Annals of Gastroenterology (2024) **37,** 1-10

Safe outpatient discharge after gastrointestinal endoscopy with sedation and analgesia: a systematic literature review

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Abstract

Sedation and analgesia during gastrointestinal (GI) endoscopy increase procedural quality, contributing at the same time to greater patient satisfaction and willingness to undergo the procedure. Although sedation use has been optimized by the advent of efficacious and safe medications, data regarding the minimal criteria for discharge after outpatient endoscopy remain scant. Moreover, the time of discharge after endoscopy can be highly variable, depending not only on the type of procedure and anesthesia administered, but also on postprocedural complications and the patient's comorbidities. To make things even more conflicting, there is neither consensus among various endoscopic societies, concerning the most appropriate discharge strategy, nor a universally established tool that could be incorporated into everyday clinical practice, allowing patients' safe discharge as well as ability to drive. In this context, we conducted a systematic review, aiming to summarize the evidence regarding the available discharge scoring systems after outpatient GI endoscopy with sedation and analgesia administration.

Keywords Gastrointestinal endoscopy, sedation, analgesia, discharge

Ann Gastroenterol 2024; 37 (XX): 1-10

Conflict of Interest: None

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Received 28 March 2024; accepted 27 May 2024; published online 12 July 2024

DOI: https://doi.org/10.20524/aog.2024.0899

Introduction

In the last few years, the number and the complexity of digestive endoscopic procedures have increased significantly as a consequence of technological advances in diagnostic and therapeutic invasive endoscopic practices, as well as the establishment of routine screening and surveillance programs for colorectal cancer prevention. The majority of endoscopic procedures are conducted on an outpatient basis, with the use of a combination of a benzodiazepine and an opioid as the gold-standard method [1]. Administration of light to moderate analgesia/sedation primarily contributes to decreasing the patient's anxiety, discomfort and pain, and results in an improvement of the patient's tolerance and the endoscopist's performance and efficiency [2-4]. Depending on the procedural duration, complexity and invasiveness, as well as the patient's

comorbidities, a combination of different sedatives and analgesic agents are preferred, leading to various adverse effects such as respiratory depression or hypotension, and various recovery patterns [5,6]. The widespread use of sedation during gastrointestinal (GI) endoscopy has introduced new challenges for both endoscopists and nursing personnel, concerning the close monitoring of patients' vital signs during and after the procedure, the optimal length of stay, and the safe discharge of patients after they become fully conscious, clinically stable, and ideally cognitively functional.

A few practical discharge scoring systems have been used by different gastroenterology units, such as the Aldrete scoring system and the modified post-anesthesia discharge scoring system (mPADSS); these are based on clinical criteria that include respiration, oxygen saturation, blood pressure and pulse, level of consciousness, mobility, nausea and vomiting, or pain [7-9]. The discharge requirements of these scoring systems are often based on subjective clinical parameters that are not consistently recorded in many digestive endoscopic centers. The majority of existing discharge scoring systems do not evaluate the patient's mental state and cognitive functioning before discharge, resulting in cognitive impairment and altered psychomotor function at discharge [10].

International guidelines for endoscopy sedation suggest the implementation of standardized discharge criteria and scoring systems in combination with clinical assessment before discharge. However, there is discordance among different endoscopic societies concerning the appropriate combination of discharge criteria and there is currently no established tool or consistent requirements for determining patients' safe discharge and home-readiness after an outpatient GI endoscopic procedure under conscious sedation [11-13].

Implementation of efficient strategies for the safe discharge after GI endoscopy is a cost-effective measure that could also optimize the management of physical space and time spent in the recovery rooms by decreasing the length of stay [14]. Moreover, the use of standardized discharge criteria could improve compliance with postprocedural recommendations, and could enhance the patient's experience [15]. Despite the extensive use of GI endoscopy, only small-scale research has focused on the patient's home-readiness and the appropriate requirements for safe discharge after outpatient digestive endoscopy, depending on different sedation practices. The purpose of this review is to present studies that used and compared different discharge scoring systems after outpatient GI endoscopy, and to address the various criteria and scoring systems used in clinical practice for enabling the safe discharge of patients who have undergone GI procedures under analgesia/sedation in different digestive endoscopic departments.

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Materials and methods

Search strategy

A computerized search of the MEDLINE electronic database was systematically performed for publications in the English language, from database inception to December 2023. The search terms included the following, both as Medical Subject Headings and as free-text terms: "*gastrointestinal endoscopy", "colonoscopy", "gastroscopy", "discharge", "discharge scoring system", "discharge criteria", "Aldrete score", "PADSS*". The search strategy was based on the PICO criteria (P: outpatients undergoing GI endoscopy; I: use of discharge criteria/ discharge scoring system; C: comparison to different or no discharge score/criteria; and O: discharge after endoscopy). To maximize the yield, we carried out a stepwise approach, with searches divided into different stages and combined at the end. Two investigators (GT and MS) conducted the search independently, and all the resulting titles were screened for inclusion. The full search strategy is outlined in Table 1.

Criteria for eligibility

Only human studies in adult populations and full-text articles in English were accepted. Exclusion criteria included non-human, *ex vivo* or pilot studies, reviews or meta-analyses, conference abstracts, editorials, case reports/series and irrelevant data (outcomes or endoscopic methods not related to this study). In addition, the reference lists of the included original studies and pertinent reviews were manually searched for studies not initially identified.

