Techniques in Coloproctology
https://doi.org/10.1007/s10151-018-1919-6

REVIEW ARTICLE

Is the outpatient management of acute diverticulitis safe and effective? A systematic review and meta-analysis

R. Cirocchi[1] · J. J. Randolph[2] · G. A. Binda[3] · S. Gioia[4] · B. M. Henry[5] · K. A. Tomaszewski[6] · M. Allegritti[7] · A. Arezzo[8] · R. Marzaioli[9] · P. Ruscelli[10]

Received: 28 July 2018 / Accepted: 26 December 2018

Abstract

Background In Western countries, the incidence of acute diverticulitis (AD) is increasing. Patients with uncomplicated diverticulitis can undergo a standard antibiotic treatment in an outpatient setting. The aim of this systematic review was to assess the safety and efficacy of the management of acute diverticulitis in an outpatient setting.

Methods A literature search was performed on PubMed, Scopus, Embase, Central and Web of Science up to September 2018. Studies including patients who had outpatient management of uncomplicated acute diverticulitis were considered. We manually checked the reference lists of all included studies to identify any additional studies. Primary outcome was the overall failure rates in the outpatient setting. The failure of outpatient setting was defined as any emergency hospital admission in patients who had outpatient treatment for AD in the previous 60 days. A subgroup analysis of failure was performed in patients with AD of the left colon, with or without comorbidities, with previous episodes of AD, in patients with diabetes, with different severity of AD (pericolic air and abdominal abscess), with or without antibiotic treatment, with ambulatory versus home care unit follow-up, with or without protocol and where outpatient management is a common practice. The secondary outcome was the rate of emergency surgical treatment or percutaneous drainage in patients who failed outpatient treatment.

Results This systematic review included 21 studies including 1781 patients who had outpatient management of AD including 11 prospective, 9 retrospective and only 1 randomized trial. The meta-analysis showed that outpatient management is safe, and the overall failure rate in an outpatient setting was 4.3% (95% CI 2.6%-6.3%). Localization of diverticulitis is not a selection criterion for an outpatient strategy (p 0.512). The other subgroup analyses did not report any factors that influence the rate of failure: previous episodes of acute diverticulitis ($p=0.163$), comorbidities ($p=0.187$), pericolic air ($p=0.653$), intra-abdominal abscess ($p=0.326$), treatment according to a registered protocol ($p=0.078$), type of follow-up ($p=0.700$), type of antibiotic treatment ($p=0.647$) or diabetes ($p=0.610$). In patients who failed outpatient treatment, the majority had prolonged antibiotic therapy and only few had percutaneous drainage for an abscess (0.13%) or surgical intervention for perforation (0.06%). These results should be interpreted with some caution because of the low quality of available data.

Conclusions The outpatient management of AD can reduce the rate of emergency hospitalizations. This setting is already part of the common clinical practice of many emergency departments, in which a standardized protocol is followed. The data reported suggest that this management is safe if associated with an accurate selection of patients (40%); but no subgroup analysis demonstrated significant differences between groups (such as comorbidities, previous episode, diabetes). The main limitations of the findings of the present review concern their applicability in common clinical practice as it was impossible to identify strict criteria of failure.

Keywords Acute diverticulitis · Outpatient · Uncomplicated diverticulitis · Outpatient management

Introduction

In Western countries the incidence of diverticulosis is constantly increasing and is reported approximately in 30% of people at the age of 60 years and 60% of people older

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10151-018-1919-6) contains supplementary material, which is available to authorized users.

Extended author information available on the last page of the article

Published online: 25 January 2019

than 80 years [1]. Only 15% of patients with diverticulosis develop acute diverticulitis (AD) [2]. The severity of presentation of acute diverticulitis (AD) may range from mild to life threatening, depending on the extent of inflammation and peritoneal contamination [3]. In the last years, some studies based on administrative databases showed an increase of hospitalization for AD. Often patients with mild diverticulitis are admitted to hospital and kept nil by mouth, while intravenous fluids and antibiotic therapy are administered [4]. The median length of stay for AD is 4 days [5]. This increases healthcare costs significantly [6, 7]. For these reasons patients with mild diverticulitis receive antibiotic treatment in an outpatient setting [8].

Several scientific societies have reported either a consensus or an expert opinion paper about the outpatient management of patients with AD. The characteristics of patients are different in these statements:

- The ASCRS (American Society of Colon and Rectal Surgeons) includes only patients who tolerate oral hydration, without relevant comorbidities, or who do have adequate support at home [9].
- The WES (World Emergency Society) includes patients with no comorbidities [10].
- The SICCR (Italian Society of Colon and Rectal Surgery) reported that an ambulatory treatment protocol is safe and effective for a majority of patients [11].

Currently there is a gap in evidence supporting this approach. These recommendations are supported from low (1C) or moderate (1B) quality evidence based respectively on observational studies or randomized controlled trials (RCTs) with important limitations.

Despite these limits, the aim of this systematic review was to assess the safety and efficacy of the management of AD in an outpatient setting.

