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Bowel cleansing effectiveness and safety of 1 L PEG + Asc in the real-world setting: Observational, retrospective, multicenter study of over 13000 patients

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ABSTRACT

Background and study aims Effective bowel cleansing is critical for detecting lesions during colonoscopy, highlighting the importance of bowel preparations. 1 L polyethylene glycol (PEG) + ascorbate (Asc) is the only recommended 1 L PEG product in Europe and the United States. Its efficacy was demonstrated in large-scale controlled trials and confirmed in smaller-scale real-world studies. However, no large-scale real-world data exist.

Patients and methods This observational, retrospective, multicenter study, used outpatient follow-up data from medical records from 10 centers in Spain and two in Portugal. Outpatients aged ≥18 years using 1 L PEG + Asc as bowel preparation were included. The main outcome measures were overall adequate colon cleansing (Boston Bowel Preparation Scale [BBPS] score ≥6 with BBPS score ≥2 in each segment) and high-quality cleansing of the right colon (BBPS score = 3).

Results Data from 13169 eligible patients were included. Overall cleansing success was achieved in 89.3% (95%CI 88.7%-89.8%) and high-quality cleansing in the right colon in 49.3% (95%CI 48.4%–50.2%) of patients. For the overnight split-dose and same-day regimens, overall adequate quality cleansing success rate was 94.7% and 86.7% (P<0.0001) and high-quality cleansing of the right colon rate was 65.4% and 41.4% (P<0.0001), respectively. Colonoscopy was completed in 97.3% of patients, with non-completion due to poor preparation in only 0.8%; 2.3% of patients experienced at least one adverse event (AE).

Conclusions This large-scale, real-world study demonstrates the effectiveness of 1 L PEG + Asc in the total and right colon, with a low percentage of patients with AEs in routine clinical practice.

Introduction

Effective bowel preparation is critical for a successful colonoscopy. High standards of cleansing improve diagnostic accuracy, resulting in a faster, less technically difficult procedure, which decreases the need for repeat colonoscopy and reduces the cost burden [1, 2, 3, 4, 5]. Two essential quality indicators for colonoscopy, the adenoma detection rate (ADR) and the cecal intubation rate (CIR), are strongly influenced by bowel preparation quality, and high levels of cleansing are necessary for optimal detection of sessile serrated adenomas [2, 6, 7]. A retrospective study assessing the ADR in patients who underwent a repeat colonoscopy owing to inadequate cleansing found that 33.8% of individuals had at least one adenoma that was missed in the initial screening, highlighting the clinical necessity of achieving high levels of bowel cleansing [8].

Traditional polyethylene glycol (PEG)-based bowel preparations are effective at delivering successful bowel cleansing but, with poor palatability and the consumption of up to 4 L of solution required, there is potential for reduced compliance and cleansing performance [9, 10, 11]. The introduction of the asymmetrically dosed 1-L PEG and ascorbate bowel preparation (1 L PEG + Asc) (PLENVU, Norgine, Harefield, UK) in Portugal in 2017 and Spain in 2018 provided the first 1 L PEG-based formulation that was specifically designed for effective bowel preparation at an ultra-low volume. This is done by delivering two doses with different formulations, with a high ascorbate content in the second dose.

1 L PEG + Asc is currently the only approved and recommended 1 L PEG product in Europe and the United States, thanks to three large-scale Phase 3 randomized controlled trials (RCTs) [12, 13, 14]. Across the trials, 1 L PEG + Asc demonstrated at least non-inferior cleansing of the overall colon compared with comparator preparations, and superior high-quality cleansing of the right colon was observed compared with 2 L PEG + Asc (MORA study) [13]. High-quality cleansing in the right colon was a co-primary endpoint in all the trials and is an important factor when determining cleansing performance for screening colonoscopy, due to the higher proportions of missed and flat adenomas in this anatomical location [15]. A recent Phase 4 study also confirmed that cleansing with 1 L PEG + Asc was non-inferior to 4 L PEG and associated with improved compliance [16].

Real-world study reports indicate that the performance of 1 L PEG + Asc in clinical trials is replicated in the less well-controlled setting of clinical practice, where patients may have more co-morbidities associated with reduced bowel cleansing efficacy or safety [17, 18, 19]. Over 2020 and 2021, four studies reported on 1 L PEG + Asc in a real-world setting on a relatively small scale and showed good efficacy, safety, and adherence rates [20, 21, 22, 23].

