enquiry intoPatient Outcome and Death (NCEPOD). London., 2004

[78] Sarkar S, Bowering K, Azim W et al. Safer sedation practice may not translate into improvements in endoscopic outcomes. European journal of gastroenterology & hepatology 2009; 21: 534–543

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

[79] Turse EP, Dailey FE, Bechtold ML. Impact of moderate versus deep sedation on adenoma detection rate in index average-risk screening colonoscopies. Gastrointest Endosc 2019; 90: 502–505

[80] Heuss LT, Froehlich F, Beglinger C. Changing patterns of sedation and monitoring practice during endoscopy: results of a nationwide survey in Switzerland. Endoscopy 2005; 37: 161–166

[81] Conigliaro R, Rossi A. Implementation of sedation guidelines in clinical practice in Italy: results of a prospective longitudinal multicenter study. Endoscopy 2006; 38: 1137–1143

[82] 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

[83] Reves JG, Glass PS, Lubarsky DA. Nonbarbiturate Intravenous Anesthetics, in Anesthesia. Miller RD,, Editor Philadelphia: Churchill Livingstone; 2000

[84] Carlsson U, Grattidge P. Sedation for upper gastrointestinal endoscopy: a comparative study of propofol and midazolam. Endoscopy 1995; 27: 240–243

[85] Patterson KW, Casey PB, Murray JP et al. Propofol sedation for outpatient upper gastrointestinal endoscopy: comparison with midazolam. Br J Anaesth 1991; 67: 108–111

[86] Riphaus A, Gstettenbauer T, Frenz MB et al. Quality of psychomotor recovery after propofol sedation for routine endoscopy: a randomized and controlled study. Endoscopy 2006; 38: 677–683

[87] Sipe BW, Rex DK, Latinovich D et al. Propofol versus midazolam/meperidine for outpatient colonoscopy: administration by nurses supervised by endoscopists. Gastrointest Endosc 2002; 55: 815–825

[88] Weston BR, Chadalawada V, Chalasani N et al. Nurse-administered propofol versus midazolam and meperidine for upper endoscopy in cirrhotic patients. Am J Gastroenterol 2003; 98: 2440–2447

[89] Hofmann C, Kiesslich R, Brackertz A et al. Propofol for sedation in gastroscopy – a randomized comparison with midazolam. Z Gastroenterol 1999; 37: 589–595

[90] Koshy G, Nair S, Norkus EP et al. Propofol versus midazolam and meperidine for conscious sedation in GI endoscopy. Am J Gastroenterol 2000; 95: 1476–1479

[91] Reimann FM, Samson U, Derad I et al. Synergistic sedation with low-dose midazolam and propofol for colonoscopies. Endoscopy 2000; 32: 239–244

[92] Heuss LT, Schnieper P, Drewe J et al. Conscious sedation with propofol in elderly patients: a prospective evaluation. Aliment Pharmacol Ther 2003; 17: 1493–1501

[93] Kazama T, Takeuchi K, Ikeda K et al. Optimal propofol plasma concentration during upper gastrointestinal endoscopy in young, middle-aged, and elderly patients. Anesthesiology 2000; 93: 662–669

[94] Rex DK, Overley CA, Walker J. Registered nurse-administered propofol sedation for upper endoscopy and colonoscopy: Why? When? How? Rev Gastroenterol Disord 2003; 3: 70–80

[95] Paspatis GA, Manolaraki MM, Tribonias G et al. Endoscopic sedation in Greece: results from a nationwide survey for the Hellenic Foundation of gastroenterology and nutrition. Dig Liver Dis 2009; 41: 807–811

[96] Külling D, Rothenbühler R, Inauen W. Safety of nonanesthetist sedation with propofol for outpatient colonoscopy and esophagogastroduodenoscopy. Endoscopy 2003; 35: 679–682

[97] Gottschling S, Larsen R, Meyer S et al. Acute pancreatitis induced by short-term propofol administration. Paediatr Anaesth 2005; 15: 1006–1008

[98] Jawaid Q, Presti ME, Neuschwander-Tetri BA et al. Acute pancreatitis after single-dose exposure to propofol: a case report and review of literature. Dig Dis Sci 2002; 47: 614–618

[99] Fudickar A, Bein B, Tonner PH. Propofol infusion syndrome in anaesthesia and intensive care medicine. Curr Opin Anaesthesiol 2006; 19: 404–410

[100] Fudickar A et al. Suggested beginning of propofol infusion syndrome in an adult patient without lactacidosis: a case report. European journal of anaesthesiology 2008; 25: 777–778

[101] Asserhøj LL, Mosbech H, Krøigaard M et al. No evidence for contraindications to the use of propofol in adults allergic to egg, soy or peanut†. Br J Anaesth 2016; 116: 77–82

[102] Dewachter P, Kopac P, Laguna JJ et al. Anaesthetic management of patients with pre-existing allergic conditions: a narrative review. Br J Anaesth 2019; 123: e65–e81

[103] Silvestri GA, Vincent BD, Wahidi MM et al. A phase 3, randomized, double-blind study to assess the efficacy and safety of fospropofol disodium injection for moderate sedation in patients undergoing flexible bronchoscopy. Chest 2009; 135: 41–47

[104] Cohen LB, Cattau E, Goetsch A et al. A randomized, double-blind, phase 3 study of fospropofol disodium for sedation during colonoscopy. J Clin Gastroenterol 2010; 44: 345–353

[105] Qadeer MA, Vargo JJ, Khandwala F et al. Propofol versus traditional sedative agents for gastrointestinal endoscopy: a meta-analysis. Clin Gastroenterol Hepatol 2005; 3: 1049–1056

[106] VanNatta ME, Rex DK. Propofol alone titrated to deep sedation versus propofol in combination with opioids and/or benzodiazepines and titrated to moderate sedation for colonoscopy. Am J Gastroenterol 2006; 101: 2209–2217

[107] Paspatis GA, Charoniti I, Manolaraki M et al. Synergistic sedation with oral midazolam as a premedication and intravenous propofol versus intravenous propofol alone in upper gastrointestinal endoscopies in children: a prospective, randomized study. Journal of pediatric gastroenterology and nutrition 2006; 43: 195–199

[108] Wang D, Chen C, Chen J et al. The use of propofol as a sedative agent in gastrointestinal endoscopy: a meta-analysis. PLoS One 2013; 8: e53311

[109] Zhang K, Xu H, Li HT. Safety and efficacy of propofol alone or in combination with other agents for sedation of patients undergoing colonoscopy: an updated meta-analysis. Eur Rev Med Pharmacol Sci 2020; 24: 4506–4518

[110] Wang D, Wang S, Chen J et al. Propofol combined with traditional sedative agents versus propofol- alone sedation for gastrointestinal endoscopy: a meta-analysis. Scand J Gastroenterol 2013; 48: 101–110

[111] Yoon SW, Choi GJ, Lee OH et al. Comparison of propofol monotherapy and propofol combination therapy for sedation during gastrointestinal endoscopy: A systematic review and meta-analysis. Dig Endosc 2018; 30: 580–591

[112] Vargo JJ. See one, do one, teach one. Gastrointestinal endoscopy 2008; 67: 419–421

[113] Riphaus A, Geist C, Schrader K et al. Intermittent manually controlled versus continuous infusion of propofol for deep sedation during interventional endoscopy: a prospective randomized trial. Scand J Gastroenterol 2012; 47: 1078–1085

[114] Martínez JF, Aparicio JR, Compañy L et al. Safety of continuous propofol sedation for endoscopic procedures in elderly patients. Rev Esp Enferm Dig 2011; 103: 76–82

[115] Adler DG, Kawa C, Hilden K et al. Nurse-administered propofol sedation is safe for patients with obstructive sleep apnea undergoing routine endoscopy: a pilot study. Dig Dis Sci 2011; 56: 2666–2671

[116] Rex DK, Deenadayalu V, Eid E. Gastroenterologist-directed propofol: an update. Gastrointestinal endoscopy clinics of North America 2008; 18: 717–725

[117] Külling D, Orlandi M, Inauen W. Propofol sedation during endoscopic procedures: how much staff and monitoring are necessary? Gastrointest Endosc 2007; 66: 443–449

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

[118] Vargo JJ. Procedural sedation and obesity: waters left uncharted. Gastrointest Endosc 2009; 70: 980–984

[119] Department of Health and Human Services, Petition denial for request for removal of warning of labeling for Diprivan (propofol). Docket no FDA-2005-P- 0059. 2010

[120] Pelosi P. Retraction of endorsement: European Society of Gastrointestinal Endoscopy, European Society of Gastroenterology and Endoscopy Nurses and Associates, and the European Society of Anaesthesiology Guideline: Non-anesthesiologist administration of propofol for GI endoscopy. Endoscopy 2012; 44: 302

[121] Ferreira AO, Torres J, Barjas E et al. Non-anesthesiologist administration of propofol sedation for colonoscopy is safe in low risk patients: results of a noninferiority randomized controlled trial. Endoscopy 2016; 48: 747–753

[122] Lee HS, Nagra N, La Selva D et al. Nurse-Administered Propofol Continuous Infusion Sedation for Gastrointestinal Endoscopy in Patients Who Are Difficult to Sedate. Clin Gastroenterol Hepatol 2021; 19: 180–188

[123] McVay T, Fang JC, Taylor L et al. Safety Analysis of Bariatric Patients Undergoing Outpatient Upper Endoscopy with Non-Anesthesia Administered Propofol Sedation. Obes Surg 2017; 27: 1501–1507

[124] Nonaka M, Gotoda T, Kusano C et al. Safety of gastroenterologist-guided sedation with propofol for upper gastrointestinal therapeutic endoscopy in elderly patients compared with younger patients. Gut and liver 2015; 9: 38–42

[125] Sato M, Horiuchi A, Tamaki M et al. Safety and Effectiveness of Nurse-Administered Propofol Sedation in Outpatients Undergoing Gastrointestinal Endoscopy. Clin Gastroenterol Hepatol 2019; 17: 1098–1104

[126] Sechzer PH. Studies in pain with the analgesic-demand system. Anesth Analg 1971; 50: 1–10

[127] Heuss LT, Drewe J, Schnieper P et al. Patient-controlled versus nurse-administered sedation with propofol during colonoscopy. A prospective randomized trial. Am J Gastroenterol 2004; 99: 511–518

[128] Luginbühl M, Vuilleumier P, Schumacher P et al. Anesthesia or sedation for gastroenterologic endoscopies. Curr Opin Anaesthesiol 2009; 22: 524–531

[129] Mazanikov M, Udd M, Kylänpää L et al. Patient-controlled sedation with propofol and remifentanil for ERCP: a randomized, controlled study. Gastrointest Endosc 2011; 73: 260–266

[130] Mazanikov M, Udd M, Kylänpää L et al. Patient-controlled sedation for ERCP: a randomized double-blind comparison of alfentanil and remifentanil. Endoscopy 2012; 44: 487–492

[131] Bright E, Roseveare C, Dalgleish D et al. Patient-controlled sedation for colonoscopy: a randomized trial comparing patient-controlled administration of propofol and alfentanil with physician-administered midazolam and pethidine. Endoscopy 2003; 35: 683–687

[132] Roseveare C, Seavell C, Patel P et al. Patient-controlled sedation and analgesia, using propofol and alfentanil, during colonoscopy: a prospective randomized controlled trial. Endoscopy 1998; 30: 768–773