Materials and methods

A systematic literature search was performed on PubMed, Scopus, Embase, Central and Web of Science up to 13 September 2018. The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) [12] was followed. The following search strategies were used in PubMed: ("outpatients" [MeSH Terms] OR "outpatients" [All Fields] OR "outpatient" [All Fields]) AND ("diverticulitis" [MeSH Terms] OR "diverticulitis" [All Fields]).

All titles and abstracts were assessed to select those focusing on outpatient management of patients with uncomplicated colonic diverticulitis. Successively, the full-text of these studies were evaluated by two authors (RC and SG). In PubMed, the function "related articles" and in Scopus "related documents" were used to research other articles. The references of the included studies were evaluated for other potential trials. Two other authors (RM and PR) evaluated the eligibility of each study.

Inclusion criteria

All control and observational studies, irrespectively of their size, publication status and language, which included patients who had outpatient management for uncomplicated colonic diverticulitis. Randomized and not-randomized comparative studies were included if they focused on emergency hospitalization versus no hospitalization in patients with acute colonic diverticulitis.

Exclusion criteria

Studies in which the clinical evaluation after hospital discharge was not reported.

Primary outcome

Overall failure of outpatient treatment. The failure was defined as any emergency hospital admission in patients treated in an outpatient setting. The time to event was reported from 11 studies: the readmission in hospital was reported during the first 30 days from discharge in 7 studies [13–19] and during the first 60 days from discharge in 4 studies [20–23]. We considered 60 days the time limit. A subgroup analysis was performed:

- Failure of outpatient setting in patients with AD of the left colon.
- Failure of outpatient setting in patients with or without comorbidities.
- Failure of outpatient setting in patients with previous episodes of AD.
- Failure of outpatient setting in patients with diabetes.
- Failure of outpatient setting in patients with different severity of AD (pericolic air and abdominal abscess).
- Failure of outpatient setting in patients with or without antibiotic treatment.
- Failure of outpatient setting in patients where outpatient management is a common practice.
- Failure of outpatient setting in patients with ambulatory versus home care unit follow-up.
- Failure of outpatient setting in patients with or without protocol.

Secondary outcome

Rate of emergency surgical treatment or percutaneous drainage in patients with failure of outpatient setting.

Statistical analyses

Outpatient failure rates were pooled under a random effects model (REML) using the MetaFor package in R (3.4.2). Prior to synthesis proportions were transformed using the Freeman–Tukey double arcsine transformed proportion; all data in the results section have been backtransformed. No correction factor was added to each proportion. Default values in Metafor's escalc and rma functions were used otherwise. Cochrane's Q and its p value, I^2, and τ^2 are included as statistical measures of heterogeneity. A subgroups moderator analysis was performed with the MetaFor package. Cochrane's Q, degrees of freedom, and the p value of Q are reported for each moderator variable as measures of heterogeneity. The QM statistic was used a measure of statistical significance for differences between sub-groups.

To explore bias, a funnel plot was visually examined, and a leave-one-out sensitivity analysis was conducted for each outcome using MetaXL. Note that studies were not excluded based on the results of the sensitivity analyses unless otherwise noted; visual analyses of funnel plots have been shown to be inaccurate for the reliable identification of publication bias [24]. We only used funnel plots to identify studies for exclusion in an exploratory sensitivity analysis. Publication bias tests were not used unless they met the criteria specified in Ionnidas and Trikalinos [25].

Risk of bias in included studies

The assessment of methodological quality was performed independently by two authors (RC and MA), who assessed methodological quality of included studies using the methods described in the Cochrane Handbook for Systematic Reviews of Interventions for randomized controlled trials (RCTs) [26]. The methodological index for nonrandomized studies (MINORS) [27] was used to evaluate the methodological quality of the included comparative and noncomparative studies.

The protocol of this systematic review and meta-analysis was registered on PROSPERO CRD42018096781 (http://www.crd.york.ac.uk/prospero). In single-arm meta-analysis, GRADE [28] is not used to evaluate the quality of outcomes included; recently, Zafer et al. modified GRADE to evaluate evidence quality for meta-analysis of single arm studies [29]; we used the GRADE' modifications reported by Zafer.

Results

The PRISMA flow diagram is presented in Fig. 1. The search strategy identified 3301 studies and 4 additional records identified through other sources. After de-duplication, 2302 citations were screened of which 2275 were excluded based on title and abstract. For the remaining 27 studies, the full texts were obtained and reviewed. Six studies were excluded on the basis of reasons listed in the section of characteristics of excluded studies [20, 21, 30–33]. In total, 21studies fulfilled the inclusion criteria [13–19, 22, 23, 34–45], (Table 1). No ongoing study was found.

Studies excluded

Six studies reported early discharge from hospital and described the possibility of outpatient management in patients with AD [20, 21, 30–33] but the outpatient treatment was not performed [20, 21, 30–32]. One study performed only an analysis on risk factors for severe outcomes in uncomplicated AD [33].