Identification and article selection

Two of the authors (MS and DZ) independently reviewed the literature according to the inclusion and exclusion criteria and then cross-checked. Disagreements about eligibility were resolved by consensus and discussion with the senior author (GT). After removal of duplicates, records were screened for inclusion by title and abstract. Other potentially eligible studies

Table 1 Search strategy

Search strategy - PubMed (Date Run: 13/03/2024)		
Step	Search terms	Found articles
#1	Search: ((((gastrointestinal endoscopy) OR (colonoscopy)) OR (gastroscopy)) OR (esophagogastroduodenoscopy)) AND (discharge) Filters: English (("endoscopy, gastrointestinal"[MeSH Terms] OR ("endoscopy"[All Fields] AND "gastrointestinal"[All Fields]) OR "gastrointestinal endoscopy"[All Fields] OR ("gastrointestinal"[All Fields] AND "endoscopy"[All Fields]) OR ("colonoscopy"[MeSH Terms] OR "colonoscopy"[All Fields] OR "colonoscopies"[All Fields]) OR ("gastroscopy"[MeSH Terms] OR "gastroscopy"[All Fields] OR "gastroscopies"[All Fields]) OR ("endoscopy, digestive system"[MeSH Terms] OR ("endoscopy"[All Fields] AND "digestive"[All Fields] AND "system"[All Fields]) OR "digestive system endoscopy"[All Fields] OR "esophagogastroduodenoscopies"[All Fields] OR "oesophagogastroduodenoscopies"[All Fields] OR "oesopha gogastroduodenoscopy"[All Fields] OR "esophagogastroduodenoscopy"[All Fields])) AND ("discharges"[All Fields] OR "discharging"[All Fields] OR "patient discharge"[MeSH Terms] OR ("patient"[All Fields] AND "discharge"[All Fields]) OR "patient discharge"[All Fields] OR "discharge"[All Fields] OR "discharged"[All Fields])) AND (english[Filter])	2,958
#2	Search: (gastrointestinal endoscopy) AND (discharge score) Filters: English	
	(("endoscopy, gastrointestinal"[MeSH Terms] OR ("endoscopy"[All Fields] AND "gastrointestinal"[All Fields]) OR "gastrointestinal endoscopy"[All Fields] OR ("gastrointestinal"[All Fields] AND "endoscopy"[All Fields])) AND (("discharges"[All Fields] OR "discharging"[All Fields] OR "patient discharge"[MeSH Terms] OR ("patient"[All Fields] AND "discharge"[All Fields]) OR "patient discharge"[All Fields] OR "discharge"[All Fields] OR "discharged"[All Fields]) AND ("score"[All Fields] OR "score s"[All Fields] OR "scored"[All Fields] OR "scores"[All Fields] OR "scoring"[All Fields] OR "scorings"[All Fields]))) AND (english[Filter])	204
#3	Search: (gastrointestinal endoscopy) AND (discharge scoring system) Filters: English (("endoscopy, gastrointestinal"[MeSH Terms] OR ("endoscopy"[All Fields] AND "gastrointestinal"[All Fields]) OR "gastrointestinal endoscopy"[All Fields] OR ("gastrointestinal"[All Fields] AND "endoscopy"[All Fields])) AND (("discharges"[All Fields] OR "discharging"[All Fields] OR "patient discharge"[MeSH Terms] OR ("patient"[All Fields] AND "discharge"[All Fields]) OR "patient discharge"[All Fields] OR "discharge"[All Fields] OR "discharged"[All Fields]) AND ("score"[All Fields] OR "score s"[All Fields] OR "scored"[All Fields] OR "scores"[All Fields] OR "scoring"[All Fields] OR "scorings"[All Fields]) AND ("system"[All Fields] OR "system s"[All Fields] OR "systems"[All Fields]))) AND (english[Filter])	61
#4	Search: (gastrointestinal endoscopy) AND (discharge criteria) AND (english[Filter]) Filters: English ((("endoscopy, gastrointestinal"[MeSH Terms] OR ("endoscopy"[All Fields] AND "gastrointestinal"[All Fields]) OR "gastrointestinal endoscopy"[All Fields] OR ("gastrointestinal"[All Fields] AND "endoscopy"[All Fields])) AND (("discharges"[All Fields] OR "discharging"[All Fields] OR "patient discharge"[MeSH Terms] OR ("patient"[All Fields] AND "discharge"[All Fields]) OR "patient discharge"[All Fields] OR "discharge"[All Fields] OR "discharged"[All Fields]) AND ("criteria s"[All Fields] OR "criterias"[All Fields] OR "standards"[MeSH Subheading] OR "standards"[All Fields] OR "criteria"[All Fields])) AND "english"[Language]) AND (english[Filter])	161
#5	Search: (gastrointestinal endoscopy) AND (Post Anesthetic Discharge Scoring System) AND (english[Filter]) AND (english[Filter]) Filters: English (("endoscopy, gastrointestinal"[MeSH Terms] OR ("endoscopy"[All Fields] AND "gastrointestinal"[All Fields]) OR "gastrointestinal endoscopy"[All Fields] OR ("gastrointestinal"[All Fields] AND "endoscopy"[All Fields])) AND ("Post"[All Fields] AND ("anaesthetically"[All Fields] OR "anaesthetics"[All Fields] OR "anesthetics"[Pharmacological Action] OR "anesthetics"[MeSH Terms] OR "anesthetics"[All Fields] OR "anesthesiology"[MeSH Terms] OR "anesthesiology"[All Fields] OR "anaesthetise"[All Fields] OR "anaesthetised"[All Fields] OR "anaesthetising"[All Fields] OR "anaesthetization"[All Fields] OR "anaesthetize"[All Fields] OR "anaesthetized"[All Fields] OR "anaesthetizing"[All Fields] OR "anesthetic s"[All Fields] OR "anesthetically"[All Fields] OR "anaesthetic"[All Fields] OR "anesthetic"[All Fields] OR "anesthetization"[All Fields] OR "anesthetize"[All Fields] OR "anesthetized"[All Fields] OR "anesthetizes"[All Fields] OR "anesthetizing"[All Fields]) AND ("discharges"[All Fields] OR "discharging"[All Fields] OR "patient discharge"[MeSH Terms] OR ("patient"[All Fields] AND "discharge"[All Fields]) OR "patient discharge"[All Fields] OR "discharge"[All Fields] OR "discharged"[All Fields]) AND ("score"[All Fields] OR "score s"[All Fields] OR "scored"[All Fields] OR "scores"[All Fields] OR "scoring"[All Fields] OR "scorings"[All Fields]) AND ("system"[All Fields] OR "system s"[All Fields] OR "systems"[All Fields])) AND "english"[Language] AND "english"[Language]) AND (english[Filter])	5

were searched manually and retrieved using the reference list of all included studies. Subsequently, after the completion of the extended screening, the full texts of all records that were rated as "potentially eligible" were independently assessed for eligibility.