[133] Lee DW, Chan AC, Sze TS et al. Patient-controlled sedation versus intravenous sedation for colonoscopy in elderly patients: a prospective randomized controlled trial. Gastrointest Endosc 2002; 56: 629–632

[134] Ng JM, Kong CF, Nyam D. Patient-controlled sedation with propofol for colonoscopy. Gastrointest Endosc 2001; 54: 8–13

[135] Crepeau T, Poincloux L, Bonny C et al. Significance of patient-controlled sedation during colonoscopy. Results from a prospective randomized controlled study. Gastroenterol Clin Biol 2005; 29: 1090–1096

[136] Lee D, Chan A, Wong S et al. The safety, feasibility, and acceptability of patient-controlled sedation for colonoscopy: Prospective study. Hong Kong medical journal = Xianggang yi xue za zhi/Hong Kong Academy of Medicine 2004; 10: 84–88

[137] Fanti L, Agostoni M, Gemma M et al. Remifentanil vs. meperidine for patient-controlled analgesia during colonoscopy: a randomized double-blind trial. Am J Gastroenterol 2009; 104: 1119–1124

[138] Jokelainen J, Udd M, Kylänpää L et al. How patient-controlled sedation is adopted in clinical practice of sedation for endoscopic retrograde cholangiopancreatography? A prospective study of 1196 cases(). Scand J Gastroenterol 2017; 52: 166–172

[139] Nilsson A, Grossmann B, Kullman E et al. Sedation during endoscopic retrograde cholangiopancreatography: a randomized controlled study of patient-controlled propofol sedation and that given by a nurse anesthetist. Scand J Gastroenterol 2015; 50: 1285–1292

[140] Lu Y, Hao L-X, Chen L et al. Systematic review and meta-analysis of patient-controlled sedation versus intravenous sedation for colonoscopy. International journal of clinical and experimental medicine 2015; 8: 19793–19803

[141] Egan TD, Kern SE, Johnson KB et al. The pharmacokinetics and pharmacodynamics of propofol in a modified cyclodextrin formulation (Captisol) versus propofol in a lipid formulation (Diprivan): an electroencephalographic and hemodynamic study in a porcine model. Anesth Analg 2003; 97: 72–79

[142] Swinhoe CF, Peacock JE, Glen JB et al. Evaluation of the predictive performance of a "Diprifusor" TCI system. Anaesthesia 1998; 53: 61–67

[143] Leslie K, Clavisi O, Hargrove J. Target-controlled infusion versus manually-controlled infusion of propofol for general anaesthesia or sedation in adults. Cochrane Database Syst Rev 2008: Cd006059. doi:10.1002/14651858.CD006059.pub2

[144] Fanti L, Agostoni M, Arcidiacono PG et al. Target-controlled infusion during monitored anesthesia care in patients undergoing EUS: propofol alone versus midazolam plus propofol. A prospective double-blind randomised controlled trial. Dig Liver Dis 2007; 39: 81–86

[145] Leslie K, Absalom A, Kenny GNC. Closed loop control of sedation for colonoscopy using the Bispectral Index*. Anaesthesia 2002; 57: 693–697

[146] Campbell L, Imrie G, Doherty P et al. Patient maintained sedation for colonoscopy using a target controlled infusion of propofol. Anaesthesia 2004; 59: 127–132

[147] Gillham MJ, Hutchinson RC, Carter R et al. Patient-maintained sedation for ERCP with a target-controlled infusion of propofol: a pilot study. Gastrointest Endosc 2001; 54: 14–17

[148] Stonell CA, Leslie K, Absalom AR. Effect-site targeted patient-controlled sedation with propofol: comparison with anaesthetist administration for colonoscopy. Anaesthesia 2006; 61: 240–247

[149] Fanti L, Gemma M, Agostoni M et al. Target Controlled Infusion for non-anaesthesiologist propofol sedation during gastrointestinal endoscopy: The first double blind randomized controlled trial. Dig Liver Dis 2015; 47: 566–571

[150] Gemma M, Pasin L, Oriani A et al. Swallowing Impairment During Propofol Target-Controlled Infusion. Anesth Analg 2016; 122: 48–54

[151] Lin YJ, Wang YC, Huang HH et al. Target-controlled propofol infusion with or without bispectral index monitoring of sedation during advanced gastrointestinal endoscopy. J Gastroenterol Hepatol 2020; 35: 1189–1195

[152] Wang JF, Li B, Yang YG et al. Target-Controlled Infusion of Propofol in Training Anesthesiology Residents in Colonoscopy Sedation: A Prospective Randomized Crossover Trial. Med Sci Monit 2016; 22: 206–210

[153] Chang YT, Tsai TC, Hsu H et al. Sedation for gastrointestinal endoscopy with the application of target-controlled infusion. Turk J Gastroenterol 2015; 26: 417–422

[154] García Guzzo ME, Fernandez MS, Sanchez Novas D et al. Deep sedation using propofol target-controlled infusion for gastrointestinal endoscopic procedures: a retrospective cohort study. BMC Anesthesiol 2020; 20: 195

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

[155] Kawano S, Okada H, Iwamuro M et al. An effective and safe sedation technique combining target-controlled infusion pump with propofol, intravenous pentazocine, and bispectral index monitoring for peroral double-balloon endoscopy. Digestion 2015; 91: 112–116

[156] Ogawa T, Tomoda T, Kato H et al. Propofol sedation with a target-controlled infusion pump in elderly patients undergoing ERCP. Gastrointest Endosc 2020; 92: 301–307

[157] Seo SI, Ryu JY, Kang SS et al. Safety of Target-Controlled Propofol Infusion by Gastroenterologists in Patients Undergoing Endoscopic Resection. Dig Dis Sci 2016; 61: 3199–3206

[158] Banerjee S, Desilets D, Diehl D et al. Computer-assisted personalized sedation. Gastrointestinal endoscopy 2011; 73: 423–427

[159] Pambianco DJ, Vargo JJ, Pruitt RE et al. Computer-assisted personalized sedation for upper endoscopy and colonoscopy: a comparative, multicenter randomized study. Gastrointest Endosc 2011; 73: 765–772

[160] Lin OS, Kozarek RA, Tombs D et al. The First US Clinical Experience With Computer-Assisted Propofol Sedation: A Retrospective Observational Comparative Study on Efficacy, Safety, Efficiency, and Endoscopist and Patient Satisfaction. Anesth Analg 2017; 125: 804–811

[161] Lin OS, La Selva D, Kozarek RA et al. One year experience with computer-assisted propofol sedation for colonoscopy. World J Gastroenterol 2017; 23: 2964–2971

[162] Lin OS, La Selva D, Kozarek RA et al. Computer-Assisted Propofol Sedation for Esophagogastroduodenoscopy Is Effective, Efficient, and Safe. Dig Dis Sci 2019; 64: 3549–3556

[163] Reves JG, Fragen RJ, Vinik HR et al. Midazolam: pharmacology and uses. Anesthesiology 1985; 62: 310–324

[164] Donnelly MB, Scott WA, Daly DS. Sedation for upper gastrointestinal endoscopy: a comparison of alfentanil-midazolam and meperidine-diazepam. Can J Anaesth 1994; 41: 1161–1165

[165] Ginsberg GG, Lewis JH, Gallagher JE et al. Diazepam versus midazolam for colonoscopy: a prospective evaluation of predicted versus actual dosing requirements. Gastrointest Endosc 1992; 38: 651–656

[166] Macken E, Gevers AM, Hendrickx A et al. Midazolam versus diazepam in lipid emulsion as conscious sedation for colonoscopy with or without reversal of sedation with flumazenil. Gastrointest Endosc 1998; 47: 57–61

[167] Lavies NG, Creasy T, Harris K et al. Arterial oxygen saturation during upper gastrointestinal endoscopy: influence of sedation and operator experience. Am J Gastroenterol 1988; 83: 618–622

[168] Carrougher JG, Kadakia S, Shaffer RT et al. Venous complications of midazolam versus diazepam. Gastrointest Endosc 1993; 39: 396–399

[169] Ladas SD, Aabakken L, Rey JF et al. Use of sedation for routine diagnostic upper gastrointestinal endoscopy: a European Society of Gastrointestinal Endoscopy Survey of National Endoscopy Society Members. Digestion 2006; 74: 69–77

[170] Zakko SF, Seifert HA, Gross JB. A comparison of midazolam and diazepam for conscious sedation during colonoscopy in a prospective double-blind study. Gastrointest Endosc 1999; 49: 684–689

[171] Cantor DS, Baldridge ET. Premedication with meperidine and diazepam for upper gastrointestinal endoscopy precludes the need for topical anesthesia. Gastrointest Endosc 1986; 32: 339–341

[172] Triantafillidis JK, Merikas E, Nikolakis D et al. Sedation in gastrointestinal endoscopy: current issues. World J Gastroenterol 2013; 19: 463–481

[173] Lee MG, Hanna W, Harding H. Sedation for upper gastrointestinal endoscopy: a comparative study of midazolam and diazepam. Gastrointest Endosc 1989; 35: 82–84

[174] Lader M, Morton S. Benzodiazepine problems. British Journal of Addiction 1991; 86: 823–828

[175] Christe C, Janssens JP, Armenian B et al. Midazolam sedation for upper gastrointestinal endoscopy in older persons: a randomized, double-blind, placebo-controlled study. J Am Geriatr Soc 2000; 48: 1398–1403

[176] Pandharipande P, Shintani A, Peterson J et al. Lorazepam is an independent risk factor for transitioning to delirium in intensive care unit patients. Anesthesiology 2006; 104: 21–26

[177] Froehlich F, Schwizer W, Thorens J et al. Conscious sedation for gastroscopy: patient tolerance and cardiorespiratory parameters. Gastroenterology 1995; 108: 697–704

[178] Yano H, Iishi H, Tatsuta M et al. Oxygen desaturation during sedation for colonoscopy in elderly patients. Hepatogastroenterology 1998; 45: 2138–2141

[179] Hirsh I, Vaissler A, Chernin J et al. Fentanyl or tramadol, with midazolam, for outpatient colonoscopy: analgesia, sedation, and safety. Dig Dis Sci 2006; 51: 1946–1951

[180] Lee S-Y, Son HJ, Lee JM et al. Identification of factors that influence conscious sedation in gastrointestinal endoscopy. Journal of Korean medical science 2004; 19: 536–540

[181] Morrow JB, Zuccaro G Jr, Conwell DL et al. Sedation for colonoscopy using a single bolus is safe, effective, and efficient: a prospective, randomized, double-blind trial. Am J Gastroenterol 2000; 95: 2242–2247

[182] Terruzzi V, Meucci G, Radaelli F et al. Routine versus "On Demand" sedation and analgesia for colonoscopy: a prospective randomized controlled trial. Gastrointestinal endoscopy 2001; 54: 169–174

[183] Conway A, Rolley J, Sutherland JR. Midazolam for sedation before procedures. Cochrane Database Syst Rev 2016; 2016: Cd009491

[184] 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: 416–421

[185] Saletin M, Malchow H, Mühlhofer H et al. A randomised controlled trial to evaluate the effects of flumazenil after midazolam premedication in outpatients undergoing colonoscopy. Endoscopy 1991; 23: 331–333