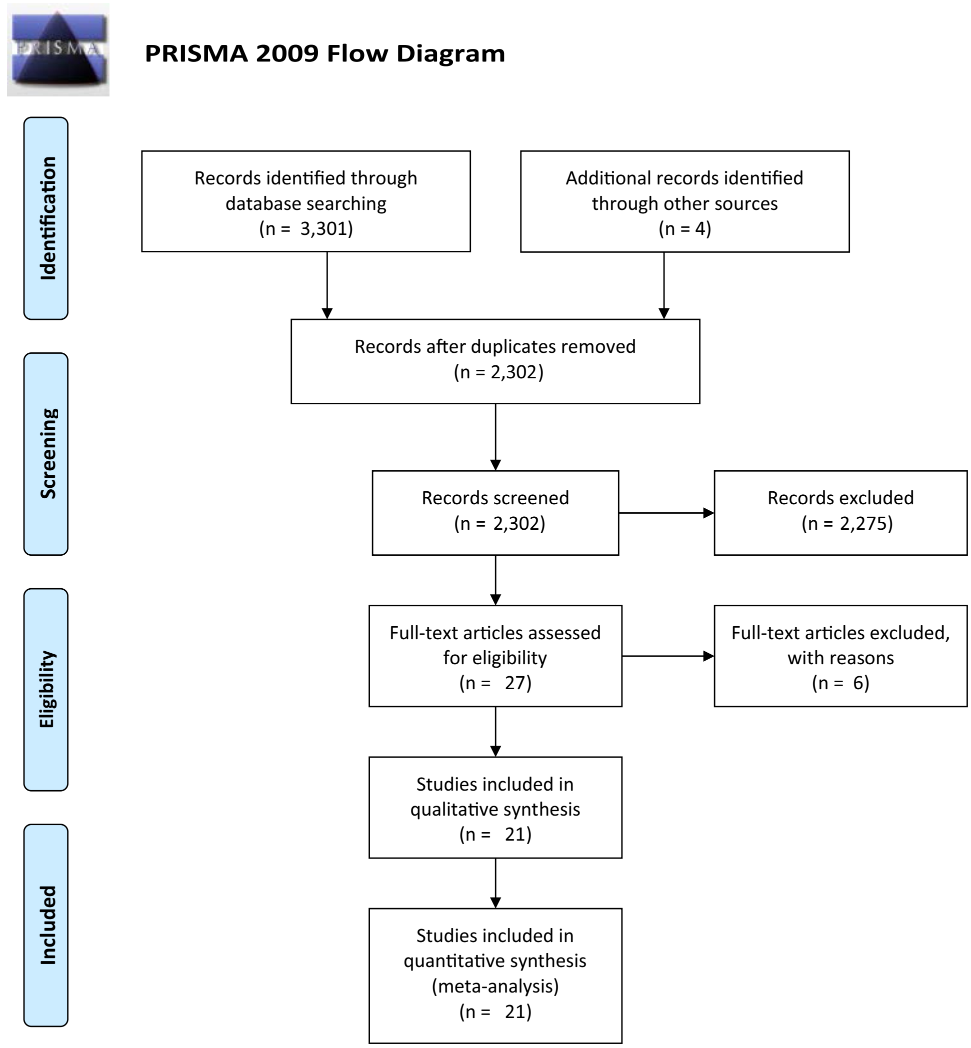
Characteristics of included studies

Twenty-one studies that met the inclusion criteria were included in this review in which 1781 patients were treated for AD in an outpatient setting (Table 1). The enrollment of patients was performed between 1997 and 2015. The study design was prospective (13 studies) and retrospective cohort study (7 studies), only 1 study was a randomized control trial (RCT). Only 12 studies reported the site of the diverticulitis: 100% in the left colon (6 studies), between 94–96% (4 studies), 84% (1 study). A study reported only patients with AD localized in right colonic side. Patient's age and sex were very heterogeneous (Table 2). Fourteen studies reported the service that performed the follow-up.

Risk of bias of included studies

The summary of the quality assessment of the included RCT [23] is shown in SDC 1. The principal limit of this trial is that there was a lack of blinding to surgeons and patients, in effect, it is impossible to blind surgeon teams or patients to surgery. The risk for blinding of outcome assessment (detection bias) was unclear, in effect Biondo et al. [23] does not describe that the personnel for data collection and analysis were independent from the study. The methodological evaluation of included studies with the MINORS scale showed that, among noncomparative studies, 7 scored 13 points, 3 had 12 points, and 3 a total of 11 points out of 16 points. In the included comparative study, 1 scored 22 points, 1 scored 20 points, 1 scored 19 points, 2 scored 18 points, 1 scored 17 points and 1 scored 14 points over a total of 24 (SDC 2). The modified Zafer' GRADE reported "very low-quality evidence" of included studies, in effect, there is a downgrade for the lack of internal comparators (SDC 3).

Fig. 1 PRISMA flow chart of the literature search



Strategy of the studies

Sixteen studies (76.1%) included a protocol (1399 patients, 78.5%), but only 9 studies reported protocol approval and/or registration (954 patients, 53.56%). Nine studies were performed in hospitals in which outpatient management was already used as common clinical practice (778 patients, 43.68%). The follow-up reported ranged between 0 and 74 months. Only 9 studies reported the follow-up (349 patients, 19.6%). Five studies reported an ambulatory follow-up (400 patients), while in 5 studies therapy at home and follow-up of the outpatients (204 patients) were provided by the home care units (Table 3). These provided admitted care to public hospital patients in the comfort of their home. Skilled nurses administer the daily dose of intravenous antibiotic and take blood samples, if need. A specialist doctor performed a home visit two or three times during the week.