Our objective was to evaluate the effectiveness and safety of 1 L PEG + Asc bowel preparation for colonoscopy in routine clinical practice in a large number of patients. We conducted an observational, multicenter, retrospective study across 12 sites in Spain and Portugal, evaluating >13000 patients who received 1 L PEG + Asc as part of a routine colonoscopy procedure.

Patients and methods

Study design

This observational, retrospective, multicenter study was based on a review of outpatient follow-up data from existing medical records. The study was approved by the Hospital Clínico San Carlos Ethical Review Committee and registered in an international clinical trials registry (ClinicalTrials.gov). Data were anonymized by center to minimize the risk of individual patient data being identified.

Study population

Outpatients ≥18 years of age who underwent a screening, follow-up or diagnostic colonoscopy between June 1, 2019 and September 1, 2021, who used 1 L PEG + Asc as preparation for the colonoscopy were included. Data were taken from 12 centers in Spain and Portugal. 1 L PEG + Asc preparation was taken as recommended in the Summary of Product Characteristics, either in an overnight split-dose regimen (i. e. the first dose taken in the evening before the clinical procedure and the second dose in the morning of the day of the clinical procedure, approximately 12 hours after the start of the first dose) or in a same-day regimen (i. e. both doses taken in the morning of the day of the clinical procedure, with the second dose being taken a minimum of 2 hours after the start of the first dose). Although split dose is generally recommended, a same-day bowel preparation may represent an acceptable alternative to split dosing, especially for afternoon colonoscopies, based on previous results [24]. All patients were instructed to follow a fiber-free diet for at least 24 hours prior to the colonoscopy preparation. Written instructions on how to consume the bowel preparation were provided by each hospital.

Patients were excluded if they had a history of colorectal cancer or colectomy before the first colonoscopy, or if any of the following mandatory data were not available: sex; age; indication for colonoscopy; dosing regimen; complete colonoscopy; Boston Bowel Preparation Scale (BBPS) of the right colon (includes cecum and ascending colon); BBPS score of transverse colon (including hepatic and splenic flexure); BBPS score of the left colon (descending colon, sigmoid, and rectum); and number of polyps in each segment.

Outcome measures

The two main endpoints were the overall adequate colon cleansing and high-quality cleansing of the right colon in routine clinical practice. Adequate overall colon cleansing was defined as a BBPS score of ≥6 with a BBPS score ≥2 in each segment. A BBPS score of 3 was considered high-quality cleansing in the right colon, and a score ≥8 was considered high quality for the total colon.

The main exploratory endpoints were polyp detection rates (PDRs) in the total colon and right colon, defined as the proportion of colonoscopies where at least one polyp was found and removed; ADR in the total colon and right colon, defined as the proportion of colonoscopies where at least one adenoma was found as determined by histological analysis; CIR; cecal intubation time and colonoscopy withdrawal time; and safety from recorded adverse events (AEs). The effectiveness and safety of 1 L PEG + Asc in patients aged ≥65 versus <65 years were also assessed. Details of the evaluation criteria for the exploratory endpoints are provided in **Table 1s**.

Statistical analysis

Descriptive statistics were used to present all quantitative and categorical variables. Mean values, standard deviations (SD), medians, and minimum and maximum values were calculated for quantitative variables. For categorical variables, the frequency and percentage were calculated and for proportion values, 95% confidence intervals (CIs) were calculated using the Wilcoxon method. The Chi-square test was used to compare outcomes in the subgroups of patients treated using overnight split versus same-day dosing, and aged ≥65 versus <65 years, but if the proportion of expected values less than 5 was higher than 20%, Fisher's exact test was applied. Statistical Analysis Software (SAS; SAS Inc., Cary, North Carolina, United States) for Windows, version 9.4 or higher, was used to perform the analyses. Because this study was descriptive, no sample size calculations were performed. However, assuming a sample of 10,000 patients and an ineligible proportion of 10%, the expected proportions of total or right colon cleansing from 70% can be estimated with a precision of ±0.95% [22].