[186] Mora CT, Torjman M, White PF. Sedative and ventilatory effects of midazolam infusion: effect of flumazenil reversal. Can J Anaesth 1995; 42: 677–684

[187] Carter AS, Bell GD, Coady T et al. Speed of reversal of midazolam-induced respiratory depression by flumazenil – a study in patients undergoing upper G.I. endoscopy. Acta Anaesthesiol Scand Suppl 1990; 92: 59–64

[188] Andrews PJ, Wright DJ, Lamont MC. Flumazenil in the outpatient. A study following midazolam as sedation for upper gastrointestinal endoscopy. Anaesthesia 1990; 45: 445–448

[189] Bartelsman JF, Sars PR, Tytgat GN. Flumazenil used for reversal of midazolam-induced sedation in endoscopy outpatients. Gastrointest Endosc 1990; 36: S9–S12

[190] Norton AC, Dundas CR. Induction agents for day-case anaesthesia. A double-blind comparison of propofol and midazolam antagonised by flumazenil. Anaesthesia 1990; 45: 198–203

[191] 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–e29

[192] Schnider T, Minto C. Context sensitive decrement times of remimazolam. Anesth Analg 2013; 117: 285

[193] Borkett KM, Riff DS, Schwartz HI et al. A Phase IIa, randomized, double-blind study of remimazolam (CNS 7056) versus midazolam for sedation in upper gastrointestinal endoscopy. Anesth Analg 2015; 120: 771–780

[194] Rex DK, Bhandari R, Desta T et al. A phase III study evaluating the efficacy and safety of remimazolam (CNS 7056) compared with placebo and midazolam in patients undergoing colonoscopy. Gastrointest Endosc 2018; 88: 427–437.e6

[195] Wang F, Zhou Q, Shen M et al. Efficacy and safety of remimazolam in procedural sedation and analgesia: A protocol for systematic review and meta analysis. Medicine (Baltimore) 2020; 99: e20765

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[196] Ulmer BJ, Hansen JJ, Overley CA et al. Propofol versus midazolam/fentanyl for outpatient colonoscopy: administration by nurses supervised by endoscopists. Clin Gastroenterol Hepatol 2003; 1: 425–432

[197] 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

[198] Jung M, Hofmann C, Kiesslich R et al. Improved sedation in diagnostic and therapeutic ERCP: propofol is an alternative to midazolam. Endoscopy 2000; 32: 233–238

[199] Wehrmann T, Grotkamp J, Stergiou N et al. Electroencephalogram monitoring facilitates sedation with propofol for routine ERCP: a randomized, controlled trial. Gastrointest Endosc 2002; 56: 817–824

[200] Wehrmann T, Kokabpick H, Jacobi V et al. Long-term results of endoscopic injection of botulinum toxin in elderly achalasic patients with tortuous megaesophagus or epiphrenic diverticulum. Endoscopy 1999; 31: 352–358

[201] Cohen LB, Hightower CD, Wood DA et al. Moderate level sedation during endoscopy: a prospective study using low-dose propofol, meperidine/fentanyl, and midazolam. Gastrointest Endosc 2004; 59: 795–803

[202] Mandel JE, Tanner JW, Lichtenstein GR et al. A randomized, controlled, double-blind trial of patient-controlled sedation with propofol/remifentanil versus midazolam/fentanyl for colonoscopy. Anesth Analg 2008; 106: 434–439

[203] Yamagata T, Hirasawa D, Fujita N et al. Efficacy of propofol sedation for endoscopic submucosal dissection (ESD): assessment with prospective data collection. Intern Med 2011; 50: 1455–1460

[204] Hansen JJ, Ulmer BJ, Rex DK. Technical performance of colonoscopy in patients sedated with nurse-administered propofol. Am J Gastroenterol 2004; 99: 52–56

[205] Rudner R, Jalowiecki P, Kawecki P et al. Conscious analgesia/sedation with remifentanil and propofol versus total intravenous anesthesia with fentanyl, midazolam, and propofol for outpatient colonoscopy. Gastrointest Endosc 2003; 57: 657–663

[206] Chin NM, Tai HY, Chin MK. Intravenous sedation for upper gastrointestinal endoscopy: Midazolam versus propofol. Singapore Med J 1992; 33: 478–480

[207] Zhang R, Lu Q, Wu Y. The Comparison of Midazolam and Propofol in Gastrointestinal Endoscopy: A Systematic Review and Meta-analysis. Surg Laparosc Endosc Percutan Tech 2018; 28: 153–158

[208] Kim DB, Kim JS, Huh CW et al. Propofol compared with bolus and titrated midazolam for sedation in outpatient colonoscopy: a prospective randomized double-blind study. Gastrointest Endosc 2021; 93: 201–208

[209] Ominami M, Nagami Y, Shiba M et al. Comparison of propofol with midazolam in endoscopic submucosal dissection for esophageal squamous cell carcinoma: a randomized controlled trial. J Gastroenterol 2018; 53: 397–406

[210] Kikuchi H, Hikichi T, Watanabe K et al. Efficacy and safety of sedation during endoscopic submucosal dissection of gastric cancers using a comparative trial of propofol versus midazolam. Endosc Int Open 2018; 6: E51–E57

[211] Wahab EA, Hamed EF, Ahmad HS et al. Conscious sedation using propofol versus midazolam in cirrhotic patients during upper GI endoscopy: A comparative study. JGH Open 2019; 3: 25–31

[212] Krugliak P, Ziff B, Rusabrov Y et al. Propofol versus midazolam for conscious sedation guided by processed EEG during endoscopic retrograde cholangiopancreatography: a prospective, randomized, double-blind study. Endoscopy 2000; 32: 677–682

[213] Riphaus A, Stergiou N, Wehrmann T. Sedation with propofol for routine ERCP in high-risk octogenarians: a randomized, controlled study. Am J Gastroenterol 2005; 100: 1957–1963

[214] Wehrmann T, Riphaus A. Sedation with propofol for interventional endoscopic procedures: a risk factor analysis. Scand J Gastroenterol 2008; 43: 368–374

[215] Paspatis GA, Manolaraki MM, Vardas E et al. Deep sedation for endoscopic retrograde cholangiopancreatography: intravenous propofol alone versus intravenous propofol with oral midazolam premedication. Endoscopy 2008; 40: 308–313

[216] Behrens A, Ell C, Studiengruppe A-P. Safety of sedation during gastroscopy and colonoscopy in low-risk patients – results of a retrospective subgroup analysis of a registry study including over 170 000 endoscopies. Z Gastroenterol 2016; 54: 733–739

[217] Goudra B, Nuzat A, Singh PM et al. Association between Type of Sedation and the Adverse Events Associated with Gastrointestinal Endoscopy: An Analysis of 5 Years' Data from a Tertiary Center in the USA. Clin Endosc 2017; 50: 161–169

[218] Wadhwa V, Issa D, Garg S et al. Similar Risk of Cardiopulmonary Adverse Events Between Propofol and Traditional Anesthesia for Gastrointestinal Endoscopy: A Systematic Review and Meta-analysis. Clin Gastroenterol Hepatol 2017; 15: 194–206

[219] Ishiguro T, Ishiguro C, Ishiguro G et al. Midazolam sedation for upper gastrointestinal endoscopy: comparison between the states of patients in partial and complete amnesia. Hepatogastroenterology 2002; 49: 438–440

[220] Arrowsmith JB, Gerstman BB, Fleischer DE et al. Results from the American Society for Gastrointestinal Endoscopy/U.S. Food and Drug Administration collaborative study on complication rates and drug use during gastrointestinal endoscopy. Gastrointest Endosc 1991; 37: 421–427

[221] Basu S, Krishnamurthy B, Walsh TH. Value of fentanyl in flexible sigmoidoscopy. World J Surg 2004; 28: 930–934

[222] Ishido S, Kinoshita Y, Kitajima N et al. Fentanyl for sedation during upper gastrointestinal endoscopy. Gastrointest Endosc 1992; 38: 689–692

[223] Robertson DJ, Jacobs DP, Mackenzie TA et al. Clinical trial: a randomized, study comparing meperidine (pethidine) and fentanyl in adult gastrointestinal endoscopy. Aliment Pharmacol Ther 2009; 29: 817–823

[224] Fassoulaki A, Iatrelli I, Vezakis A et al. Deep sedation for endoscopic cholangiopancreatography with or without pre or intraprocedural opioids: A double-blind randomised controlled trial. Eur J Anaesthesiol 2015; 32: 602–608

[225] Kapila A, Glass PS, Jacobs JR et al. Measured context-sensitive half-times of remifentanil and alfentanil. Anesthesiology 1995; 83: 968–975

[226] Akcaboy ZN, Akcaboy EY, Albayrak D et al. Can remifentanil be a better choice than propofol for colonoscopy during monitored anesthesia care? Acta Anaesthesiol Scand 2006; 50: 736–741

[227] Manolaraki MM, Theodoropoulou A, Stroumpos C et al. Remifentanil compared with midazolam and pethidine sedation during colonoscopy: a prospective, randomized study. Dig Dis Sci 2008; 53: 34–40

[228] Hong MJ, Sung IK, Lee SP et al. Randomized comparison of recovery time after use of remifentanil alone versus midazolam and meperidine for colonoscopy anesthesia. Dig Endosc 2015; 27: 113–120

[229] Zhang J, Huang Y, Li Z et al. Sedation and use of analgesics in endoscopic retrograde cholangiopancreatography: a double-blind comparison study of meperidine/midazolam, remifentanil/ midazolam, and remifentanil alone. Int J Clin Pharmacol Ther 2016; 54: 872–879

[230] Borrat X, Valencia JF, Magrans R et al. Sedation-analgesia with propofol and remifentanil: concentrations required to avoid gag reflex in upper gastrointestinal endoscopy. Anesth Analg 2015; 121: 90–96

[231] Prause A, Wappler F, Scholz J et al. Respiratory depression under long-term sedation with sufentanil, midazolam and clonidine has no clinical significance. Intensive Care Med 2000; 26: 1454–1461

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

[232] Monk JP, Beresford R, Ward A. Sufentanil. A review of its pharmacological properties and therapeutic use. Drugs 1988; 36: 286–313

[233] Deng C, Wang X, Zhu Q et al. Comparison of nalbuphine and sufentanil for colonoscopy: A randomized controlled trial. PLoS One 2017; 12: e0188901

[234] Green SM, Li J. Ketamine in adults: what emergency physicians need to know about patient selection and emergence reactions. Acad Emerg Med 2000; 7: 278–281

[235] White PF, Way WL, Trevor AJ. Ketamine – its pharmacology and therapeutic uses. Anesthesiology 1982; 56: 119–136

[236] Ward J, Standage C. Angina pain precipitated by a continuous subcutaneous infusion of ketamine. J Pain Symptom Manage 2003; 25: 6–7

[237] Green SM, Roback MG, Kennedy RM et al. Clinical practice guideline for emergency department ketamine dissociative sedation: 2011 update. Ann Emerg Med 2011; 57: 449–461

[238] Schmenger P. Intravenöse Anästhetika. In: Tonner PH, Hein L, ed.; Pharmakotherapie in der Anästhesie und Intensivmedizin. Berlin Heidelberg: Springer; 2011: 81–108