Patients with diverticulitis evaluated in the emergency department

Nine studies reported data about the overall number of patients with AD evaluated in the Emergency Department (2198 patients). In these studies, only 879 patients (40.0%) were enrolled to outpatient management. Seventeen studies (77.3%) reported data about the overall number of patients with uncomplicated AD evaluated (2394). In these studies, only 1498 patients (62.6%) were enrolled in outpatient management.

Confirmation of diagnosis and evaluation of inflammatory process

In the majority of the studies (90.5%) the diagnosis and the evaluation of inflammatory process was performed with

Table 1 Characteristics of included studies

References	Nation	Study design	Time of enrollment	Patients with diverticulitis	Patients with uncomplicated diverticulitis	Managed as outpatients
Mizuki et al. [13]	Japan	Prospective cohort	1997–2002	137	83	70
Peláez et al. [34]	Spain	Prospective cohort	2003–2005	NR	53	40
Martín Gil et al. [35]	Spain	Prospective cohort	2000–2006	NR	NR	74
Rodríguez-Cerrillo et al. [36]	Spain	Prospective cohort	2007–2009	NR	NR	24[a]
Alonso et al. [14]	Spain	Prospective cohort	2003–2008	NR	96	70
Park et al. [37]	Korea	Prospective cohort	2007–2009	NR	103	40
Latuwak [38]	USA	Retrospective cohort	2010–2011	NR	50	21
Rueda et al. [39]	Spain	Retrospective cohort	2008–2010	NR	56	38
Moya et al. [40]	Spain	Prospective clinical control trial	2007–2009	111	34[b]	32[b]
Rodríguez-Cerrillo et al. [41]	Spain	Prospective clinical control trial	2011–2012	NR	72	34[c]
Ünlü et al. [22]	The Netherlands	Retrospective cohort	2004–2012	627	214	118
Lorente et al. [42]	Spain	Retrospective cohort–clinical control trial	2005–2011	NR	136	90
Mora Lopez et al. [43]	Spain	Prospective clinical control trial	2010–2013	205	149	68
Biondo et al. [23]	Spain	Randomized control trial	2009–2011	258	63	63
Isacson et al. [15]	Sweden	Prospective cohort	2012–2013	NR	NR	155
Estrada Ferrer et al. [44]	Spain	Prospective cohort	2013–2014	110	99	68
Mali et al. [16]	Finland	Prospective cohort	2014–2015	248	161	140
Moya et al. [45]	Spain	Retrospective cohort	2010–2014	262	235	224
Joliat et al. [17]	Switzerland	Retrospective cohort	2006–2012	NR	540	171
Sirany et al. [18]	USA	Retrospective cohort	2010–2015	240	NR	96
Jasacson et al. [19]	Sweden	Prospective clinical control trial	2011	NR	254	51 (20%)
			2014		240	145 (60%)

[a] 2008–2009

[b] Only patients with co-morbidities

[c] Only elderly patients

the use of abdominal computed tomography (CT) scan with contrast media. Only Isacson [15, 19] and Mizuki [13] reported the use of ultrasonography. Few studies reported the time of radiological evaluation, which was in all cases 24 h after admission. Similarly, few studies reported the time at discharge from the Emergency Department ranging between 12 and 48 h. Inclusion criteria were CT findings of inflammation limited to the diverticulum (focal diverticulitis), colonic wall thickening (> 4 mm), soft tissue stranding of the pericolic fat and small collection of pericolic free peritoneal air and fluid. Nine studies (746 patients, 41.9%) did not include patients with intra-abdominal abscess, while 6 studies included any intra-abdominal abscess ≤ 2 cm in diameter (753 patients, 42.3%) and 3 studies any intra-abdominal abscess ≥ 2 cm in diameter (142, 8.0%) (Table 3).

Presence of comorbidities

In some studies, only selected patients were included in the outpatient's settings, while in other studies patients were included without restriction for comorbidities [18, 19, 36, 39–41, 45]. The most common comorbidities reported were diabetes (50%) and heart failure (43.7%).

Previous episodes of diverticulitis

Seventeen studies reported the previous episodes of diverticulitis; of these, 14 studies (82.35%) considered these episodes as an exclusion criteria for the outpatient setting. Another exclusion criterion in all studies was the lack of family support.