Extraction of data items

Data extraction was performed using a structured form, based on a Microsoft Excel sheet (Microsoft Co., Redmond, WA, USA). The following data were extracted from each study:

first author name, study setting (publication year, study period, country), study design and primary outcomes, type of procedure (gastroscopy/colonoscopy), type of sedation/analgesia used, discharge tool, content of discharge scoring system/method, range of discharge scoring system rating, criteria for discharge, timing of discharge assessment after the endoscopy, primary outcomes.

Results

The initial search yielded 3389 articles, and 35 additional articles were identified by manual search. Then, 560 duplicates were removed and 2864 articles were screened by title and abstract, resulting in 125 full-text articles assessed for eligibility. After excluding articles that did not meet the inclusion criteria, we ultimately identified 5 articles evaluating different discharge scoring systems, and 45 studies of various design, focusing on discharge after administration of different types of sedatives during ambulatory GI endoscopy [18,20,22-28,30-71]. Table 2 summarizes the characteristics of the studies comparing discharge scoring systems, while data from all other studies evaluating other discharge scoring systems are presented in Supplementary Table 1 in a top-down approach. A study flowchart is presented in Fig. 1.

Aldrete score

The Aldrete scoring system was initially introduced in 1970, as a tool used to assess a patient's early recovery (phase I) following anesthesia, in the setting of ambulatory surgery. It is also widely used to evaluate whether a patient is fit for discharge after sedative endoscopy. The original scoring system consisted of 5 parameters: activity, respiration, circulation, consciousness, and oxygenation; the latter estimated by skin color [16]. To ensure a more reliable assessment of oxygenation, the modified Aldrete scoring system was created, including oxygen saturation instead of skin color [7]. The Aldrete score is relatively simple, and can readily be obtained by the attending nurse in the recovery area, analogous to the Apgar scoring system for neonates that was proposed in 1953 and that is still in use worldwide [17]. In most centers, a score of 9 or 10 is required for a patient to be discharged, although a cutoff score of 8 has also been used [18,19]. However, it should be noted that the Aldrete scoring system only assesses parameters at discharge compared with pre-procedure parameters, without taking into consideration sedation depth or medication type used.

The evidence

To date, data regarding the effect of the Aldrete scoring system on recovery time in everyday clinical practice remain

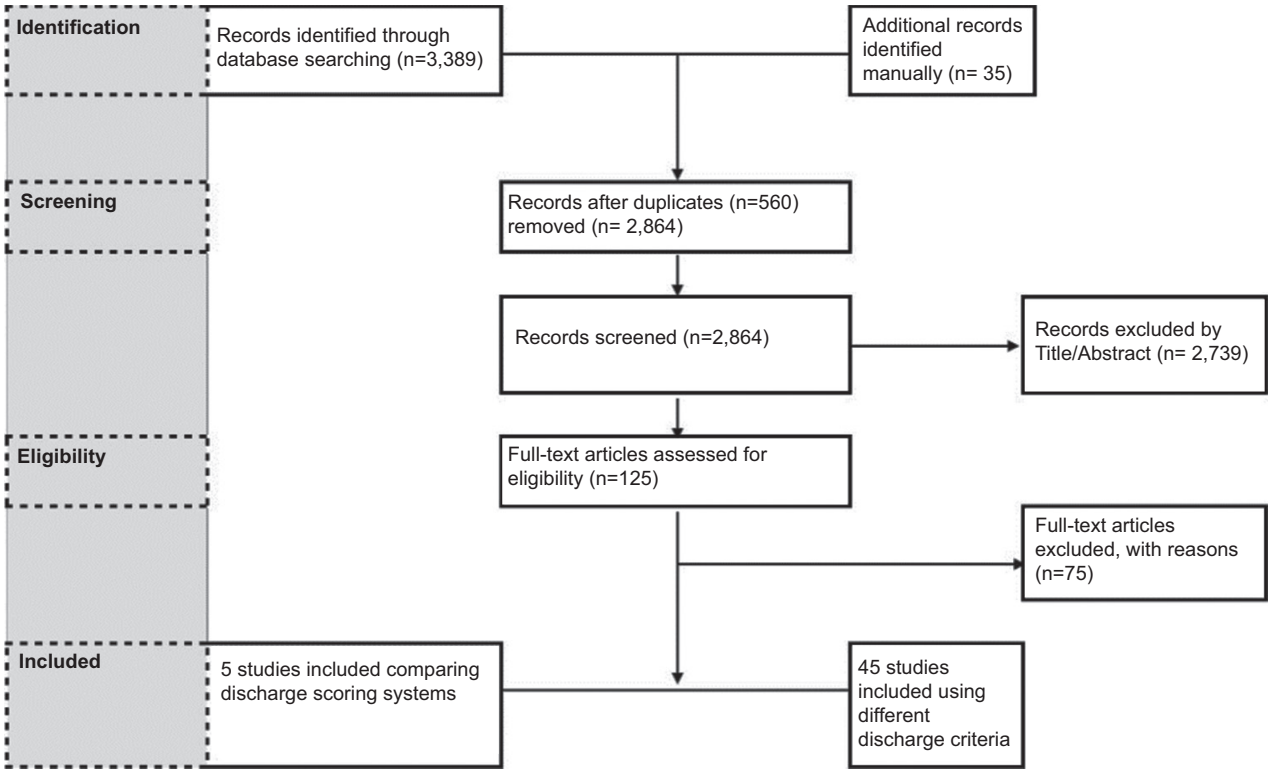

Figure 1 Flow diagram of the literature search strategy and evaluation of studies identified for review