[239] Aggarwal A, Ganguly S, Anand VK et al. Efficacy and safety of intravenous ketamine for sedation and analgesia during pediatric endoscopic procedures. Indian Pediatr 1998; 35: 1211–1214

[240] Gilger MA, Spearman RS, Dietrich CL et al. Safety and effectiveness of ketamine as a sedative agent for pediatric GI endoscopy. Gastrointest Endosc 2004; 59: 659–663

[241] Rösing C, Trinkl W, Rösing K et al. Midazolam plus ketamine as premedication for colonoscopies. A double-blind, randomized study. Med Klin (Munich) 1991; 86: 190–193

[242] Ong WC, Santosh D, Lakhtakia S et al. A randomized controlled trial on use of propofol alone versus propofol with midazolam, ketamine, and pentazocine "sedato-analgesic cocktail" for sedation during ERCP. Endoscopy 2007; 39: 807–812

[243] Tian L, Luan H, Zhu P et al. A randomized controlled trial for measuring effects on cognitive functions of adding ketamine to propofol during sedation for colonoscopy. Medicine (Baltimore) 2020; 99: e21859

[244] Turk HS, Aydogmus M, Unsal O et al. Ketamine versus alfentanil combined with propofol for sedation in colonoscopy procedures: a randomized prospective study. Turk J Gastroenterol 2014; 25: 644–649

[245] Tuncali B, Pekcan YO, Celebi A et al. Addition of low-dose ketamine to midazolam-fentanyl-propofol-based sedation for colonoscopy: a randomized, double-blind, controlled trial. J Clin Anesth 2015; 27: 301–306

[246] Yin S, Hong J, Sha T et al. Efficacy and Tolerability of Sufentanil, Dexmedetomidine, or Ketamine Added to Propofol-based Sedation for Gastrointestinal Endoscopy in Elderly Patients: A Prospective, Randomized, Controlled Trial. Clin Ther 2019; 41: 1864–1877.e0

[247] Paris A, Philipp M, Tonner PH et al. Activation of alpha 2B-adrenoceptors mediates the cardiovascular effects of etomidate. Anesthesiology 2003; 99: 889–895

[248] Jabre P, Combes X, Lapostolle F et al. Etomidate versus ketamine for rapid sequence intubation in acutely ill patients: a multicentre randomised controlled trial. Lancet 2009; 374: 293–300

[249] Cuthbertson BH, Sprung CL, Annane D et al. The effects of etomidate on adrenal responsiveness and mortality in patients with septic shock. Intensive Care Med 2009; 35: 1868–1876

[250] Albert SG, Ariyan S, Rather A. The effect of etomidate on adrenal function in critical illness: a systematic review. Intensive Care Med 2011; 37: 901–910

[251] Albert SG, Sitaula S. Etomidate, Adrenal Insufficiency and Mortality Associated With Severity of Illness: A Meta-Analysis. J Intensive Care Med 2021; 36: 1124–1129

[252] Ye L, Xiao X, Zhu L. The Comparison of Etomidate and Propofol Anesthesia in Patients Undergoing Gastrointestinal Endoscopy: A Systematic Review and Meta-Analysis. Surg Laparosc Endosc Percutan Tech 2017; 27: 1–7

[253] Han SJ, Lee TH, Yang JK et al. Etomidate Sedation for Advanced Endoscopic Procedures. Dig Dis Sci 2019; 64: 144–151

[254] Dyck JB, Maze M, Haack C et al. The pharmacokinetics and hemodynamic effects of intravenous and intramuscular dexmedetomidine hydrochloride in adult human volunteers. Anesthesiology 1993; 78: 813–820

[255] Tonner PH, Paris A. α2-Agonists in anesthesia and intensive care. Pharm Unserer Zeit 2011; 40: 474–479

[256] Quintin L, Ghignone M. Risks associated with peri-operative use of alpha2-adrenoceptor agonists. In: Scholz J, Tonner PH,, eds. Alpha2-adrenoceptor agonists in anaesthesia and intensive care. London: Bailliere Tindall; 2000: 347–368

[257] Nishizawa T, Suzuki H, Sagara S et al. Dexmedetomidine versus midazolam for gastrointestinal endoscopy: a meta-analysis. Dig Endosc 2015; 27: 8–15

[258] Zhang F, Sun HR, Zheng ZB et al. Dexmedetomidine versus midazolam for sedation during endoscopy: A meta-analysis. Exp Ther Med 2016; 11: 2519–2524

[259] Nishizawa T, Suzuki H, Hosoe N et al. Dexmedetomidine vs propofol for gastrointestinal endoscopy: A meta-analysis. United European Gastroenterol J 2017; 5: 1037–1045

[260] Takacs J. Toxicology of nitrous oxide. In: Tonner PH, Scholz J,, eds. Use of nitrous oxide in anaesthesia. London: Bailliere Tindall; 2001: 349–362

[261] Deutsche Gesellschaft für Anästhesiologie und Intensivmedizin e.V., Berufsverband Deutscher Anästhesisten e.V.. Stellungnahme der DGAI und des BDA zur Einführung von LIVOPAN® in Deutschland. Entschliessungen, Recommendation en, Vereinbarungen – Ein Beitrag zur Qualitätssicherung in der Anästhesiologie. Ebelsbach: Aktiv Druck und Verlag; 2011: 533

[262] Welchman S, Cochrane S, Minto G et al. Systematic review: the use of nitrous oxide gas for lower gastrointestinal endoscopy. Aliment Pharmacol Ther 2010; 32: 324–333

[263] Aboumarzouk OM, Agarwal T, Syed Nong Chek SA et al. Nitrous oxide for colonoscopy. Cochrane Database Syst Rev 2011: Cd008506. doi:10.1002/14651858.CD008506.pub2

[264] 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

[265] Løberg M, Furholm S, Hoff I et al. Nitrous oxide for analgesia in colonoscopy without sedation. Gastrointest Endosc 2011; 74: 1347–1353

[266] 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: 471–479

[267] Wang CX, Wang J, Chen YY et al. Randomized controlled study of the safety and efficacy of nitrous oxide-sedated endoscopic ultrasound-guided fine needle aspiration for digestive tract diseases. World J Gastroenterol 2016; 22: 10242–10248

[268] Xiaoqian Z, Tao Z, Bingsong L et al. Clinical comparative study on Nitrous Oxide inhalation versus intravenous propofol and Midazolam sedation in Transnasal Gastroscopy. Pak J Med Sci 2017; 33: 891–894

[269] Fanti L, Testoni PA. Sedation and analgesia in gastrointestinal endoscopy: what's new? World J Gastroenterol 2010; 16: 2451–2457

[270] Waring JP, Baron TH, Hirota WK et al. Guidelines for conscious sedation and monitoring during gastrointestinal endoscopy. Gastrointest Endosc 2003; 58: 317–322

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

[271] Jameson JS, Kapadia SA, Polson RJ et al. Is oropharyngeal anaesthesia with topical lignocaine useful in upper gastrointestinal endoscopy? Aliment Pharmacol Ther 1992; 6: 739–744

[272] Milligan KR, Howe JP, McLoughlin J et al. Midazolam sedation for outpatient fibreoptic endoscopy: evaluation of alfentanil supplementation. Ann R Coll Surg Engl 1988; 70: 304–306

[273] Seifert H, Schmitt TH, Gültekin T et al. Sedation with propofol plus midazolam versus propofol alone for interventional endoscopic procedures: a prospective, randomized study. Aliment Pharmacol Ther 2000; 14: 1207–1214

[274] DiPalma JA, Herrera JL, Weis FR et al. Alfentanil for conscious sedation during colonoscopy. South Med J 1995; 88: 630–634

[275] Moerman AT, Struys MM, Vereecke HE et al. Remifentanil used to supplement propofol does not improve quality of sedation during spontaneous respiration. J Clin Anesth 2004; 16: 237–243

[276] Rembacken BJ, Axon AT. The role of pethidine in sedation for colonoscopy. Endoscopy 1995; 27: 244–247

[277] Chen M, Lu Y, Liu H et al. The propofol-sparing effect of intravenous lidocaine in elderly patients undergoing colonoscopy: a randomized, double-blinded, controlled study. BMC Anesthesiol 2020; 20: 132

[278] Forster C, Vanhaudenhuyse A, Gast P et al. Intravenous infusion of lidocaine significantly reduces propofol dose for colonoscopy: a randomised placebo-controlled study. Br J Anaesth 2018; 121: 1059–1064

[279] Kim JE, Choi JB, Koo BN et al. Efficacy of Intravenous Lidocaine During Endoscopic Submucosal Dissection for Gastric Neoplasm: A Randomized, Double-Blind, Controlled Study. Medicine (Baltimore) 2016; 95: e3593

[280] Liu J, Liu X, Peng LP et al. Efficacy and safety of intravenous lidocaine in propofol-based sedation for ERCP procedures: a prospective, randomized, double-blinded, controlled trial. Gastrointest Endosc 2020; 92: 293–300

[281] Rex DK. Review article: moderate sedation for endoscopy: sedation regimens for non-anaesthesiologists. Aliment Pharmacol Ther 2006; 24: 163–171

[282] Cohen LB, Dubovsky AN, Aisenberg J et al. Propofol for endoscopic sedation: A protocol for safe and effective administration by the gastroenterologist. Gastrointest Endosc 2003; 58: 725–732

[283] Regula J, Sokol-Kobielska E. Sedation in endoscopy: when and how. Best Pract Res Clin Gastroenterol 2008; 22: 945–957

[284] Clarke AC, Chiragakis L, Hillman LC et al. Sedation for endoscopy: the safe use of propofol by general practitioner sedationists. Med J Aust 2002; 176: 158–161

[285] Paspatis GA, Manolaraki M, Xirouchakis G et al. Synergistic sedation with midazolam and propofol versus midazolam and pethidine in colonoscopies: a prospective, randomized study. Am J Gastroenterol 2002; 97: 1963–1967

[286] Lubarsky DA, Candiotti K, Harris E. Understanding modes of moderate sedation during gastrointestinal procedures: a current review of the literature. J Clin Anesth 2007; 19: 397–404

[287] Goyal R, Hasnain S, Mittal S et al. A randomized, controlled trial to compare the efficacy and safety profile of a dexmedetomidine-ketamine combination with a propofol-fentanyl combination for ERCP. Gastrointest Endosc 2016; 83: 928–933

[288] Han G, Yu WW, Zhao P. A randomized study of intranasal vs. intravenous infusion of dexmedetomidine in gastroscopy. Int J Clin Pharmacol Ther 2014; 52: 756–761

[289] Inatomi O, Imai T, Fujimoto T et al. Dexmedetomidine is safe and reduces the additional dose of midazolam for sedation during endoscopic retrograde cholangiopancreatography in very elderly patients. BMC Gastroenterol 2018; 18: 166

[290] Lee BS, Ryu J, Lee SH et al. Midazolam with meperidine and dexmedetomidine vs. midazolam with meperidine for sedation during ERCP: prospective, randomized, double-blinded trial. Endoscopy 2014; 46: 291–298

[291] Lee SP, Sung IK, Kim JH et al. Comparison of dexmedetomidine with on-demand midazolam versus midazolam alone for procedural sedation during endoscopic submucosal dissection of gastric tumor. J Dig Dis 2015; 16: 377–384