Table 2 Characteristics of patients reported in the included studies

References	Age, years, mean ± SD	Sex, male %	Left side	Follow-up (months) mean ± SD
Mizuki et al. [13]	NR	NR	NR	30.8 (0.9–58)[a]
Peláez et al. [34]	56,9 (31–87)[a]	50%	100%	18 ± 6
Martín Gil et al. [35]	55 (31–90)[a]	59.5%	NR	NR
Rodríguez-Cerrillo et al. [36]	73.4 (67–84)[a]	NR	NR	NR
Alonso et al. [14]	57	54.3%	100%	39 ± 23
Park et al. [37]	36.8 ± 10.4	20	0^^	19
Latuwak [38]	62 (28–89)[a]	100%	NR	NR
Rueda [39]	63.97	NR	NR	NR
Moya et al. [40]	56.06 (32–83)[a]	50%	84%	7 ± 9
Rodríguez-Cerrillo et al. [41]	77 (71–90)[a]	82.4%	NR	NR
Ünlü et al. [22]	54.5 ± 11.1	42.4%	100%	48 ± 26.4
Lorente et al. [42]	58.75 ± 15	44.4%	NR	17 ± 5
Mora Lopez et al. [43]	59 (25–90)[a]	NR	NR	NR
Biondo et al. [23]	55.9 (13.4)	48.5%	100%	2
Isacson et al. [15]	57 ± 12	34.8%	100%	3
Estrada Ferrer et al. [44]	NR	NR	100%	6 (3–12)[a]
Mali et al. [16]	57 (25–86)[a]	36%	94%	1
Moya et al. [45]	57.7 (19–89)[a]	47.7%	95%	15 ± 5
Joliat et al. [17]	53 (44–64)	63.7%	96%	46.5 (29–74)[a]
Sirany et al. [18]	NR	50%	96%	36.5 (25–43)[a]
Jasacson et al. [19]	61	37%	NR	1
	60	33%		

SD standard deviation

[a]Median, range

^^ Only right colonic side

Antibiotic treatment after the discharge from emergency department

Eighteen studies reported data about the use of antibiotics during the home stay. Three studies did not report the use of antibiotics after discharge from the emergency department [15, 16, 19]. The type of home antibiotic treatment was heterogeneous. The highest number of authors used co-amoxiclav 1.2 g TDS IV or ciprofloxacin 400 mg BD IV and metronidazole [14, 18, 23, 34, 35, 37, 40, 45]. Others administrated ertapenem every day [36, 39, 41] or intravenous ceftriaxone 2 g/24 h [43, 44]. Estrada Ferrer et al. [44] performed a tailored antibiotic therapy based on AD severity.

Endoscopic evaluation during the follow-up

In ten studies, a colonoscopy or a CT colonography was performed during the follow-up to exclude a synchronous cancer, between 1 and 3 months after the acute episode.

Results

Overall outpatient failure rate

Out of 1781 patients across 21 studies, the overall pooled outpatient failure rate was 4.3% (95% CI 2.64, 6.28). There was a statistically significant amount of heterogeneity, $I^2 = 64.84\%$, $Q(20) = 53.3$, $p < 0.001$ (Table 3) (Fig. 2). Similar results were reported in the RCT by Biondo et al., with a raw failure rate of 4.5% (3/66) [23].

We conducted several sensitivity analyses. First, a visual analysis of Fig. 2 indicated that the studies performed by Rueda et al. [39], Estrada Ferrer et al. [44], and Sirany et al. [18] appeared to be outlying studies. Without those two studies, the outpatient failure rate was 3.3% (95% CI 2.08, 4.82), but a statistically significant amount of heterogeneity remained, $I^2 = 42.6\%$, $Q(17) = 29.4$, $p < 0.031$. A leave-one-out-analysis indicated that no single study's exclusion changed the pooled failure rate more than 1%. Visual analyses of funnel plots indicated that the three outlying studies [39, 44] and one other article [35] fell slightly outside