Table 2 Studies comparing the performance of available discharge models

Author [ref.]	Country	Study design	Study period	No. of patients	Type of procedure	Type of sedation/ analgesia	Standard/Tool	Criteria for discharge	Aim	Findings
Yamaguchi *et al* [25]	Japan	Propensity score-matched study	July 2019 to January 2020	376	Gastroscopy, colonoscopy, EUS	midazolam	Aldrete score = 195 PADSS = 181	Aldrete score ≥ 9 MPADSS ≥ 9	Comparison of Aldrete score vs. MPADSS regarding recovery time and safety	-More patients had a recovery within 60 min after endoscopy using the Aldrete score compared to MPADSS (42.5% versus 25.0%, respectively; P < 0.01). Drowsiness at discharge was more frequent with Aldrete score (19.1% versus 5.0%, respectively; P<0.01)
Amornyotin *et al* [22]	Thailand	Prospective study	NA	369	Gastroscopy, colonoscopy	propofol, propofol+ midazolam, fentanyl, pethidine	PADSS = 369	PADSS ≥ 9	To demonstrate that, using PADSS, the majority of patients would be ready for discharge before or on 2 h.	-97.9% and 100% of patients satisfied PADSS criteria for discharge at 60 and 90 min respectively. No unanticipated admission was reported
Roelandt *et al* [20]	Belgium	Prospective observational study	November 2019 to March 2020	328	Gastroscopy, colonoscopy, endoscopic ultrasound	midazolam +pethidine	Aldrete score = 97 subjective assessment by the nurse = 231	Aldrete score ≥ 9 clinical assessment by the nurse	Effect of application of Aldrete score on recovery time.	-Significantly decreased recovery time with Aldrete score (47±25 vs. 59±22 min, P<0.01) -No complications due to earlier discharge were reported
Trevisani *et al* [23]	Italy	Prospective, non-randomized study	NA	207	colonoscopy	Midazolam+ Meperidine	PADSS = 104 blood pressure, heart rate, SaO2 (control group) = 103	PADSS ≥ 9 if blood pressure, heart rate and SaO2 were stable	To assess whether PADSS is as safe as clinical criteria and leads to earlier discharge	-Recovery time was faster in PADSS group compared to control group (58.75 ± 18.67 min and 95.14 ± 10.8 min, respectively; P<0.001) -no early complications and no re-admissions were reported in both groups
de Benito Sanz *et al* [24]	Spain	Single-center randomized non-blinded clinical trial	NA	118	gastroscopy, colonoscopy, ERCP, EUS	propofol, propofol+ midazolam	PADSS = 58 discharge according to the usual practice (control group) = 60	MPADSS ≥ 9 according to the usual practice	Assessment of recovery time and complications rate using the PADSS	- Shorter recovery time in MPADSS-group (median time of 10 min vs. 15 min, P=0.002) -no differences in terms of safety between MPADSS score and the usual practice

EUS, endoscopic ultrasound; PADSS, post-anesthesia discharge scoring system; MPADDS, modified PADDS; N/A, not applicable; SaO_2, oxygen saturation; ERCP, endoscopic retrograde cholangiopancreatography

scant. Roelandt *et al* [20] performed a prospective observational study of 231 patients to evaluate the effect of the Aldrete scoring system on recovery time after sedation using midazolam during various endoscopic procedures (gastroscopy, colonoscopy and endoscopic ultrasound). Time until discharge was significantly shorter when the Aldrete scoring system was applied (47±25 vs. 59±22 min, P<0.01), while no complications or readmissions due to the earlier discharge were noticed. The period following a colonoscopy, therapeutic gastroscopy, and combined gastroscopy-colonoscopy was most affected by the use of the Aldrete score in this study. These results favoring the use of the Aldrete score were corroborated by, as far as we are aware, the only randomized clinical trial to address this issue, originating from Europe and published as abstract [21]. In this study, 200 consecutive outpatients undergoing diagnostic or therapeutic endoscopy were randomized to assessment in the resuscitation room using the modified Aldrete score, or exit after empirical evaluation, respectively. Preliminary results of this study showed that application of the modified Aldrete score was associated with a shorter length of stay in the recovery room (16.2±4.1 vs. 24.1±8.2 min, P<0.001) compared to empirical evaluation, while at 24-h follow up, significantly more patients in the empirical evaluation group reported headache compared to those released on the basis of their Aldrete score (37.6% vs. 19.2%, P=0.003).

mPADSS

The modified PADSS, similarly to the Aldrete score, was initially developed to assess the recovery process of patients after ambulatory surgery, and is now widely utilized in the discharge decision-making process after endoscopic sedation. mPADSS comprises vital signs, nausea and vomiting, postprocedural pain, activity, and bleeding at the intervention site as criteria; according to the original article, a score of 9 or 10 is desirable for discharge [8].

The evidence

So far, only a few studies that assessed the effect of mPADSS on recovery time and safety after endoscopy have been published. Amornyotin *et al* [22], reported on a prospective study involving 369 patients who underwent endoscopy and were assessed with mPADSS every 30 min until discharge. All patients were discharged safely within 2 h, with 97.9% and 100% reaching an acceptable discharge score (mPADSS ≥9) at 60 and 90 min, respectively. After 24 h, no unexpected readmission was reported.

Another prospective study aimed to compare mPADSS (n=104) with common clinical criteria for discharge (n=103) in terms of recovery time and safety. mPADSS was assessed every 20 min, and patients were required to have 2 consecutive scores of 9 or higher for discharge. Application of mPADSS was related with shorter recovery times compared to the usual clinical criteria (58.75±18.67 vs. 95.14±10.85 min, respectively; P<0.001). No early complications and no readmissions were recorded in either group, while no significant differences were noticed in the post-discharge symptom rates [23].