[292] Nishikawa H, Iwata Y, Ishii A et al. Effect of dexmedetomidine in the prophylactic endoscopic injection sclerotherapy for oesophageal varices: a study protocol for prospective interventional study. BMJ Open Gastroenterol 2017; 4: e000149

[293] Nonaka T, Inamori M, Miyashita T et al. Feasibility of deep sedation with a combination of propofol and dexmedetomidine hydrochloride for esophageal endoscopic submucosal dissection. Dig Endosc 2016; 28: 145–151

[294] Radaelli F, Meucci G, Terruzzi V et al. Single bolus of midazolam versus bolus midazolam plus meperidine for colonoscopy: a prospective, randomized, double-blind trial. Gastrointest Endosc 2003; 57: 329–335

[295] Cinar K, Yakut M, Ozden A. Sedation with midazolam versus midazolam plus meperidine for routine colonoscopy: a prospective, randomized, controlled study. Turk J Gastroenterol 2009; 20: 271–275

[296] Hayee B, Dunn J, Loganayagam A et al. Midazolam with meperidine or fentanyl for colonoscopy: results of a randomized trial. Gastrointest Endosc 2009; 69: 681–687

[297] Lee CK, Lee SH, Chung IK et al. Balanced propofol sedation for therapeutic GI endoscopic procedures: a prospective, randomized study. Gastrointest Endosc 2011; 73: 206–214

[298] Cordruwisch W, Doroschko M, Wurbs D. [Deep sedation in gastrointestinal endoscopic interventions: safety and reliability of a combination of midazolam and propofol]. Dtsch Med Wochenschr 2000; 125: 619–622

[299] Mui LM, Ng EK, Chan KC et al. Randomized, double-blinded, placebo-controlled trial of intravenously administered hyoscine N-butyl bromide in patients undergoing colonoscopy with patient-controlled sedation. Gastrointest Endosc 2004; 59: 22–27

[300] Vargo JJ, Holub JL, Faigel DO et al. Risk factors for cardiopulmonary events during propofol-mediated upper endoscopy and colonoscopy. Aliment Pharmacol Ther 2006; 24: 955–963

[301] Iber FL, Sutberry M, Gupta R et al. Evaluation of complications during and after conscious sedation for endoscopy using pulse oximetry. Gastrointest Endosc 1993; 39: 620–625

[302] Lieberman DA, Wuerker CK, Katon RM. Cardiopulmonary risk of esophagogastroduodenoscopy. Role of endoscope diameter and systemic sedation. Gastroenterology 1985; 88: 468–472

[303] Thompson AM, Park KG, Kerr F et al. Safety of fibreoptic endoscopy: analysis of cardiorespiratory events. Br J Surg 1992; 79: 1046–1049

[304] Assy N, Rosser BG, Grahame GR et al. Risk of sedation for upper GI endoscopy exacerbating subclinical hepatic encephalopathy in patients with cirrhosis. Gastrointest Endosc 1999; 49: 690–694

[305] Vasudevan AE, Goh KL, Bulgiba AM. Impairment of psychomotor responses after conscious sedation in cirrhotic patients undergoing therapeutic upper GI endoscopy. Am J Gastroenterol 2002; 97: 1717–1721

[306] Muravchick S. Aging, anesthesia, and antioxidants. J Clin Anesth 2008; 20: 409–410

[307] Qureshi WA, Zuckerman MJ, Adler DG et al. ASGE guideline: modifications in endoscopic practice for the elderly. Gastrointest Endosc 2006; 63: 566–569

[308] Darling E. Practical considerations in sedating the elderly. Crit Care Nurs Clin North Am 1997; 9: 371–380

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[309] Dhariwal A, Plevris JN, Lo NT et al. Age, anemia, and obesity-associated oxygen desaturation during upper gastrointestinal endoscopy. Gastrointest Endosc 1992; 38: 684–688

[310] Heuss LT, Schnieper P, Drewe J et al. Safety of propofol for conscious sedation during endoscopic procedures in high-risk patients-a prospective, controlled study. Am J Gastroenterol 2003; 98: 1751–1757

[311] Harikumar R, Raj M, Paul A et al. Listening to music decreases need for sedative medication during colonoscopy: a randomized, controlled trial. Indian J Gastroenterol 2006; 25: 3–5

[312] Rudin D, Kiss A, Wetz RV et al. Music in the endoscopy suite: a meta-analysis of randomized controlled studies. Endoscopy 2007; 39: 507–510

[313] Kerker A, Hardt C, Schlief HE et al. Combined sedation with midazolam/propofol for gastrointestinal endoscopy in elderly patients. BMC Gastroenterol 2010; 10: 11

[314] Riphaus A, Lechowicz I, Frenz MB et al. Propofol sedation for upper gastrointestinal endoscopy in patients with liver cirrhosis as an alternative to midazolam to avoid acute deterioration of minimal encephalopathy: a randomized, controlled study. Scand J Gastroenterol 2009; 44: 1244–1251

[315] Correia LM, Bonilha DQ, Gomes GF et al. Sedation during upper GI endoscopy in cirrhotic outpatients: a randomized, controlled trial comparing propofol and fentanyl with midazolam and fentanyl. Gastrointest Endosc 2011; 73: 45–51.e1

[316] Amorós A, Aparicio JR, Garmendia M et al. Deep sedation with propofol does not precipitate hepatic encephalopathy during elective upper endoscopy. Gastrointest Endosc 2009; 70: 262–268

[317] Khamaysi I, William N, Olga A et al. Sub-clinical hepatic encephalopathy in cirrhotic patients is not aggravated by sedation with propofol compared to midazolam: a randomized controlled study. J Hepatol 2011; 54: 72–77

[318] Sharma P, Singh S, Sharma BC et al. Propofol sedation during endoscopy in patients with cirrhosis, and utility of psychometric tests and critical flicker frequency in assessment of recovery from sedation. Endoscopy 2011; 43: 400–405

[319] Küper MA, Kratt T, Kramer KM et al. Effort, safety, and findings of routine preoperative endoscopic evaluation of morbidly obese patients undergoing bariatric surgery. Surg Endosc 2010; 24: 1996–2001

[320] Wani S, Azar R, Hovis CE et al. Obesity as a risk factor for sedation-related complications during propofol-mediated sedation for advanced endoscopic procedures. Gastrointest Endosc 2011; 74: 1238–1247

[321] Coté GA. The debate for nonanesthesiologist-administered propofol sedation in endoscopy rages on: who will be the "King of Prop?". Gastrointest Endosc 2011; 73: 773–776

[322] Coté GA, Hovis RM, Ansstas MA et al. Incidence of sedation-related complications with propofol use during advanced endoscopic procedures. Clin Gastroenterol Hepatol 2010; 8: 137–142

[323] Rivera R, Antognini JF. Perioperative drug therapy in elderly patients. Anesthesiology 2009; 110: 1176–1181

[324] Horiuchi A, Nakayama Y, Tanaka N et al. Propofol sedation for endoscopic procedures in patients 90 years of age and older. Digestion 2008; 78: 20–23

[325] Friedrich K, Stremmel W, Sieg A. Endoscopist-administered propofol sedation is safe – a prospective evaluation of 10000 patients in an outpatient practice. J Gastrointestin Liver Dis 2012; 21: 259–263

[326] Nonaka M, Gotoda T, Kusano C et al. Safety of gastroenterologist-guided sedation with propofol for upper gastrointestinal therapeutic endoscopy in elderly patients compared with younger patients. Gut Liver 2015; 9: 38–42

[327] Ching HL, Branchi F, Sanders DS et al. Paradigm shift: should the elderly undergo propofol sedation for DBE? A prospective cohort study. Frontline Gastroenterol 2018; 9: 192–199

[328] 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: 1051–1059

[329] Khoi CS, Wong JJ, Wang HC et al. Age correlates with hypotension during propofol-based anesthesia for endoscopic retrograde cholangiopancreatography. Acta Anaesthesiol Taiwan 2015; 53: 131–134

[330] Lovett P, Gómez V, Hodge DO et al. Propofol Versus Midazolam/Fentanyl Sedation for Colonoscopy in the Elderly Patient Population. J Perianesth Nurs 2017; 32: 210–214

[331] Agostoni M, Fanti L, Gemma M et al. Adverse events during monitored anesthesia care for GI endoscopy: an 8-year experience. Gastrointest Endosc 2011; 74: 266–275

[332] Sharma SK, Maharjan DK, Thapa PB et al. The role of sedation and pulse oximetry during upper gastrointestinal endoscopy. JNMA J Nepal Med Assoc 2009; 48: 92–98

[333] Vargo JJ. Sedation in the bariatric patient. Gastrointest Endosc Clin N Am 2011; 21: 257–263

[334] Heuss LT, Schnieper P, Drewe J et al. Risk stratification and safe administration of propofol by registered nurses supervised by the gastroenterologist: a prospective observational study of more than 2000 cases. Gastrointest Endosc 2003; 57: 664–671

[335] Tsai HC, Lin YC, Ko CL et al. Propofol versus midazolam for upper gastrointestinal endoscopy in cirrhotic patients: a meta-analysis of randomized controlled trials. PLoS One 2015; 10: e0117585

[336] Jo HB, Lee JK, Jang DK et al. Safety and effectiveness of midazolam for cirrhotic patients undergoing endoscopic variceal ligation. Turk J Gastroenterol 2018; 29: 448–455

[337] Costa A, Montalbano LM, Orlando A et al. Music for colonoscopy: A single-blind randomized controlled trial. Dig Liver Dis 2010; 42: 871–876

[338] El-Hassan H, McKeown K, Muller AF. Clinical trial: music reduces anxiety levels in patients attending for endoscopy. Aliment Pharmacol Ther 2009; 30: 718–724

[339] Meeuse JJ, Koornstra JJ, Reyners AK. Listening to music does not reduce pain during sigmoidoscopy. Eur J Gastroenterol Hepatol 2010; 22: 942–945

[340] Tam WW, Wong EL, Twinn SF. Effect of music on procedure time and sedation during colonoscopy: a meta-analysis. World J Gastroenterol 2008; 14: 5336–5343

[341] Smolen D, Topp R, Singer L. The effect of self-selected music during colonoscopy on anxiety, heart rate, and blood pressure. Appl Nurs Res 2002; 15: 126–136

[342] Walter S, Gruss S, Neidlinger J et al. Evaluation of an Objective Measurement Tool for Stress Level Reduction by Individually Chosen Music During Colonoscopy-Results From the Study "ColoRelaxTone". Front Med (Lausanne) 2020; 7: 525

[343] Schaible A, Schwan K, Bruckner T et al. Acupuncture to improve tolerance of diagnostic esophagogastroduodenoscopy in patients without systemic sedation: results of a single-center, double-blinded, randomized controlled trial (DRKS00000164). Trials 2016; 17: 350

[344] Aisenberg J, Cohen LB. Sedation in endoscopic practice. Gastrointest Endosc Clin N Am 2006; 16: 695–708

[345] The use of pulse oximetry during conscious sedation. Council on Scientific Affairs, American Medical Association. Jama 1993; 270: 1463–1468

[346] Eisenbacher S, Heard L. Capnography in the gastroenterology lab. Gastroenterol Nurs 2005; 28: 99–105

[347] Graber RG. Propofol in the endoscopy suite: an anesthesiologist's perspective. Gastrointest Endosc 1999; 49: 803–806