Results

Patient characteristics

A total of 13169 eligible patients with mandatory data were identified across 10 centers in Spain and two centers in Portugal (▶ **Table 1**, **Fig. 1**, **Table 2s**). Of those, 48.6% were male and 51.4% were female, and the average age of the total population was 57.0 ± 13.1 years (▶ **Table 1**). Overall, 29.8% of patients (3929/13169) were ≥65 years of age (mean ± SD, 72.0 ± 5.6; median 71.0; range 65–95), of whom 50.6% were male. The main indications for colonoscopy were screening for colorectal cancer (41.9%), diagnostic (29.4%), follow-up (26.2%), or other (2.6%). Of those patients with available body mass index (BMI) data, 23.2% (255/1098) had a BMI >30 kg/m^2. Where data were available, the following comorbidities were present in the population: hypertension 8.1% of patients (1065/13169); diabetes mellitus 3.3% (440/13169); constipation 2.9% (375/13169); inflammatory bowel disease 1.5% (203/13169); mild kidney impairment 0.8% (108/13169); and moderate kidney impairment 0.2% (25/13169) (▶ **Table 1**). Same-day dosing was administered in 67.2% of patients (8853/13169) and overnight split dosing in 32.8% (4316/13169); no patient received 1-day dosing on the day before the colonoscopy (▶ **Table 1**). Among the 8853 patients who underwent same-day dosing, the interval between the last dose of laxative and colonoscopy was recorded for 6649 patients: the interval was ≥5 hours in 94.3% of these patients and <5 hours in 5.7%.

Bowel cleansing effectiveness

In the clinical setting, 1 L PEG + Asc yielded high rates of overall bowel cleansing success, with 89.3% of patients (95%CI 88.7%–89.8%) achieving overall adequate colon cleansing and 53.0% (95%CI 52.1%–53.8%) achieving high-quality cleansing (BBPS score ≥8) (▶ **Fig. 2a**). The rate of high-quality cleansing in the right colon was 49.3% (95%CI 48.4%–50.2%) (▶ **Fig. 2b**). The mean (SD) BBPS score was 7.31 (1.84) for the total colon (▶ **Fig. 3**), and 2.38 (0.71) for the right colon.

Bowel cleansing effectiveness in subgroups

Colonoscopy indication

Overall adequate colon cleansing success was attained in 89.6% of patients (4937/5513) who underwent a screening colonoscopy, 89.3% (3459/3872) of those who had a diagnostic colonoscopy, and 88.8% (3061/3446) of those in the follow-up colonoscopy subgroup. Overall high-quality cleansing was achieved in 51.0% (2813/5513), 55.9% (2166/3872), and 52.0% (1791/3446) of those undergoing screening, diagnostic, and follow-up colonoscopies, respectively. High-quality cleansing of the right colon was achieved in 48.6% (2681/5513), 49.6% (1921/3872) and 49.5% (1706/3446) of those undergoing screening, diagnostic and follow-up colonoscopies, respectively.

Dosing regimen

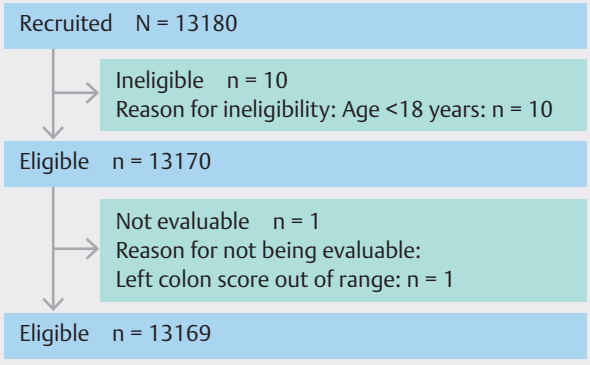
Adequate colon cleansing success rate was 94.7% with the overnight split-dose regimen and 86.7% with the same-day dosing regimen (P <0.0001). High-quality cleansing in the total colon was achieved in 72.0% of patients in the overnight split-dose subgroup and 43.7% of patients in the in the same-day dosing group (P <0.0001), and high-quality cleansing in the right colon was achieved in 65.4% and 41.4% of patients (P <0.0001) in the two respective groups (▶ **Fig. 2**). Mean BBPS score was higher in the overnight split-dose regimen subgroup compared with