De Benito Sanz *et al* [24] performed the only randomized clinical trial to evaluate the efficacy and safety of mPADSS for patients' discharge after different endoscopic procedures (gastroscopy, colonoscopy, endoscopic retrograde cholangiopancreatography [ERCP], and endoscopic ultrasound [EUS]). A total of 118 patients were randomized and discharged, either by using PADSS or by following the usual practice (control group). Patients in the mPADSS group were discharged faster compared to the control group, with a median time of 10 vs. 15 mins, respectively (P=0.002). It is noteworthy that more than 75% of patients in the mPADSS group met the criteria for discharge at 10 min. No differences were found between the 2 groups regarding post-discharge symptoms, patients' satisfaction or readmission rate.

Further insights regarding the use of the Aldrete score were provided in a subsequent prospective propensity score-matched study comparing mPADSS (n=120) with the Aldrete score (n=120) [25]. Although the average recovery time was similar between the 2 groups, a higher percentage of patients in the Aldrete group experienced recovery after 60 min compared to the mPADSS group (42.5% versus 25.0%, respectively; P<0.01). Drowsiness at discharge was more common in patients assessed by the Aldrete score (19.1% vs. 5.0%, P<0.01). According to the authors, this could potentially be related to the greater number of patients deemed suitable for discharge within 60 min in the Aldrete group compared to the mPADSS group. The incidence of adverse effects after 24 h was comparable between the 2 groups. Although the Aldrete score seems promising, it is far from being the perfect discharge modality, as it records neither pain nor heart rate fluctuations (as a surrogate marker for pain), which can commonly be encountered during GI endoscopy. Moreover, significant medications, i.e., antihypertensive drugs or antiarrhythmic β-blockers, are also not included in the scoring system.

Various discharge criteria

Although the Aldrete score and the PADSS scoring system constitute the most widely used discharge criteria recommended by international endoscopic societies, several studies assessing recovery after the administration of various types of analgesia/sedation have utilized alternative discharge requirements, as presented in Table 2. Gurunathan *et al* [26] and Brumby *et al* [27] used a different scoring system for recovery after surgery, the Postoperative Quality of Recovery Scale (PostopQRS), to determine a patient's fitness for discharge after outpatient endoscopy. This scoring system consists of 5 subdomains: the physiological, the nociceptive, the emotional, the cognitive and the activities of daily living subdomain. Patients were discharged as long as they returned to baseline preoperative values in each subdomain of the scoring system.

In many endoscopic units, patients' home-readiness is based exclusively on clinical assessment, with or without

the assistance of post-anesthesia care unit nurses. There is a wide variation in the combination of clinical criteria among different departments. The clinical assessment often involves the evaluation of the level of consciousness and patients are discharged provided they have regained full awareness and alertness, respond to questions from the recovery room nurse, and are oriented with respect to time, place and individuals. Other units examine the patient's ability to stand at the bedside without assistance, sometimes using the Romberg-steadiness sign or the ability to stand on 1 foot in order to discharge the patient safely. Tang *et al* [28] used a 5 m heel-toe line walk test, and examined the patient's capability to walk in a straight line without instability for 5 m to assess any psychomotor impairment after the endoscopic procedure. Another parameter that is usually evaluated is the patient's hemodynamic status, and the presence of hypotension, bradycardia or hypoxemia at discharge. Stable vital signs, including saturation greater than 90% on room air, blood pressure and heart rate within 20% of baseline measurements, are essential for safe discharge after sedation in many centers. Finally, the ability to dress and tolerate oral fluids is also commonly assessed, in combination with other criteria, as separate requirements for discharge.

Critical appraisal of the evidence

While our review suggests that both the Aldrete and the mPADSS scoring system exert a positive impact on reducing patients' recovery time following endoscopy, while maintaining a favorable patient safety profile, it also highlights important methodological concerns. It is of paramount importance to recognize and consider the possible limitations inherent in both the studies and the scoring systems to achieve a more reliable perspective on their role in discharge policy. First, because of the statistical and clinical heterogeneity among the studies, a meta-analysis could not be performed. Second, the studies that directly accessed discharge scoring systems were single-center studies, and only a few of them had a randomized controlled design. Hence, these results are susceptible to several significant types of bias and should be evaluated with this caveat. In addition, with a single exception, the studies included various endoscopic procedures, such as gastroscopy, colonoscopy, ERCP and EUS. Moreover, only 1 study examined the particular effects of the use of discharge scoring systems regarding the recovery after each specific procedure. In their prospective study, Roelandt *et al* [20] demonstrated that the decrease in recovery time was more noticeable for colonoscopy, therapeutic gastroscopy and combined colonoscopy and gastroscopy. The efficiency of scoring systems in shortening recovery time may indeed vary across different procedures, and may be correlated with the nature of the procedure, particularly if the endoscopy involves therapeutic interventions, such as the addition of polypectomy. Therefore, additional data concerning the effect of discharge scoring systems on the recovery after each distinct procedure will be needed.

Another clear drawback in the existing literature is the lack of a standardized interval for the evaluation of discharge scoring systems, contributing to variability among studies in the assessment period chosen. Furthermore, in some centers, achieving the desired score in 2 consecutive assessments is necessary. These factors contributed to variations in the observed recovery times among studies, emphasizing the necessity for establishing a consistent interval.

Both the mPADSS and the Aldrete score evaluate patient's vital signs by comparing post-endoscopic values with pre-endoscopic measurements. It is important to note that some values may be elevated prior to endoscopy as a result of procedure-related anxiety, requiring a careful examination of the results [23]. Additionally, there is a prevailing opinion that the Aldrete score lacks a comprehensive assessment, as it notably omits consideration of typical postprocedural symptoms such as pain and nausea, while also failing to evaluate psychomotor function [29]. The latter may remain impaired for a prolonged period after endoscopy, because of the effects of sedative drugs. In fact, Willey *et al* [30] reported that in 31 patients who underwent esophagogastroduodenoscopy, psychomotor function was noticeably decreased, even when an appropriate Aldrete score for discharge was achieved. Recognizing these limitations, some centers use additional criteria alongside the Aldrete score for patient discharge, such as the patient's ability to walk unaided, or tolerate oral fluids, and the absence of nausea [31].