[348] Harris JK, Froehlich F, Wietlisbach V et al. Factors associated with the technical performance of colonoscopy: An EPAGE Study. Dig Liver Dis 2007; 39: 678–689

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

[349] Jamieson J. Anesthesia and sedation in the endoscopy suite? (influences and options). Curr Opin Anaesthesiol 1999; 12: 417–423

[350] Leslie K, Stonell CA. Anaesthesia and sedation for gastrointestinal endoscopy. Curr Opin Anaesthesiol 2005; 18: 431–436

[351] López Rosés L. Subcomité de Protocolos Of The Spanish Society Of Gastrointestinal Endoscopy S. Sedation/analgesia guidelines for endoscopy. Rev Esp Enferm Dig 2006; 98: 685–692

[352] Mahoney LB, Lightdale JR. Sedation of the pediatric and adolescent patient for GI procedures. Curr Treat Options Gastroenterol 2007; 10: 412–421

[353] Moos DD, Cuddeford JD. Methemoglobinemia and benzocaine. Gastroenterol Nurs 2007; 30: 342–345

[354] Morlote EB, Zweng TN, Strodel WE. Hemodynamic monitoring and pulse oximetry during percutaneous gastrostomy and jejunostomy: necessity or nuisance? Surg Endosc 1991; 5: 130–134

[355] Overley CA, Rex DK. A nursing perspective on sedation and nurse-administered propofol for endoscopy. Gastrointest Endosc Clin N Am 2004; 14: 325–333

[356] Robbertze R, Posner KL, Domino KB. Closed claims review of anesthesia for procedures outside the operating room. Curr Opin Anaesthesiol 2006; 19: 436–442

[357] Guidelines for nursing care of the patient receiving sedation and analgesia in the gastrointestinal endoscopy setting. Society of Gastroenterology Nurses and Associates, Inc. Gastroenterol Nurs 1997; 20 (2): suppl 1–6

[358] Training guideline for use of propofol in gastrointestinal endoscopy. Gastrointest Endosc 2004; 60: 167–172

[359] Vargo JJ, Ahmad AS, Aslanian HR et al. Training in patient monitoring and sedation and analgesia. Gastrointest Endosc 2007; 66: 7–10

[360] Zebris J, Maurer W. Quality assurance in the endoscopy suite: sedation and monitoring. Gastrointest Endosc Clin N Am 2004; 14: 415–429

[361] Heneghan S, Myers J, Fanelli R et al. Society of American Gastrointestinal Endoscopic Surgeons (SAGES) guidelines for office endoscopic services. Surg Endosc 2009; 23: 1125–1129

[362] Dumonceau JM, Riphaus A, Aparicio JR et al. European Society of Gastrointestinal Endoscopy, European Society of Gastroenterology and Endoscopy Nurses and Associates, and the European Society of Anaesthesiology Guideline: Non-anesthesiologist administration of propofol for GI endoscopy. Endoscopy 2010; 42: 960–974

[363] Borgaonkar MR, Hookey L, Hollingworth R et al. Indicators of safety compromise in gastrointestinal endoscopy. Can J Gastroenterol 2012; 26: 71–78

[364] Vargo JJ, DeLegge MH, Feld AD et al. Multisociety Sedation Curriculum for Gastrointestinal Endoscopy. Am J Gastroenterol 2012. doi:10.1038/ajg.2012.112

[365] Dumonceau JM, Riphaus A, Aparicio JR et al. European Society of Gastrointestinal Endoscopy, European Society of Gastroenterology and Endoscopy Nurses and Associates, and the European Society of Anaesthesiology Guideline: Non-anaesthesiologist administration of propofol for GI endoscopy. Eur J Anaesthesiol 2010; 27: 1016–1030

[366] Jain R, Ikenberry SO, Anderson MA et al. Minimum staffing requirements for the performance of GI endoscopy. Gastrointest Endosc 2010; 72: 469–470

[367] Vargo JJ, Cohen LB, Rex DK et al. Position statement: Nonanesthesiologist administration of propofol for GI endoscopy. Gastroenterology 2009; 137: 2161–2167

[368] Lichtenstein DR, Jagannath S, Baron TH et al. Sedation and anesthesia in GI endoscopy. Gastrointest Endosc 2008; 68: 815–826

[369] Muñoz-Martínez T, Pardo-Rey C, Silva-Obregón JA. Sedation in special procedures and situations. Med Intensiva 2008; 32 Spec No. 1: 107–114

[370] Society of Gastroenterology Nurses Association (SGNA). Statement on the use of sedation and analgesia in the gastrointestinal endoscopy setting. Gastroenterol Nurs 2008; 31: 249–251

[371] Byrne MF, Chiba N, Singh H et al. Propofol use for sedation during endoscopy in adults: a Canadian Association of Gastroenterology position statement. Can J Gastroenterol 2008; 22: 457–459

[372] Riphaus A, Wehrmann T, Weber B et al. S3-guidelines – sedation in gastrointestinal endoscopy. Z Gastroenterol 2008; 46: 1298–1330

[373] Dumonceau JM, Riphaus A, Schreiber F et al. Non-anesthesiologist administration of propofol for gastrointestinal endoscopy: European Society of Gastrointestinal Endoscopy, European Society of Gastroenterology and Endoscopy Nurses and Associates Guideline—Updated June 2015. Endoscopy 2015; 47: 1175–1189

[374] Practice guidelines for sedation and analgesia by non-anesthesiologists. A report by the American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists. Anesthesiology 1996; 84: 459–471

[375] Gottlieb KT, Banerjee S, Barth BA et al. Monitoring equipment for endoscopy. Gastrointest Endosc 2013; 77: 175–180

[376] Deutsche Gesellschaft für Anästhesie und Intensivmedizin. Stufe 1 Leitlinie Sedierung und Analgesie durch Nicht-Anaesthesisten. 2003

[377] Hofmann C, Jung M. Sedierung und Überwachung bei endoskopischen Eingriffen. 24–29

[378] Sedation and Monitoring Of Patients Undergoing Gastrointestinal Endoscopic Procedures. Gastrointest Endosc; 1995; 42: 626–629

[379] American Society of Anesthesiologists Task Force on Postanesthetic Care. Practice guidelines for postanesthetic care: a report by the American Society of Anesthesiologists Task Force on Postanesthetic Care. Anesthesiology 2002; 96: 742–752

[380] American College of Gastroenterology (ACG), American Gastroenterological (AGA), American Society for Gastrointestinal Endoscopy. Joint statement of a Working from the American College of Gastroenterology (ACG), the American Gastroenterological (AGA), and the American Society for Gastrointestinal Endoscopy: Recommendations on the administration of sedation for the performance of endoscopic procedures. 2006

[381] Kang H, Kim DK, Choi YS et al. Practice guidelines for propofol sedation by non-anesthesiologists: the Korean Society of Anesthesiologists Task Force recommendations on propofol sedation. Korean J Anesthesiol 2016; 69: 545–554

[382] Conigliaro R, Fanti L, Manno M et al. Italian Society of Digestive Endoscopy (SIED) position paper on the non-anaesthesiologist administration of propofol for gastrointestinal endoscopy. Dig Liver Dis 2017; 49: 1185–1190

[383] Early DS, Lightdale JR, Vargo JJ et al. Guidelines for sedation and anesthesia in GI endoscopy. Gastrointest Endosc 2018; 87: 327–337

[384] Gotoda T, Akamatsu T, Abe S et al. Guidelines for sedation in gastroenterological endoscopy (second edition). Dig Endosc 2021; 33: 21–53

[385] Kiesslich R, Moenk S, Reinhardt K et al. Combined simulation training: a new concept and workshop is useful for crisis management in gastrointestinal endoscopy. Z Gastroenterol 2005; 43: 1031–1039

[386] Cabadas Avión R, Baluja A, Ojea Cendón M et al. Effectiveness and safety of gastrointestinal endoscopy during a specific sedation training program for non-anesthesiologists. Rev Esp Enferm Dig 2019; 111: 199–208

[387] 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: 619–627

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

[388] Dumonceau JM, Riphaus 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

[389] 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: 141–147

[390] Obara K, Haruma K, Irisawa A et al. Guidelines for sedation in gastroenterological endoscopy. Dig Endosc 2015; 27: 435–449

[391] Slagelse C, Vilmann P, Hornslet P et al. Nurse-administered propofol sedation for gastrointestinal endoscopic procedures: first Nordic results from implementation of a structured training program. Scand J Gastroenterol 2011; 46: 1503–1509

[392] Jensen JT, Savran MM, Møller AM et al. Development and validation of a theoretical test in non-anaesthesiologist-administered propofol sedation for gastrointestinal endoscopy. Scand J Gastroenterol 2016; 51: 872–879

[393] 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

[394] Rex DK, Deenadayalu VP, Eid E et al. Endoscopist-directed administration of propofol: a worldwide safety experience. Gastroenterology 2009; 137: 1229–1237

[395] Behrens A, Labenz J, Schuler A et al. How safe is sedation in gastrointestinal endoscopy? A multicentre analysis of 388404 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: 432–436

[396] Frieling T, Heise J, Kreysel C et al. Sedation-associated complications in endoscopy – prospective multicentre survey of 191142 patients. Z Gastroenterol 2013; 51: 568–572

[397] Jamil LH, Naveed M, Agrawal D et al. ASGE guideline on minimum staffing requirements for the performance of GI endoscopy. Gastrointest Endosc 2020; 91: 723–729.e17

[398] 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: 445–452

[399] Gouda B, Gouda G, Borle A et al. Safety of non-anesthesia provider administered propofol sedation in non-advanced gastrointestinal endoscopic procedures: A meta-analysis. Saudi J Gastroenterol 2017; 23: 133–143

[400] Heron V, Golden C, Blum S et al. Endoscopist-Directed Propofol as an Adjunct to Standard Sedation: A Canadian Experience. J Can Assoc Gastroenterol 2020; 3: 141–144

[401] Jensen JT, Møller A, Hornslet P et al. Moderate and deep nurse-administered propofol sedation is safe. Dan Med J 2015; 62: A5049

[402] Jensen JT, Hornslet P, Konge L et al. High efficacy with deep nurse-administered propofol sedation for advanced gastroenterologic endoscopic procedures. Endosc Int Open 2016; 4: E107–E111

[403] Lapidus A, Gralnek IM, Suissa A et al. Safety and efficacy of endoscopist-directed balanced propofol sedation during endoscopic retrograde cholangiopancreatography. Ann Gastroenterol 2019; 32: 303–311

[404] Ooi M, Thomson A. Morbidity and mortality of endoscopist-directed nurse-administered propofol sedation (EDNAPS) in a tertiary referral center. Endosc Int Open 2015; 3: E393–E397

[405] Sathananthan D, Young E, Nind G et al. Assessing the safety of physician-directed nurse-administered propofol sedation in low-risk patients undergoing endoscopy and colonoscopy. Endosc Int Open 2017; 5: E110–E115

[406] Yamamoto H, Gotoda T, Nakamura T et al. Clinical impact of gastroenterologist-administered propofol during esophagogastroduodenoscopy: a randomized comparison at a single medical clinic. Gastric Cancer 2015; 18: 326–331

[407] Rex DK, Overley C, Kinser K et al. Safety of propofol administered by registered nurses with gastroenterologist supervision in 2000 endoscopic cases. Am J Gastroenterol 2002; 97: 1159–1163