▶ **Table 1** Patient characteristics

	Indication for colonoscopy				Dose regimen		
	Screening (n = 5513)	**Diagnostic (n = 3872)**	**Follow-up (n = 3446)**	**Other (n = 338)**	**Split-dose (n = 4316)**	**Same-day (n = 8853)**	**Total (n = 13169)**
Sex, n (%)							
Male	2724 (49.41%)	1661 (42.90%)	1833 (53.19%)	188 (55.62%)	2070 (47.96%)	4336 (48.98%)	6406 (48.64%)
Female	2789 (50.59%)	2211 (57.10%)	1613 (46.81%)	150 (44.38%)	2246 (52.04%)	4517 (51.02%)	6763 (51.36%)
Age (years)							
n (missing)	5513 (0)	3872 (0)	3446 (0)	338 (0)	4316 (0)	8853 (0)	13169 (0)
Median	57	53	61	58	59	56	57
Min:max	19:93	18:94	18:94	18:95	18:94	18:95	18:95
Age ranges, n (%)							
≥ 65 years	1390 (25.21%)	1111 (28.69%)	1311 (38.04%)	117 (34.62%)	1442 (33.41%)	2487 (28.09%)	3929 (29.84%)
< 65 years	4123 (74.79%)	2761 (71.31%)	2135 (61.96%)	221 (65.38%)	2874 (66.59%)	6366 (71.91%)	9240 (70.16%)
Body mass index (kg/m^2)							
n (missing)	750 (4763)	98 (3774)	213 (3233)	37 (301)	910 (3406)	188 (8665)	1098 (12071)
Median	27	26	26	26	27	26	27
Min:max	17:46	17:40	17:40	16:38	16:46	17:40	16:46
BMI >30 kg/m^2, n (%)	200 (26.7%)	21 (21.4%)	29 (13.6%)	5 (13.5%)	230 (25.3%)	25 (13.3%)	255 (23.2%)
Medical history							
Inflammatory bowel disease							
Yes	12 (0.22%)	11 (0.28%)	176 (5.11%)	4 (1.18%)	82 (1.90%)	121 (1.37%)	203 (1.54%)
No	1220 (22.13%)	449 (11.60%)	659 (19.1%)	230 (68.05%)	2040 (47.27%)	518 (5.85%)	2558 (19.42%)
Missing	4281	3412	2611	104	2194	8214	10,408
Constipation							
Yes	72 (1.31%)	188 (4.86%)	98 (2.84%)	17 (5.03%)	156 (3.61%)	219 (2.47%)	375 (2.85%)
No	1230 (22.31%)	688 (17.77%)	874 (25.36%)	276 (81.66%)	1959 (45.39%)	1109 (12.53%)	3068 (23.30%)
Missing	4211	2996	2474	45	2201	7525	9726
Diabetes mellitus							
Yes	141 (2.56%)	128 (3.31%)	127 (3.69%)	44 (13.02%)	278 (6.44%)	162 (1.83%)	440 (3.34%)
No	1064 (19.30%)	749 (19.34%)	854 (24.78%)	249 (73.67%)	1736 (40.22%)	1180 (13.33%)	2916 (22.14%)
Missing	4308	2995	2465	45	2302	7511	9813
Hypertension							
Yes	341 (6.19%)	298 (7.70%)	314 (9.11%)	112 (33.14%)	679 (15.73%)	386 (4.36%)	1065 (8.09%)
No	972 (17.63%)	580 (14.98%)	669 (19.41%)	181 (53.55%)	1437 (33.29%)	965 (10.90%)	2402 (18.24%)
Missing	4200	2994	2463	45	2200	7502	9702
Mild kidney impairment							
Yes	6 (0.11%)	66 (1.70%)	33 (0.96%)	3 (0.89%)	23 (0.53%)	85 (0.96%)	108 (0.82%)
No	1192 (21.62%)	811 (20.95%)	937 (27.19%)	290 (85.80%)	1990 (46.11%)	1240 (14.01%)	3230 (24.53%)
Missing	4315	2995	2476	45	2303	7528	9831

▶ **Table 1** (Continuation)

	Indication for colonoscopy				Dose regimen		
Moderate kidney impairment							
Yes	7 (0.13%)	11 (0.28%)	5 (0.15%)	2 (0.59%)	16 (0.37%)	9 (0.10%)	25 (0.19%)
No	1293 (23.45%)	866 (22.37%)	961 (27.89%)	290 (85.80%)	2094 (48.52%)	1316 (14.87%)	3410 (25.89%)
Missing	4213	2995	2480	46	2206	7528	9734
First colonoscopy							
Yes	1451 (26.32%)	694 (17.92%)	299 (8.68%)	48 (14.20%)	1843 (42.70%)	649 (7.33%)	2492 (18.92%)
No	802 (14.55%)	871 (22.49%)	1325 (38.45%)	246 (72.78%)	1817 (42.10%)	1427 (16.12%)	3244 (24.63%)
Missing	3260	2307	1822	44	656	6777	7433
Personal history of colorectal cancer							
Yes	4 (0.07%)	1 (0.03%)	32 (0.93%)	2 (0.59%)	35 (0.81%)	4 (0.05%)	39 (0.30%)
No	1212 (21.98%)	445 (11.49%)	803 (23.30%)	228 (67.46%)	2045 (47.38%)	643 (7.26%)	2688 (20.41%)
Missing	4297	3426	2611	108	2236	8206	10442



▶ **Fig. 1** Flowchart of patient recruitment.

same-day dosing in the total colon (8.02 [1.46] vs. 6.96 [1.91]; *P* <0.0001) and in all individual segments (*P* <0.0001) (▶ **Fig. 3**).