Alternatively, in some centers the Aldrete score is utilized to assess early recovery and is accompanied by mPADSS for a more thorough assessment [32]. Consequently, there exists variability in the role of scoring systems, particularly the Aldrete score, and variability in the combinations of discharge criteria adopted across studies.

Clinical implications and future directions

Sedation and analgesia are a cardinal aspect of modern GI endoscopy practice, as they enhance procedural quality and patient-reported outcomes. However, the most efficacious manner in which to discharge patients after sedation is still not known. Our review indicates that different scoring discharge systems (Aldrete, PADSS) are available, and have been demonstrated to improve discharge after outpatient endoscopy; nevertheless, they suffer from major limitations, since they do not evaluate psychomotor function. Most of the evidence highlights that the Aldrete and PADSS scoring systems are perhaps the most promising ones, resulting in a significant improvement in safe discharge compared to usual care. Yet, these data are not solid enough to demonstrate the superiority of any one of these strategies over the others, but rather imply that only multiple strategies have the potential to ensure safe patient discharge.

Moreover, local factors, such as staff availability, education practices and patient characteristics, must also be taken into account, as they have the potential to affect which intervention is most effective in any given healthcare setting. Prior to the implementation of a particular intervention, healthcare practices might consider meticulously analyzing their post-

sedation discharge approach and assess the impact of any interventions as part of a Plan-Do-Study-Act (PDSA) cycle [33].

Safe patient discharge post-endoscopy is a complex and cumbersome procedure that should be individualized, taking into account setting and patient related factors. It is therefore of paramount importance for all healthcare professionals involved in this process to ensure that all patients undergoing GI endoscopy are discharged in the optimal way.

From the clinician's point of view, safe patient discharge is a commonly encountered problem. While studies reviewed here do not provide definitive guidance on how best to discharge patients after GI endoscopy, in the opinion of the authors, the first step should be adoption of a validated and easy-to-use, discharge model as an efficacious intervention that could indeed assist clinicians to promptly identify patients at high risk for sedation/analgesia-related complications. In this regard, the modified Aldrete score and PADSS are valuable tools that can be applied accurately, taking into consideration objective parameters, regardless of the physician's expertise level, status of previous training or access to each patient's medical file, while at the same time they can be replicated in various different settings. The Aldrete score is relatively simple and can readily be obtained by the attending nurse in the recovery area. One might refute the use of discharge models for assessment of resuscitation after GI endoscopy, as they can be deemed hard to elaborate and time-consuming; however, regardless of the model, it can be easily assessed, as it is generally straightforward, demanding nothing but basic information about the patients' clinical status. Moreover, these tools are available as web-based applications underlining the models' "operator-friendly" character.

Our review also highlights some areas for future research. First, none of the studies included here comprehensively evaluated known risk factors that could potentially interfere with patient safe discharge (e.g., comorbidities, medications). In this sense, future studies should systematically address these risk factors, allowing for identification of heterogeneity in treatment effects, and optimize approaches that assign an intervention based on individual patient characteristics. Second, only a handful studies included in the review were randomized and controlled, limiting the ability to assess adherence to the interventions and making conclusions susceptible to many biases. Third, future studies should have larger sample sizes, hence adequate statistical power to address changes in clinically orientated outcomes, such as post-endoscopy sedation/analgesia related complications or economic outcomes i.e. cost/time. Finally, future evidence should evaluate in detail the advantages and disadvantages of available discharge models.

Concluding remarks

While evidence to broadly recommend the use of specific models in everyday clinical practice for safe patient discharge post-endoscopy may be currently lacking, healthcare practices should be aware of these options as they consider strategies for optimizing service provision. This topic is likely to grow in importance as forthcoming studies strengthen this scant evidence for model use in different populations and types of endoscopic procedure, placing outpatient discharge after GI endoscopy at the focal point of quality measures and payer reimbursement.

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Supplementary material

Supplementary Table 1 Studies comparing the performance of other available discharge models

Author [ref.]	Type of study	Type of sedation/analgesia	Findings
Sato M *et al* [34]	Prospective study	IV propofol	100% of patients fully recovered within 60 min after the procedure
Horiuchi A *et al* [35]	Prospective study	IV propofol	Full recovery occurred in 99.9% of patients 60 min after the procedure. 368 out of the 400 patients (92%) drove home or to their workplace without an incident
Mathus-Vliegen E *et al* [18]	Prospective study	Iv midazolam +/- fentanyl + flumazenil	Flumazenil was highly accepted by patients and patients could be discharged safely with the care of an escort at an earlier stage
Lucendo A *et al* [36]	Prospective study	IV propofol	The average recovery time was 18.6 min (SD 8.8, range 4–75 min) and was longer in ASA class II patients (P=0.05)
Rizzi M *et al* [37]	Retrospective monocentric analytic study	IV fentanyl and midazolam	The mean Aldrete score upon discharge was 9.56 (min 7, max 10). An increase by 0.5 mg in midazolam dosage was accompanied by a decrease in the mean value of the Aldrete score by 0.14
Gurunathan U *et al* [26]	2-center double-blinded, placebo-controlled, parallel-group, randomized, phase IV study	IV midazolam vs. IV propofol +/- opiate	No difference in recovery of the PostopQRS cognitive domain was observed between groups across all time points in this study
Chen S *et al* [38]	Multicentered, randomized, positive-controlled, phase III clinical trial	IV remimazolam tosylate vs. IV propofol	No difference was observed in time to fully alert (P=0.181) or time to discharge (P=0.501) between the two groups
Kim DB *et al* [39]	Prospective randomized double-blind study	IV propofol vs. IV bolus midazolam/meperidine vs. IV titrated midazolame/ meperidine	Recovery and discharge time were shorter in patients of the propofol group [(11.5 vs. 29.5 vs. 29.2 min; P<0.001) and (20.6 vs. 34.9 vs. 34.7 min; P<0.001) respectively] than patients in the bolus midazolam group and titrated midazolam group
Lovett P *et al* [40]	Retrospective study	IV propofol vs. IV midazolam/fentanyl	Mean recovery times were longer in patients who received sedation with propofol in comparison to patients who received midazolam/fentanyl sedation (50 vs. 31 min, P=0.001)
Hsieh Y-H *et al* [41]	Randomized prospective trial	IV meperidine + propofol vs. propofol alone	Patients in the meperidine and propofol group presented shorter recovery times than those in the propofol group
Padmanabhan U *et al* [42]	Prospective, randomized study	IV propofol alone vs. IV propofol + midazolam, and/ or fentanyl	Recovery times, recall, dreaming and quality of recovery were similar between the groups. At discharge, 18.5% of patients were cognitively impaired to an extent equivalent to a blood- alcohol concentration of 0.05%
VanNatta ME *et al* [43]	Randomized controlled trial	IV propofol alone vs. IV fentanyl + propofol vs. IV midazolam + propofol vs. IV fentanyl + midazolam + propofol	Patients receiving propofol alone presented significantly longer time from scope out to reaching the three discharge criteria
Eberl S *et al* [44]	Randomized prospective study	IV midazolam/ fentanyl (group M) vs. IV alfentanil (group A) vs. IV propofol/ alfentanil (group P)	Recovery time was much shorter in patients who received sedation with alfentanil and 93% of all alfentanil patients scored an Aldrete score ≥9 right after their arrival on the recovery unit. Aldrete score at 30 min differed significantly among the three groups