[408] Rex DK, Heuss LT, Walker JA et al. Trained registered nurses/endoscopy teams can administer propofol safely for endoscopy. Gastroenterology 2005; 129: 1384–1391

[409] Walker JA, McIntyre RD, Schleinitz PF et al. Nurse-administered propofol sedation without anesthesia specialists in 9152 endoscopic cases in an ambulatory surgery center. Am J Gastroenterol 2003; 98: 1744–1750

[410] Behrens A, Labenz J, Schuler A et al. Wie sicher ist die Sedierung in der gastrointestinalen Endoskopie? Eine multizentrische Auswertung von 388404 Endoskopien und Auswertung der Daten aus prospektiv geführten Komplikationsregistern von Mitgliedern der Arbeitsgemeinschaft leitender Gastroenterologen im Krankenhaus (ALGK). Z Gastroenterol 2013; 51: 432–436

[411] Heuss LT, Froehlich F, Beglinger C. Nonanesthesiologist-administered propofol sedation: from the exception to standard practice. Sedation and monitoring trends over 20 years. Endoscopy 2012; 44: 504–511

[412] Müller M, Wehrmann T. How best to approach endoscopic sedation? Nat Rev Gastroenterol Hepatol 2011; 8: 481–490

[413] Cohen LB, Ladas SD, Vargo JJ et al. Sedation in digestive endoscopy: the Athens international position statements. Aliment Pharmacol Ther 2010; 32: 425–442

[414] Gerstenberger PD. Capnography and patient safety for endoscopy. Clin Gastroenterol Hepatol 2010; 8: 423–425

[415] Cohen LB. Patient monitoring during gastrointestinal endoscopy: why, when, and how? Gastrointest Endosc Clin N Am 2008; 18: 651–663, vii

[416] Aisenberg J. Endoscopic sedation: equipment and personnel. Gastrointest Endosc Clin N Am 2008; 18: 641–649, vii

[417] Wilson S, McCluskey A. Use of capnography during endoscopic retrograde cholangio-pancreatography. Anaesthesia 2008; 63: 1016–1017

[418] Wall BF, Magee K, Campbell SG et al. Capnography versus standard monitoring for emergency department procedural sedation and analgesia. Cochrane Database of Systematic Reviews 2017. doi:10.1002/14651858.CD010698.pub2

[419] Jopling MW, Qiu J. Capnography sensor use is associated with reduction of adverse outcomes during gastrointestinal endoscopic procedures with sedation administration. BMC Anesthesiol 2017; 17: 157

[420] Saunders R, Erslon M, Vargo J. Modeling the costs and benefits of capnography monitoring during procedural sedation for gastrointestinal endoscopy. Endosc Int Open 2016; 4: E340–E351

[421] Kim SH, Park M, Lee J et al. The addition of capnography to standard monitoring reduces hypoxemic events during gastrointestinal endoscopic sedation: a systematic review and meta-analysis. Ther Clin Risk Manag 2018; 14: 1605–1614

[422] Slagelse C, Vilmann P, Hornslet P et al. The role of capnography in endoscopy patients undergoing nurse-administered propofol sedation: a randomized study. Scand J Gastroenterol 2013; 48: 1222–1230

[423] Friedrich-Rust M, Welte M, Welte C et al. Capnographic monitoring of propofol-based sedation during colonoscopy. Endoscopy 2014; 46: 236–244

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

[424] Mehta PP, Kochhar G, Albeldawi M et al. Capnographic Monitoring in Routine EGD and Colonoscopy With Moderate Sedation: A Prospective, Randomized, Controlled Trial. Am J Gastroenterol 2016; 111: 395–404

[425] Peveling-Oberhag J, Michael F, Tal A et al. Capnography monitoring of non-anesthesiologist provided sedation during percutaneous endoscopic gastrostomy placement: A prospective, controlled, randomized trial. J Gastroenterol Hepatol 2020; 35: 401–407

[426] Michael FA, Peveling-Oberhag J, Herrmann E et al. Evaluation of the Integrated Pulmonary Index® during non-anesthesiologist sedation for percutaneous endoscopic gastrostomy. J Clin Monit Comput 2021; 35: 1085–1092

[427] Prathanvanich P, Chand B. The role of capnography during upper endoscopy in morbidly obese patients: a prospective study. Surg Obes Relat Dis 2015; 11: 193–198

[428] Takimoto Y, Iwasaki E, Masaoka T et al. Novel mainstream capnometer system is safe and feasible even under CO(2) insufflation during ERCP-related procedure: a pilot study. BMJ Open Gastroenterol 2019; 6: e000266

[429] Teng WN, Ting CK, Wang YT et al. Oral capnography is more effective than nasal capnography during sedative upper gastrointestinal endoscopy. J Clin Monit Comput 2018; 32: 321–326

[430] Bakry M, Bakry R. Changes in topographic electroencephalogram during deepening levels of propofol sedation based on alertness/sedation scale under bispectral index guidance. Anaesthesiol Intensive Ther 2019; 51: 224–229

[431] Garbe J, Eisenmann S, Kantelhardt JW et al. Capability of processed EEG parameters to monitor conscious sedation in endoscopy is similar to general anaesthesia. United European Gastroenterol J 2021. doi:10.1177/2050640620959153

[432] Jang SY, Park HG, Jung MK et al. Bispectral index monitoring as an adjunct to nurse-administered combined sedation during endoscopic retrograde cholangiopancreatography. World J Gastroenterol 2012; 18: 6284–6289

[433] Sasaki T, Tanabe S, Azuma M et al. Propofol sedation with bispectral index monitoring is useful for endoscopic submucosal dissection: a randomized prospective phase II clinical trial. Endoscopy 2012; 44: 584–589

[434] von Delius S, Salletmaier H, Meining A et al. Bispectral index monitoring of midazolam and propofol sedation during endoscopic retrograde cholangiopancreatography: a randomized clinical trial (the EndoBIS study). Endoscopy 2012; 44: 258–264

[435] Kang KJ, Min BH, Lee MJ et al. Efficacy of Bispectral Index Monitoring for Midazolam and Meperidine Induced Sedation during Endoscopic Submucosal Dissection: A Prospective, Randomized Controlled Study. Gut Liver 2011; 5: 160–164

[436] Wehrmann T. Extended monitoring of the sedated patient: bispectral index, Narcotrend and automated responsiveness monitor. Digestion 2010; 82: 90–93

[437] Paspatis GA, Chainaki I, Manolaraki MM et al. Efficacy of bispectral index monitoring as an adjunct to propofol deep sedation for ERCP: a randomized controlled trial. Endoscopy 2009; 41: 1046–1051

[438] Qadeer MA, Vargo JJ. BIS: hit or miss? Am J Gastroenterol 2009; 104: 1850

[439] Hata K, Andoh A, Hayafuji K et al. Usefulness of bispectral monitoring of conscious sedation during endoscopic mucosal dissection. World J Gastroenterol 2009; 15: 595–598

[440] Imagawa A, Fujiki S, Kawahara Y et al. Satisfaction with bispectral index monitoring of propofol-mediated sedation during endoscopic submucosal dissection: a prospective, randomized study. Endoscopy 2008; 40: 905–909

[441] DeWitt JM. Bispectral index monitoring for nurse-administered propofol sedation during upper endoscopic ultrasound: a prospective, randomized controlled trial. Dig Dis Sci 2008; 53: 2739–2745

[442] Zhang H, Lu Y, Wang L et al. Bispectral index monitoring of sedation depth during endoscopy: a meta-analysis with trial sequential analysis of randomized controlled trials. Minerva Anestesiol 2019; 85: 412–432

[443] Yu YH, Han DS, Kim HS et al. Efficacy of bispectral index monitoring during balanced propofol sedation for colonoscopy: a prospective, randomized controlled trial. Dig Dis Sci 2013; 58: 3576–3583

[444] Park WY, Shin YS, Lee SK et al. Bispectral index monitoring during anesthesiologist-directed propofol and remifentanil sedation for endoscopic submucosal dissection: a prospective randomized controlled trial. Yonsei Med J 2014; 55: 1421–1429

[445] Heo J, Jung MK, Lee HS et al. Effects of bispectral index monitoring as an adjunct to nurse-administered propofol combined sedation during colonoscopy: a randomized clinical trial. Korean J Intern Med 2016; 31: 260–266

[446] Sargin M, Uluer MS, Şimşek B. The effect of bispectral index monitoring on cognitive performance following sedation for outpatient colonoscopy: a randomized controlled trial. Sao Paulo Med J 2019; 137: 305–311

[447] von Delius S, Thies P, Rieder T et al. Auditory evoked potentials compared with bispectral index for monitoring of midazolam and propofol sedation during colonoscopy. Am J Gastroenterol 2009; 104: 318–325

[448] Amornyotin S, Chalayonnawin W, Kongphlay S. Deep sedation for endoscopic retrograde cholangiopancreatography: a comparison between clinical assessment and Narcotrend(TM) monitoring. Med Devices (Auckl) 2011; 4: 43–49

[449] Holley K, MacNabb CM, Georgiadis P et al. Monitoring minute ventilation versus respiratory rate to measure the adequacy of ventilation in patients undergoing upper endoscopic procedures. J Clin Monit Comput 2016; 30: 33–39

[450] Mathews DM, Oberding MJ, Simmons EL et al. Improving patient safety during procedural sedation via respiratory volume monitoring: A randomized controlled trial. J Clin Anesth 2018; 46: 118–123

[451] Touw HRW, Verheul MH, Tuinman PR et al. Photoplethysmography respiratory rate monitoring in patients receiving procedural sedation and analgesia for upper gastrointestinal endoscopy. J Clin Monit Comput 2017; 31: 747–754

[452] Phan AD, Neuschwander A, Perrod G et al. Noninvasive continuous monitoring versus intermittent oscillometric measurements for the detection of hypotension during digestive endoscopy. PLoS One 2020; 15: e0240241

[453] Takamaru H, Kawaguchi Y, Oda I et al. A new reliable acoustic respiratory monitoring technology during upper gastrointestinal tract therapeutic endoscopy with CO(2) insufflation. J Clin Monit Comput 2020. doi:10.1007/s10877-020-00547-2

[454] Wadhwa V, Gonzalez AJ, Selema K et al. Novel device for monitoring respiratory rate during endoscopy-A thermodynamic sensor. World J Gastrointest Pharmacol Ther 2019; 10: 57–66

[455] Parzeller M, Wenk M, Zedler B et al. Aufklärung und Einwilligung bei ärztlichen Eingriffen. Dtsch Arztebl International 2007; 104: A 576–A 586

[456] Hochberger J. Die Einverständniserklärung zu endoskopischen Eingriffen. In: Sauerbruch T, Scheurlen C,, eds. Recommendation en der Deutschen Gesellschaft für Verdauungs- und Stoffwechselkrankheiten (DGVS) zur Durchführung endoskopischer Untersuchungen. 3. erweiterte und überarbeitete Auflage. Stuttgart: Demeterverlag; 2002: 1–11

[457] Practice Guidelines for Sedation and Analgesia by Non-Anesthesiologists: A Report by the American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists. Anesthesiology 1996; 84: 459–471

[458] Rieger HJ. Timeliness of informing the patient. Decision of the Federal Court, 3/25/2003 -VI ZR 131/02. Dtsch Med Wochenschr 2003; 128: 1728–1729

This document was downloaded for personal use only. Unauthorized distribution is strictly prohibited.