Table 3 Outpatient failure rate

Subgroup	Studies	N	FailureRate	95% CIs		I^2	T^2	Q	P of Q
All studies	21	1781	4.3	2.64	6.28	64.84	0.01	53.23	< 0.001
Abscess: QM(2) = 2.24, p = 0.326									
Abscess < 2 cm	6	753	5.57	2.3	10.01	79.44	0.01	19.82	0.001
No Abscess	9	746	3.43	1.86	5.35	24.94	0.00	11.15	0.193
Abscess > 2 cm	3	142	1.3	0	6.45	54.55	0.01	4.46	0.107
Presence of comorbidities: QM(1) = 1.74, p = 0.187									
No comorbidity	12	1094	3.95	2.31	5.92	44.75	< 0.00	20.38	0.040
Comorbidity	5	335	6.93	1.46	15.25	79.11	0.02	18.73	0.001
Diabetic: QM(df = 1) = 2.59, p = 0.610									
No diabetic patients	6	451	3.59	1.93	5.66	0	0	1.83	0.873
Diabetic patients	5	319	4.82	0.11	13.78	83.72	0.02	21.32	< 0.001
Antibiotic: QM(df = 2) = 0.87, p = 0.647									
Oral	10	799	4.17	1.91	7.11	63.36	0.01	24.41	0.004
Endovenous	4	164	4.35	0	15.48	80.93	0.03	14.51	0.002
No antibiotics	3	440	2.73	1.33	4.54	< 0.01	0.00	0.02	0.988
Common practice: QM(df = 1) = 0.712, p = 0.399									
Not common practice?	12	1003	3.72	2	5.84	51.51	< 0.00	22.04	0.024
Common practice	9	778	5.06	1.86	9.43	77.86	0.01	27.84	0.001
Type of follow-up: QM(df = 1) = 0.18, p = 0.700									
Home care	5	204	4.53	0.14	12.68	74.38	0.02	14.51	0.006
Ambulatory	5	400	3.73	1.94	5.98	0	< 0.00	2.08	0.721
Protocol: QM(df = 2) = 5.09, p = 0.078									
Registered protocol	9	954	4.26	2.48	6.43	46.07	< 0.00	15.08	0.058
Unregistered protocol	7	445	2.15	0.33	5.01	47.54	< 0.00	11.49	0.074
None protocol	5	382	7.9	2.43	15.75	81	0.01	15.97	0.003
Left colon diverticulitis: QM(df = 1) = 0.43, p = 0.512									
Not left colon diverticulitis?	15	1267	3.79	1.76	6.41	71.8	0.01	43.52	< 0.001
Left colon diverticulitis	6	514	5.38	2.78	8.66	47.38	< 0.00	9.43	0.093
Previous diverticulitis: QM(df = 1) = 1.94, p = 0.163									
No previous diverticulitis	14	1253	4.43	2.46	6.84	62.43	< 0.00	32.85	0.002
Previous diverticulitis	3	254	8.51	5.28	12.37	0	< 0.00	1.4	0.497
Pericolic air: QM(1) = 0.20, p = 0.653									
Without pericolic air	11	861	4.71	2.44	7.54	57.86	< 0.01	23.19	0.010
With pericolic air	7	738	3.95	1.08	8.22	81.3	0.01	27.01	< 0.001

The QM statistic indicates the degree of statistical significance for between group effects. The Q statistic is a measure of statistical heterogeneity between studies within a group

of the funnel area (Fig. 3). Removing those 4 studies, the pooled failure rate decreased to 3.8% (95% CI 2.6%, 5.2%) and heterogeneity was also reduced significantly ($I^2 = 28.5\%$, $Q(16) = 22.0$, $p < 0.145$).

Subgroup analysis

Outpatient failure rates for patients with diverticulitis of the left colon

In the 6 studies that reported on 514 patients with diverticulitis only of the left colon, the pooled outpatient failure rate was 5.4% (95% CI 2.8%, 8.7%) compared to a 3.8% pooled failure rate (95% CI 1.76, 6.41) in 15 studies that reported on patients without diverticulitis of the left colon. The difference between groups was not statistically significant: QM(1) = 0.43, p = 0.512 (Table 3; Fig. 4).

Outpatient failure rates for patients with or without comorbidities

The overall outpatient pooled failure rate for patients without comorbidities was 4.0% (95% CI 2.3%, 5.9%, 12 studies, 1094 patients) compared to 6.9% for patients with