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Supplementary Table 1 (*Continued*)

Author [ref.]	Type of study	Type of sedation/analgesia	Findings
Yi Y *et al* [45]	Prospective, single-blind and randomized study	IV 0.03 mg/kg midazolam (group I) vs. IV 0.06 mg/kg midazolam (group II) vs. IV 0.09 mg/ kg midazolam (group III)	The discharge time was significantly prolonged in group III in comparison to the other two groups, but did not differ between groups I and II (34±7, 36±6 and 41±8 min for groups I, II and III, respectively; P<0.05)
Van der Linden P *et al* [46]	Prospective randomized assessor-blinded trial	IV propofol bolus vs. target-controlled infusion system (TCI)	Time to reach a PADS ≥9 was 20 min in both groups
Fanti L *et al* [47]	Double blind randomized controlled trial	IV fentanyl (1 μg/kg) + midazolam (0.03–0.04mg/kg) or midazolam only (standard group) vs. IV fentanyl (1 μg/kg) + propofol	Discharge time was significantly shorter in the propofol than the standard group (1.1±0.3 vs. 5±10.2 min, respectively; P=0.03)
Molina-Infante J *et al* [48]	Double-blinded, randomised, placebo-controlled trial	IV propofol vs. IV propofol and Midazolam	Early recovery time was significantly longer for midazolam/propofol group. No differences in time to meet discharge criteria after early recovery were observed between both groups
Cohen LB *et al* [2]	Randomized, double-blind, multicenter trial	IV fospropofol (2, 5, 6.5 or 8 mg⁄kg) vs. IV midazolam 0.02 mg⁄kg following pre-treatment with fentanyl	Sedation with fospropofol disodium results is safe and effective for patients undergoing colonoscopy
Paspatis *et al* [49]	Randomized prospective trial	IV 2-3 mg of midazolam + a median dose of 80 mg of propofol (range 40 –150) vs. a median dose of 5 mg of midazolam (range 3–7) + 75 mg of pethidine	Shorter recovery times were observed in the group of patients sedated with a low dose of midazolam combined with propofol
Manolaraki M *et al* [32]	Randomized prospective study	IV remifentanil vs. IV midazolam + pethidine	Recovery and discharge were longer for the midazolam + pethidine group compared with the remifentanil group
Edokpolo LU *et al* [50]	Randomized controlled trial	IV propofol + placebo vs. IV propofol + bolus dexmedetomidine 0.3 μg/kg	26 of 51 (51%) patients receiving propofol-dexmedetomidine resulted in readiness for discharge by 30 min after the procedure, compared with 44 of 50 (88%) receiving propofol (P<0.001). At the time of PACU arrival, fewer patients sedated with propofol–dexmedetomidine scored an Aldrete scale ≥9. The median Aldrete score was 8 (7 to 9) in propofol–dexmedetomidine group and 10 (9 to 10) in propofol group (P<0.001)
Brumby A *et al* [27]	Observational pilot study	N/A	The study revealed modest but clinically significant differences regarding the early quality of recovery among different endoscopic procedures
Akcaboy Z *et al* [51]	Randomized prospective trial	IV remifentanil (group R, 0.5 m g/kg followed by 0.05m g/kg/min) vs. IV propofol (group P, 0.5 mg/kg followed by 50 m g/kg/min	The time to achieve an Aldrete score ≥9 was shorter in group Remifentanil (P=0.001), but the discharge times were similar between the two groups (P=0.081)
Rudner R *et al* [52]	Randomized prospective trial	Conscious analgesia/ sedation (Sedation group) IV remifentanil (0.20 to 0.25 μg/kg/min) + propofol vs. total intravenous anesthesia (TIVA group) with fentanyl (2 μg/kg), midazolam (0.05 mg/kg) and propofol (dosage titrated)	Recovery to full psychomotor function was achieved sedation group presented extremely fast and resulted in readiness for discharge in approximately 15 min after the procedure in comparison to TIVA

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Supplementary Table 1 (*Continued*)