Age

Overall, 88.3% of patients (3468/3929) aged ≥65 years achieved overall adequate colon cleansing vs. 89.7% (8289/9240) of patients aged < 65 years (*P* = 0.0145). Overall high-quality cleansing was achieved in 52.2% of patients (2050/3929) ≥65 years old, and in 53.3% of patients (4927/9240) <65 years (*P* = 0.2278). The high-quality cleansing rate in the right colon was 47.1% (1850/3929) in patients aged ≥65 years vs. 50.2% (4642/9240) in patients <65 years old (*P*<0.0001) (**Fig. 1s**).

Polyp and adenoma detection rates

At least one polyp was detected and removed in half of those undergoing a colonoscopy (PDR 49.2% [6478/13169] [95%CI 48.3%–50.1%]) (▶ **Fig. 4a**). In the right colon, the PDR was 22.7% (95%CI 22.3%–23.7%). The mean PDR in the total colon was 1.17 (SD 2.09), and 0.36 (SD 0.89) in the right colon (▶ **Fig. 4b**). The ADR was 42.5% (3953/9310) (95%CI 41.5%–43.5%) in the total colon and 24.3% (2054/8457) (95%CI 23.4%–25.2%) in the right colon.

Other quality performance outcomes for colonoscopy

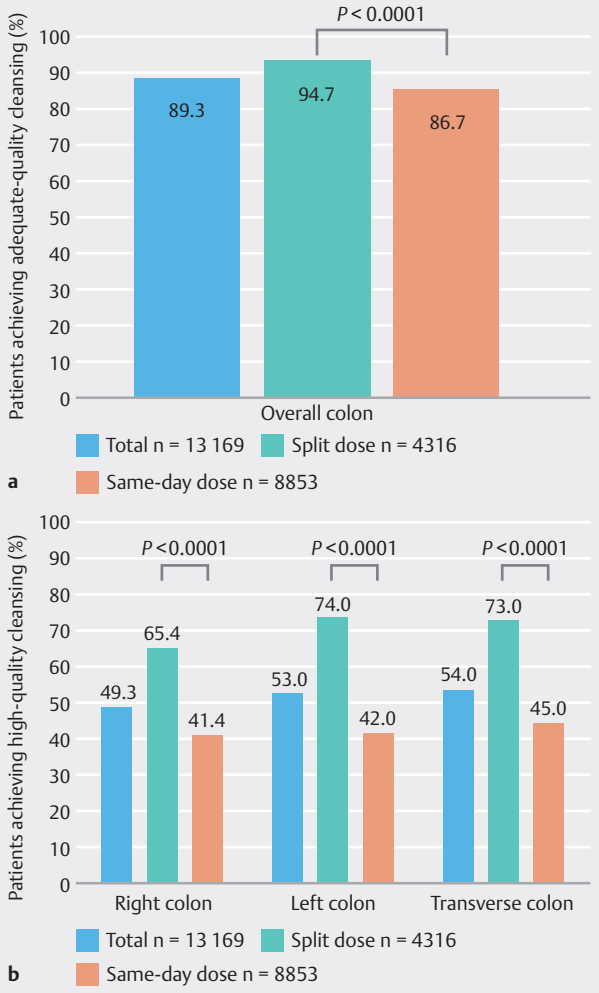
Colonoscopy was completed in 97.3% of patients (12809/13169) (95%CI 96.97%-97.53%). Of the 2.7% of patients in whom colonoscopy was incomplete, this was due to poor preparation in only 0.8% (**Table 3s**). Of 6325 patients assessed, 97.6% had a complete cecal intubation. The mean intubation time was 6.0 minutes, and the mean withdrawal time was 8.4 minutes (▶ **Table 2**).