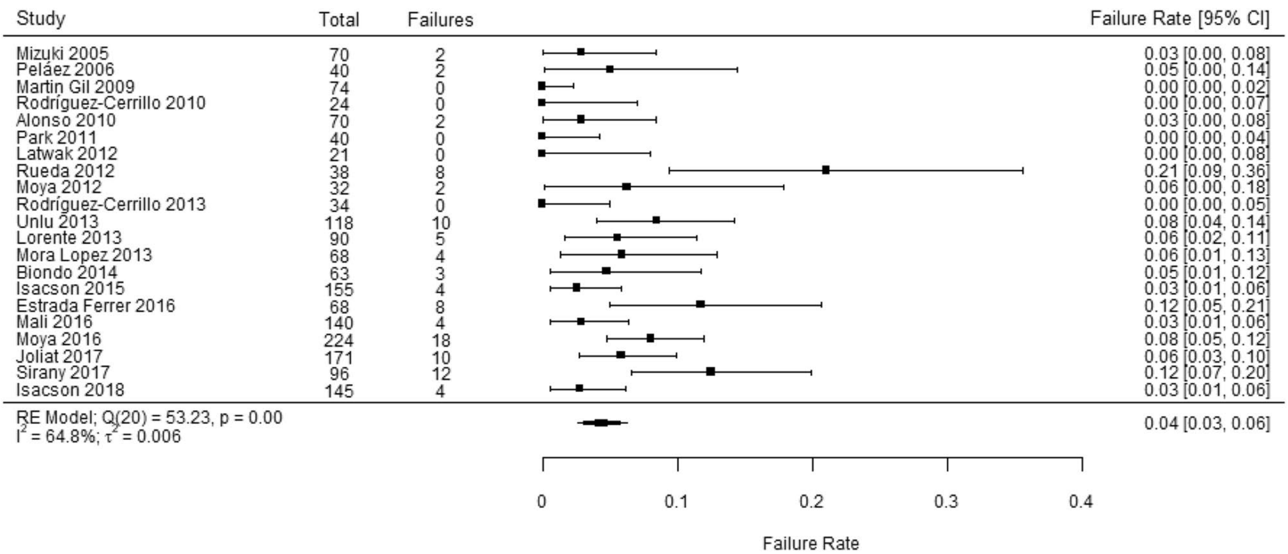


Fig. 2 Overall pooled outpatient failure rate

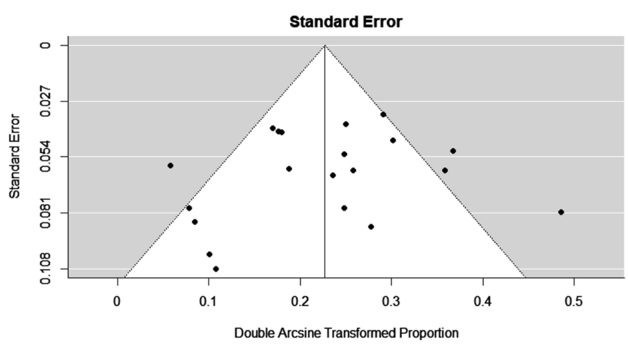


Fig. 3 Funnel plot for all studies

comorbidities (95% CI 1.5%, 15.6%, 6 studies, 335 patients). The difference between groups was not statistically significant: QM(1) = 1.74, p = 0.187 (Table 3; Fig. 4).

Outpatient failure rates for patients with or without previous episodes of diverticulitis

The pooled failure rate for patients with previous episodes of diverticulitis was 8.5% (95% CI 5.28, 12.37, 3 studies, 254 patients) compared to 4.4% (95% CI 2.5%, 6.8%, 14 studies, 1253 patients) for patients without previous episodes. The difference was not statistically significant however: QM(1) = 1.94, p = 0.163 (Table 3).

Outpatient failures rates for patients with diabetes

There was no statistically significant difference in the outpatient failure rates between diabetic and nondiabetic patients, QM(1) = 2.59, p = 0.610. Diabetic patients' failure rate (4.8%, 95% CI 0.11% 13.8%, 5 studies, 319 patients) was 4.8% compared to 3.6% (95% CI 1.9%, 5.7%, 6 studies, 451 patients) for patients without diabetes. (Table 3).

Outpatient failure rates for patients with or without pericolic air

Patients with pericolic air had an outpatient failure rate of 4.0% (95% CI 1.1%, 8.2%, 7 studies, 738 patients) compared to an outpatient failure rate of 4.7% for patients without pericolic air (95% CI 2.4, 7.5, 11 studies, 861 patients). The difference in outpatient failure rates between groups was not statistically significant: QM(1) = 0.20, p = 0.653.

Outpatient failure rates for patients with or without abdominal abscess

There was no statistically significant difference in outpatient failure rates between patients without an abscess (3.4%, 95% CI 1.9%, 5.4%, 9 studies, 746 patients); patients with an abscess, but less than 2 cm (5.6%, 95% CI 2.3%, 10.1, 6 studies, 753 patients) and patients with an abscess greater than 2 cm (1.3%, 95% CI 0.0, 6.45%, 3, studies, 142 patients). The difference between groups was not statistically significant: QM(2) = 2.24, p = 0.326.

Outpatient failure rates for patients by type of antibiotic treatment

There was no statistically significant difference in outpatient failure rates between types of antibiotic treatment, QM(2) = 0.87, p = 0.647. Patients without antibiotic treatment at home had an outpatient failure rate of 2.7% (95%