Author [ref.]	Type of study	Type of sedation/analgesia	Findings
Hsu CD *et al* [53]	Observational prospective study	IV propofol target-controlled infusion (TCI) vs. IV combination of propofol TCI plus midazolam and fentanyl (group C)	Both recovery time and discharge time were shorter in Group C (P<0.001 and P=0.006 respectively)
Riphaus A *et al* [54]	Randomized, controlled study	IV propofol alone vs. IV midazolam + pethidine	The mean recovery time and quality of recovery were significantly shorter and better after propofol sedation (14+/-9min vs. 25+/-8min and 8.7+/-1.3 vs. 6.3+/-1.1 points) (P<0.01)
Sargin M *et al* [55]	Randomized controlled trial	IV Propofol	There were no significant differences between the groups regarding the baseline values of the cognitive function test results
Sipe WB *et al* [56]	Prospective safety study	IV propofol, midazolam, and meperidine	The mean times to stand at the bedside without assistance, completion of all discharge criteria, and actual discharge were 10 +/- 8 min, 20 +/- 20 min, and 37 +/- 23 min, respectively
Uzman S *et al* [57]	Prospective, randomized, double-blind study	Iv propofol vs. IV midazolam/meperidine	Awake time and time to hospital discharge were significantly shorter in the propofol group (6.58±.72 vs. 9.32±4.26 min, P=0.030 and 27.60±7.88 vs. 32.00±10.54 min, P=0.019)
Khudhairi DA *et al* [58]	Randomized prospective trial	IV midazolam 0.1 mg/kg vs. diazepam 0.15 mg/kg	Recovery rate after sedation with midazolam was faster compared with diazepam. All the stages of recovery were achieved earlier in those who received diazepam and the mean discharge times were 85 min for diazepam (range 69-102) and 102 min for midazolam (range 74-122)
Ulmer B *et al* [59]	Randomized controlled trial	IV propofol vs. IV Midazolam/Fentanyl	Patients receiving propofol reached full recovery sooner (16.5 vs. 27.5 min; P=0.0001) and were discharged sooner (36.5 vs. 46.1 min; P=0.01)
Tuncali B *et al* [60]	Randomized, double-blind, controlled trial	IV midazolam (0.02 mg/kg) + fentanyl (1 μg/kg) + ketamine (0.3 mg/kg) (group K) vs. IV midazolam (0.02 mg/kg), fentanyl (1 μg/kg), and placebo (0.9% sodium chloride) (group C)	Patient recovery times, and discharge times were similar among different groups.
Tutal ZB *et al* [61]	Double-blinded prospective random- ized controlled trial	IV propofol (GroupP) vs. IV propofol/ketamine (GroupPK)	GroupPK patients presented longer recovery times (MAS≥9, 1 vs. 5 min, P=0.005)
Fanti L *et al* [62]	Prospective randomized controlled trial	IV meperidine (Group M) vs. IV remifentanil 0.5μg/kg (Group R1) vs. IV remifentanil 0.8 μg/kg (Group R2)	Discharge time was significantly longer in Group M
Kovacevic M *et al* [63]	Double-blinded prospective randomized controlled trial	IV fentanyl-propofol (Group FP) vs. IV ketamine-propofol (Group KP) vs. IV propofol alone (Group C)	The combination of ketamine and propofol provided a more appropriate analgesic results compared to fentanyl and propofol and propofol alone for colonoscopy

(*Contd...*)

Supplementary Table 1 (*Continued*)

Author [ref.]	Type of study	Type of sedation/analgesia	Findings
Tang J *et al* [28]	Randomized, double-blinded study	IV midazolam 1 mg (Group I) + meperidine 50 mg vs. IV Ro 48-6791 0.5 mg (Group II) + meperidine 50 mg vs. IV Ro 48-6791 1.0 mg (Group III)	The time for the HTLW test to return to baseline values after the procedure was similar among the three groups
Turk HS *et al* [64]	Randomized prospective trial	IV 1 μg.kg-1 fentanyl, 1 mg.kg-1 propofol (Group PF) vs. IV 10 μg.kg-1 alfentanil, 1 mg.kg-1 propofol (Group PA)	Mean recovery time of Group PA was significantly longer than the recovery time of Group PF (P=0.032). Mean discharge times were similar in both groups
Sultan SS *et al* [65]	Randomized, controlled double-blind study	IV propofol/remifentanil (PR Group) vs. IV propofol/ alfentanil	Time from removal of colonoscope to discharge time was shorter in PR group
Fanti L *et al* [66]	Randomized double-blind trial	IV midazolam 0.03mg/kg + IV remifentanil (R) vs. IV midazolam 0.03mg/kg +meperidine (P)	The time to achieve an Aldrete score ≥9 was significantly shorter in group R than in group P (min 0±0.0 vs. min 7.8±3.4; P<0.0001). discharge times did not differ in the two groups (min 13.5±13 vs. min 10.4±10; P=0.36)
Toklu S *et al* [67]	Randomized double-blind trial	IV etomidate–remifentanil vs. IV propofol– remifentanil	Recovery time was shorter in the etomidate group (P=0.01)
Campo R *et al* [68]	randomized, double-blinded study	IV midazolam 35 μg/kg vs. IV midazolam 70 μg/kg vs. placebo	Patients receiving lower doses of midazolam were discharged earlier
Robertson DJ *et al* [69]	Single-center randomized controlled trial	IV Meperidine vs. IV fentanyl	Shorter mean recovery time was observed in the fentanyl group (63.0 min) compared with the meperidine group (76.2 min) (P=0.07)
Hong MJ *et al* [31]	Randomized prospective trial	IV remifentanil (group-R) vs. IV midazolam-meperidine (group-MM)	Time to achieve Aldrete score = 10 was significantly shorter in group-R than in group-MM (P<0.001). A significantly higher number of individuals achieved Aldrete score = 10 at 10 min and 30 min after the procedure in group-R than in group-MM (74 vs. 15% and 100 vs. 47%, respectively). Almost 50% of patients in group-MM required >30 min to achieve Aldrete score = 10
Horiuchi A *et al* [70]	Prospective, consecutive study	IV propofol	Full recovery was achieved in all patients within 1 h after the procedure. Driving skills recovered to the baseline levels 1 h after colonoscopy
Moerman AT *et al* [71]	Prospective, randomized study	IV propofol vs. IV remifentanil	Early recovery was significantly delayed in the propofol group (P<0.002)

IV, intravenous; N/A, not applicable; ERCP, endoscopic retrograde cholangiopancreatography; EUS, endoscopic ultrasound; PADSS, post-anesthesia discharge scoring system; MPADSS, modified PADSS; HR, heart rate; SpO_2, blood oxygen saturation