Safety

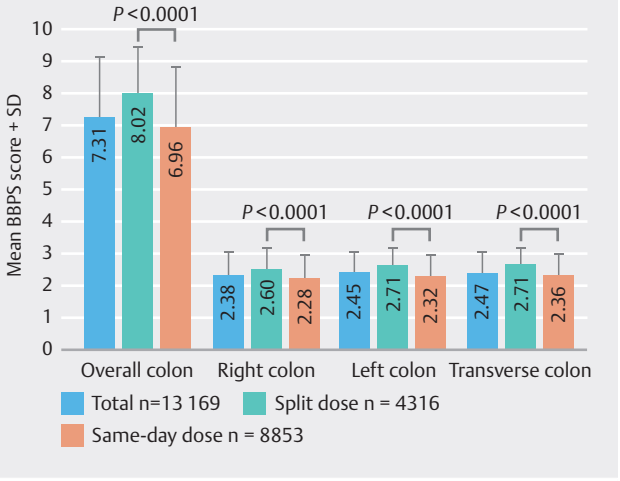
In total, 2.3% of patients (95%CI 2.0%-2.5%) experienced at least one AE (n = 13169). The most common AE was nausea (n = 155; 1.2%), followed by vomiting (n = 104; 0.8%) and abdominal pain (n = 23; 0.2%) (▶ **Table 3**). Among the 104 patients reporting vomiting, the rate of adequate bowel cleansing was 91.4%. There were no significant differences in the incidence of AEs by patient age or colonoscopy indication. However, AE incidence was higher with overnight split-dose than with same-day dosing (3.94% vs. 1.43%, respectively; *P*<0.0001), although the overall rates remained low in both regimens (<5% of patients).

Discussion

This is the largest study on the use of a 1 L PEG-based bowel preparation in real-world practice to date, providing robust data demonstrating that 1 L PEG + Asc routinely delivers effective bowel cleansing in real-world settings across multiple centers in Spain and Portugal. Our results on overall cleansing suc-



▶ **Fig. 2** Cleansing rates according to dosing regimen. **a** Percentage of patients who achieved adequate quality cleansing in the overall colon (Boston Bowel Preparation Scale [BBPS] score ≥6 with a BBPS score ≥2 in each segment). **b** Percentage of patients who achieved high-quality cleansing in individual segments (BBPS score of 3). *P* values were calculated by Chi-square test.



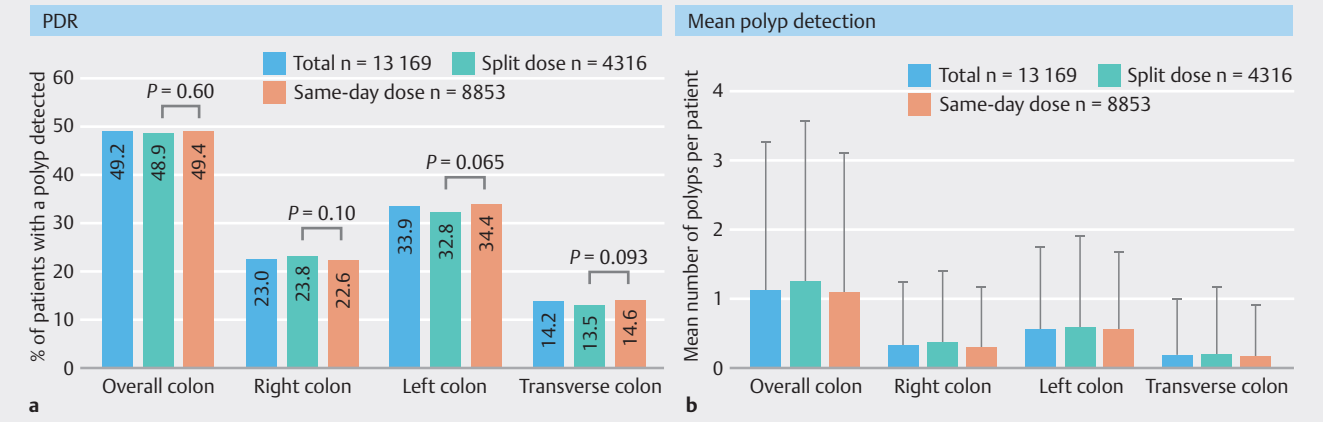
▶ **Fig. 3** Cleansing scores according to dosing regimen. Mean Boston Bowel Preparation Scale (BBPS) scores in each segment. *P* values were calculated by Chi-square test.

cess and right colon high-quality cleansing with both dosing regimens were similar to those seen in three Phase 3 clinical trials, despite this study being a real-world study [13, 14].