[459] Sieg A, Hachmoeller-Eisenbach U, Eisenbach T. Prospective evaluation of complications in outpatient GI endoscopy: a survey among German gastroenterologists. Gastrointest Endosc 2001; 53: 620–627

[460] Lee SY, Son HJ, Lee JM et al. Identification of factors that influence conscious sedation in gastrointestinal endoscopy. J Korean Med Sci 2004; 19: 536–540

[461] Mahajan RJ, Johnson JC, Marshall JB. Predictors of patient cooperation during gastrointestinal endoscopy. J Clin Gastroenterol 1997; 24: 220–223

[462] Peña LR, Mardini HE, Nickl NJ. Development of an instrument to assess and predict satisfaction and poor tolerance among patients undergoing endoscopic procedures. Dig Dis Sci 2005; 50: 1860–1871

[463] Lazzaroni M, Bianchi Porro G. Preparation, premedication, and surveillance. Endoscopy 2005; 37: 101–109

[464] Laufs A, Uhlenbruck W. Handbuch des Arztrechts. 3 Aufl. 2022

[465] 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

[466] 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: 437–479

[467] OLG Stuttgart. MedR. 1986: 41–42

[468] OLG Zweibrücken. MedR. 1995: 407–408

[469] Hayes A, Buffum M. Educating patients after conscious sedation for gastrointestinal procedures. Gastroenterol Nurs 2001; 24: 54–57

[470] Smith MR, Bell GD, Fulton B et al. A comparison of winged steel needles and Teflon cannulas in maintaining intravenous access during gastrointestinal endoscopy. Gastrointest Endosc 1993; 39: 33–36

[471] Alcaín G, Guillén P, Escolar A et al. Predictive factors of oxygen desaturation during upper gastrointestinal endoscopy in nonsedated patients. Gastrointest Endosc 1998; 48: 143–147

[472] Jurell KR, O'Connor KW, Slack J et al. Effect of supplemental oxygen on cardiopulmonary changes during gastrointestinal endoscopy. Gastrointest Endosc 1994; 40: 665–670

[473] Wang CY, Ling LC, Cardosa MS et al. Hypoxia during upper gastrointestinal endoscopy with and without sedation and the effect of preoxygenation on oxygen saturation. Anaesthesia 2000; 55: 654–658

[474] Reshef R, Shiller M, Kinberg R et al. A prospective study evaluating the usefulness of continuous supplemental oxygen in various endoscopic procedures. Isr J Med Sci 1996; 32: 736–740

[475] Rozario L, Sloper D, Sheridan MJ. Supplemental oxygen during moderate sedation and the occurrence of clinically significant desaturation during endoscopic procedures. Gastroenterol Nurs 2008; 31: 281–285

[476] Bell GD, Bown S, Morden A et al. Prevention of hypoxaemia during upper-gastrointestinal endoscopy by means of oxygen via nasal cannulae. Lancet 1987; 1: 1022–1024

[477] Kim H, Hyun JN, Lee KJ et al. Oxygenation before Endoscopic Sedation Reduces the Hypoxic Event during Endoscopy in Elderly Patients: A Randomized Controlled Trial. J Clin Med 2020; 9. doi:10.3390/jcm9103282

[478] Ayuse T, Sawase H, Ozawa E et al. Study on prevention of hypercapnia by nasal high flow in patients undergoing endoscopic retrograde cholangiopancreatography during intravenous anesthesia. Medicine (Baltimore) 2020; 99: e20036

[479] Dimou F, Huynh S, Dakin G et al. Nasal positive pressure with the SuperNO(2)VA™ device decreases sedation-related hypoxemia during pre-bariatric surgery EGD. Surg Endosc 2019; 33: 3828–3832

[480] Ristikankare M, Julkunen R, Mattila M et al. Conscious sedation and cardiorespiratory safety during colonoscopy. Gastrointest Endosc 2000; 52: 48–54

[481] Petelenz M, Gonciarz M, Macfarlane P et al. Sympathovagal balance fluctuates during colonoscopy. Endoscopy 2004; 36: 508–514

[482] Ristikankare M, Julkunen R, Heikkinen M et al. Cardiac autonomic regulation during gastroscopy. Dig Liver Dis 2009; 41: 648–652

[483] Ristikankare M, Julkunen R, Heikkinen M et al. Sedation, topical pharyngeal anesthesia and cardiorespiratory safety during gastroscopy. J Clin Gastroenterol 2006; 40: 899–905

[484] Bahalla A, Sood A, Sachdeva A et al. Cardiorespiratory compromise under conscious sedation during upper gastrointestinal endoscopy. J Coll Physicians Surg Pak 2006; 16: 585–589

[485] Kounis NG, Zavras GM, Papadaki PJ et al. Electrocardiographic changes in elderly patients during endoscopic retrograde cholangiopancreatography. Can J Gastroenterol 2003; 17: 539–544

[486] Jaca IJ, Desai D, Barkin JS. Paroxysmal supraventricular tachycardia after administration of glucagon during upper endoscopy. Gastrointest Endosc 2002; 56: 304

[487] Murray AW, Morran CG, Kenny GN et al. Examination of cardiorespiratory changes during upper gastrointestinal endoscopy. Comparison of monitoring of arterial oxygen saturation, arterial pressure and the electrocardiogram. Anaesthesia 1991; 46: 181–184

[488] Soar J, Böttiger BW, Carli P et al. European Resuscitation Council Guidelines 2021: Adult advanced life support. Resuscitation 2021; 161: 115–151

[489] Lewalter T, Lickfett L, Schwab JO et al. Notfall Herzrhythmusstörungen. Dtsch Arztebl International 2007; 104: A-1172–/B-1045/C-997

[490] Sieg A. Propofol sedation in outpatient colonoscopy by trained practice nurses supervised by the gastroenterologist: a prospective evaluation of over 3000 cases. Z Gastroenterol 2007; 45: 697–701

[491] Olasveengen TM, Semeraro F, Ristagno G et al. European Resuscitation Council Guidelines 2021: Basic Life Support. Resuscitation 2021; 161: 98–114

[492] Leslie K, Tay T, Neo E. Intravenous fluid to prevent hypotension in patients undergoing elective colonoscopy. Anaesth Intensive Care 2006; 34: 316–321

[493] Ristikankare M, Julkunen R, Laitinen T et al. Effect of conscious sedation on cardiac autonomic regulation during colonoscopy. Scand J Gastroenterol 2000; 35: 990–996

[494] Hynynen M, Korttila K, Tammisto T. Pain on i.v. injection of propofol (ICI 35868) in emulsion formulation. Short communication. Acta Anaesthesiol Scand 1985; 29: 651–652

[495] Gajraj NM, Nathanson MH. Preventing pain during injection of propofol: the optimal dose of lidocaine. J Clin Anesth 1996; 8: 575–577

[496] Auerswald K, Pfeiffer F, Behrends K et al. Pain on injection with propofol. Anasthesiol Intensivmed Notfallmed Schmerzther 2005; 40: 259–266

[497] Fischer MJ, Leffler A, Niedermirtl F et al. The general anesthetic propofol excites nociceptors by activating TRPV1 and TRPA1 rather than GABAA receptors. J Biol Chem 2010; 285: 34781–34792

[498] Ead H. From Aldrete to PADSS: Reviewing discharge criteria after ambulatory surgery. J Perianesth Nurs 2006; 21: 259–267

[499] Deutsche Gesellschaft für Anästhesiologie und Intensivmedizin, Berufsverband Deutscher Anästhesisten. Recommendation en zur Überwachung nach Anästhesieverfahren. Anästh Intensivmed 2009; 50: 485–488

[500] Aldrete JA. Modifications to the postanesthesia score for use in ambulatory surgery. J Perianesth Nurs 1998; 13: 148–155

[501] Chung F, Chan VW, Ong D. A post-anesthetic discharge scoring system for home readiness after ambulatory surgery. J Clin Anesth 1995; 7: 500–506

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[502] Amornyotin S, Chalayonnavin W, Kongphlay S. Recovery pattern and home-readiness after ambulatory gastrointestinal endoscopy. J Med Assoc Thai 2007; 90: 2352–2358

[503] Aldrete JA. The post-anesthesia recovery score revisited. J Clin Anesth 1995; 7: 89–91

[504] Willey J, Vargo JJ, Connor JT et al. Quantitative assessment of psychomotor recovery after sedation and analgesia for outpatient EGD. Gastrointest Endosc 2002; 56: 810–816

[505] Nuotto EJ, Korttila KT, Lichtor JL et al. Sedation and recovery of psychomotor function after intravenous administration of various doses of midazolam and diazepam. Anesth Analg 1992; 74: 265–271

[506] Thapar P, Zacny JP, Thompson W et al. Using alcohol as a standard to assess the degree of impairment induced by sedative and analgesic drugs used in ambulatory surgery. Anesthesiology 1995; 82: 53–59

[507] Watkins TJ, Bonds RL, Hodges K et al. Evaluation of postprocedure cognitive function using 3 distinct standard sedation regimens for endoscopic procedures. AANA J 2014; 82: 133–139

[508] British Society of Gastroenterology. Clinical Practice Guidelines: Safety and sedation during endoscopic procedures. 2003

[509] Korttila K, Linnoila M. Psychomotor skills related to driving after intramuscular administration of diazepam and meperidine. Anesthesiology 1975; 42: 685–691

[510] Korttila K, Linnoila M. Recovery and skills related to driving after intravenous sedation: dose-response relationship with diazepam. Br J Anaesth 1975; 47: 457–463

[511] Korttila K. Recovery after intravenous sedation. A comparison of clinical and paper and pencil tests used in assessing late effects of diazepam. Anaesthesia 1976; 31: 724–731

[512] Horiuchi A, Nakayama Y, Katsuyama Y et al. Safety and driving ability following low-dose propofol sedation. Digestion 2008; 78: 190–194

[513] Horiuchi A, Nakayama Y, Hidaka N et al. Low-dose propofol sedation for diagnostic esophagogastroduodenoscopy: results in 10,662 adults. Am J Gastroenterol 2009; 104: 1650–1655

[514] Horiuchi A, Nakayama Y, Fujii H et al. Psychomotor recovery and blood propofol level in colonoscopy when using propofol sedation. Gastrointest Endosc 2012; 75: 506–512

[515] Brechmann T, Maier C, Kaisler M et al. Propofol sedation during gastrointestinal endoscopy arouses euphoria in a large subset of patients. United European Gastroenterology Journal 2018; 6: 536–546

[516] Riphaus A, Slottje M, Bulla J et al. Women awaken faster than men after electroencephalogram-monitored propofol sedation for colonoscopy: A prospective observational study. European Journal of Anaesthesiology 2017; 34: 681–687

[517] Loryan I, Lindqvist M, Johansson I et al. Influence of sex on propofol metabolism, a pilot study: implications for propofol anesthesia. Eur J Clin Pharmacol 2012; 68: 397–406

[518] Pitetti R, Davis PJ, Redlinger R et al. Effect on hospital-wide sedation practices after implementation of the 2001 JCAHO procedural sedation and analgesia guidelines. Arch Pediatr Adolesc Med 2006; 160: 211–216

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