Our results confirm the effectiveness of 1 L PEG + Asc previously demonstrated in smaller-scale real-world studies. Maida et al. reported that 1 L PEG + Asc outperformed 2 L and 4 L PEG preparations. Multiple regression models showed that 1 L PEG + Asc was an independent predictor of overall cleansing success, high-quality cleansing of the right colon, and tolerability [22]. Several other real-world evidence studies across Europe and the United States comparing 1 L PEG + Asc with various other preparations reported improved cleansing, as well as high rates of adherence and patient satisfaction [16, 20, 21, 23]. A recent publication by Bednarska et al. comparing 1 L PEG + Asc with a 2 L PEG-based preparation with ascorbic acid (2 L PEG-Asc) and 4 L PEGs showed that all segmental BBPS scores were significantly greater for 1 L PEG + Asc. Smell, taste, and total experience were better with 1 L PEG + Asc than 4 L PEG, and similar to 2 L PEG-ASC [23]. In a prospective real-world trial of seven bowel preparations in more than 4000 patients, Gu et al. [25] reported that the best performing preparation had a mean overall BBPS score of 7.30 with an overnight split-dose regimen, compared with 8.02 in our study of over 13000 individuals. However, differences remain between the two studies, including the prospective study design and a multi-variable regression analysis performed by Gu et al. These data contribute to a growing body of evidence showing that 1 L PEG + Asc delivers high effectiveness and good tolerability in both clinical trials and real-world settings.

In our dataset, adoption of the overnight split-dosing regimen was relatively low (32.8%). Differences in dosing administration were primarily due to differences in clinical practice between countries. While hospitals in Portugal tend to adopt a same-day dosing regimen because colonoscopy procedures are often carried out in the afternoon, this practice is less common in hospitals in Spain. Arieira et al. reported that overnight split dosing was associated with low adherence among patients for cultural and social reasons; consequently, same-day dosing is frequently used in certain hospitals [21].

Same-day dosing on the day of colonoscopy has been shown to be as effective as overnight split dosing [26, 27]. In the current study, high rates of overall colon cleansing success and high-quality cleansing in the right colon were attained with both the same-day and the overnight split-dosing regimens, although results were greater for the overnight split-dosing regimen. This difference may be due to the long interval (≥5 hours) between the last dose of the preparation and the start of the colonoscopy in the majority of the patients in the same-day dosing subgroup (94.3%). The European Society of Gastrointestinal Endoscopy (ESGE) guidelines recommend overnight split-dosing due to its proven superior efficacy compared with day-before dosing, and a same-day bowel preparation as an accept-



▶ **Fig. 4** **a** Polyp detection rates (PDRs) according to dosing regimen. **b** Mean number of polyps per patient. Percentage of patients with a polyp detected. PDR is defined as at least one polyp being found and removed. *P* values were calculated by Chi-square test.

▶ **Table 2** Cecal intubation and withdrawal times.

	n (%) (N = 13169)	95% CI
Complete cecal intubation		[97.24%–97.99%]
Yes	6176 (97.64%)	
No	149 (2.36%)	
Missing	6844	
Cecal intubation time (minutes)		
n	581	
Mean (SD)	5.98 (3.63)	
95% CI of the mean	(5.68–6.27)	
Withdrawal time (minutes)		
n	3971	
Mean (SD)	8.36 (4.17)	
95% CI of the mean	(8.23–8.49)	

CI, confidence interval; SD, standard deviation.

▶ **Table 3** Safety.

	N = 13169
Patients reporting at least one adverse event, n (%)	
Yes	297 (2.26%)
No	12872 (97.74%)
Adverse event, n (%)	**n = 332[a]**
Nausea	155 (1.18%)
Vomiting	104 (0.79%)
Abdominal pain	23 (0.17%)
Dehydration	21 (0.16%)
Headache	13 (0.10%)
Dizziness	11 (0.08%)
Anal pain	3 (0.02%)
Other	2 (0.02%)

[a]Total number of adverse events (some patients reported more than one adverse event).

able alternative to split-dosing, for patients undergoing afternoon colonoscopy [24]. However, it is also strongly recommended to start the last dose of bowel preparation within 5 hours of colonoscopy [24].

Consequently, to improve quality of bowel cleansing, it is important to consider not only the dosing regimen but also the interval between last dose of bowel preparation and the start of the colonoscopy, mainly when scheduling an afternoon procedure.

The colonoscopy completion rate in our study, another measure of quality performance, was high (97.3%). Incomplete colonoscopies were due to poor preparation in a very small proportion of cases (0.7%), even lower than the rate of 2.1% reported by Bednarska et al. (n = 523) [23]. Both results represent a considerable improvement over previous reports from the USA, the UK, and Italy, which found that 17% to 25% of incomplete colonoscopies using various bowel preparations were due to poor preparation [28, 29, 30]. The CIR of 97.6% (6176/6325) exceeded the minimum and target ESGE guideline of 90% and 95%, respectively. In this study, the mean withdrawal time was 8.4 minutes for all patients: according to ESGE guidelines the minimum mean time is 6 minutes, and the target standard mean time is 10 minutes. The ADR of 42.5% (3953/9310) also surpassed the minimum ESGE target of 25%. As reported by Hassan et al. ADR is a clinically relevant measure as it is linked to future colorectal cancer disease risk and mortality rates, with patients with high-quality cleansing achieving better colorectal cancer prevention [31]. These data support the capabil-

ities of 1 L PEG + Asc to consistently deliver robust colonoscopy outcomes owing to effective cleansing. It should be noted that in this real-world study, information on complete cecal intubation was not recorded for approximately 50% of patients despite there being clear guidance on the importance of recording this quality indicator [32], suggesting a gap in documentation in real-world clinical practice, in line with the findings of a European survey which identified areas requiring quality improvement and the need to promote quality monitoring throughout the colonoscopy procedure [33]. In the current study, incidence of AEs was low (2.3%) with only 1.2% of patients reporting nausea and 0.8% reporting vomiting. Overall, incidence of AEs was consistently low across all subgroups per indication and per comorbidity. We found no difference in the occurrence of AEs in those aged over 65 compared with those under 65 years of age. In agreement with our results, previous studies have demonstrated the safety of low-volume preparations compared with traditional higher-volume preparations [34], including recent evidence from the real-world setting, which showed no differences in AEs or ADRs with 1 L PEG + Asc compared with 4 L PEGs [16, 22]. Together, these results show that reported AEs were substantially lower in the real world than in clinical trials, where they reached rates of up to 15% [13, 14]. This could also be explained by AEs being solicited in trials, whereas in clinical practice they are spontaneously reported by patients, so AEs perceived as less important may not be reported.

This study has several strengths. A broad cross-section of patients was captured due to the large number of participants and wide inclusion criteria, with a variety of ages and co-morbidities. Thus, it provides a representative overview of cleansing results within the general population. It included 12 centers across Spain and Portugal, representing a range of practices, procedures, and healthcare professionals. Importantly, the naturalistic, retrospective study design allowed us to determine the performance of 1 L PEG + Asc in clinical practice, without the participant altering their behavior due to being observed (the Hawthorne effect).

An important limitation of our study is the lack of randomization, which potentially introduces selection bias. Nonetheless, the lack of randomization is secondary to the nature of the study, which was designed to be observational to better reflect the real-world practice. In addition, the lack of a comparator group in our study did not allow comparison of the performance of 1 L PEG-Asc with other bowel preparations that may be used in clinical practice. Furthermore, due the retrospective design of the study, high rates of missing data for some endpoints were observed. Thus, our analysis focused mainly on procedure endpoints consistently collected in daily practice. Another important limitation of the current study is the difference in the data collection methodology adopted in different centers. To demonstrate clinically meaningful differences between regimens in terms of bowel preparation quality, future studies of large patient cohorts might benefit from including patient-outcome endpoints, such as the rate of post-colonoscopy colorectal cancer (i. e., missed lesions). Finally, while some statistically significant differences were observed between subgroups (i. e., dosing regimens and age), the clinical relevance of these differences is unclear and needs to be further studied.

Conclusions

In conclusion, results from this large-scale, multicenter study confirmed the effectiveness of 1 L PEG + Asc in real-world settings with regard to high rates of overall colon cleansing success, high-quality cleansing in the right colon and high PDRs across different subgroups, including challenging populations such as elderly patients. This is associated with optimization of quality indicators in colonoscopy that, despite being a retrospective study in which endoscopists did not feel monitored, is broadly in line with the standards of the ESGE. These data also showed that 1 L PEG + Asc is well tolerated overall, with a low incidence of AEs.

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Conflict of Interest

S. Rodríguez and E. Pérez Arellano have received a speaker's fee from Norgine. F. Akriche and C. Turbí Disla are employees of Norgine. All other authors have no conflict of interest.

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Clinical trial

Trial registry: ClinicalTrials.gov (http://www.clinicaltrials.gov/)
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Type of Study: observational, retrospective, multicenter

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