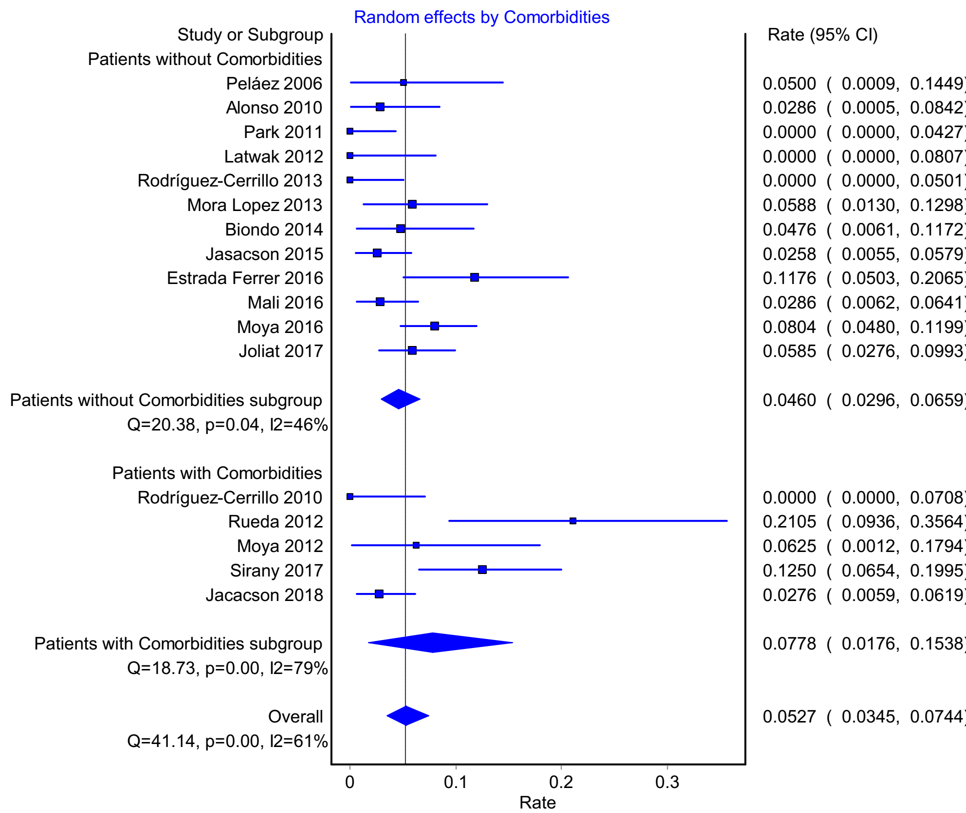


Fig. 4 Pooled rates for patients with and woithout comorbidities

CI 1.3,% 4.5,% 3 studies, 440 patients), compared to 4.2% (95% CI 1.9%, 7.1%, 10 studies, 799 patients) for patients treated with oral antibiotics, and 4.4% (95% CI 0.0, 15.5%, 4 studies, 164 patients) for patients treated with endovenous antibiotics. The difference between groups was not statistically significant: QM(df = 2) = 0.87, p = 0.647.

Failure of outpatient setting in patients where outpatient management is a common practice

The rate of failure in the outpatient setting was 1.3% lower in hospitals where outpatient management was a common clinical practice (5.1%, 95% CI 1.9%, 9.4%, 9 studies, 778 patients) compared to hospitals where it was not a common practice (3.7%, 95% CI 2.05, 5.8%, 12 studies, 1003 patients). The difference was not statistically significant: QM(1) = 0.71, p = 0.399 (Table 3).

Failure of outpatient setting in patients with ambulatory versus home care unit follow-up

The overall failure rate was lower in patients who underwent ambulatory follow-up (3.7%, 95% CI 1.9%, 6.0%, 5 studies, 400 patients) than patients who were in a home care unit (4.5%, 95% CI 0.1%, 12.7%, 5 studies, 204 patients); the difference was not statistically significant between groups however: QM(1) = 0.18, p = 0.700 (Table 3).

Outpatient failure rate in patients with or without protocol

The outpatient failure rate was 7.9% (95% CI 2.4%, 15.8%, 382 patients) in the 5 studies with no protocol, 2.2% (95% CI 0.3%, 5.0%, 7 studies, 445 patients) in the 7 studies with an unregistered protocol, and 4.3% (95% CI 2.5%, 6.4%, 954 patients) in the 9 studies with a registered protocol. Type of protocol registration was not a statistically significant moderator of outpatient failure rates: QM(2) = 5.09, p = 0.078 (Table 3).

Results of analysis: secondary outcome

Rate of emergency surgical treatment or percutaneous drainage in patients with failure of outpatient setting

All studies, except Rueda et al. [39] and Joliat et al. [17], reported on the treatment of patients with outpatient failure (1572). The majority of patients were treated by further antibiotic therapy (1569); only few patients with failure of outpatient management underwent percutaneous drainage for an abscess (0.13%, 2/1572) or emergency surgical treatment for perforation (0.06%, 1/1572).

Discussion

This systematic review included 21 studies and enrolled 1781 selected patients with AD had outpatient management. The meta-analysis showed that outpatient management is safe, but the subgroup analysis did not report any factors (previous episodes of AD, intra-abdominal abscess, strategy of the studies, types of follow-up, antibiotic treatment after discharge from the emergency department) that influence the rate of failure.

The first outcome of this systematic review is the failure of outpatient management, although the rate of severe adverse events in uncomplicated diverticulitis is very low [46, 47]. This review showed that the localization of diverticulitis in the sigmoid colon is not a selection criterion for outpatient management; there is no difference in failure rate between overall (3.79%) versus a selected group with left colon diverticulitis (5.38%). This result disagrees with the results of Yoo et al. [32], in which the hospital stay was significantly lower in right diverticulitis ($p = < 0.001$).

Outpatient treatment can be performed in patients with uncomplicated diverticulitis (Hinchey 1); the failure of an outpatient strategy is higher in patients with complicated diverticulitis. This setting is suggested in all guidelines, but the level of evidence to support this management is very low and the selection of patients is not homogeneous. Differentiating between uncomplicated and complicated AD is possible only with clinical evaluation and/or laboratory evaluation; many studies reported CT scan as the standard needed for adequate selection. An international, expert-based, consensus statement regarding the management of AD and all guidelines also support CT scan of the abdomen and pelvis as the most suitable modality with which to gauge the severity of AD [48]. In effect during the past decade, CT scan has dramatically changed the way diverticulitis is diagnosed. CT clearly depicts diverticulitis in its early stage, demonstrates complications with high sensitivity (79–99%), and is of use in noninvasive therapeutic approaches such as percutaneous drainage [49, 50]. The American Society of Colon and Rectal Surgeons reported "CT scan of the abdomen and pelvis is the most appropriate initial imaging modality in the assessment of suspected diverticulitis". Although CT scan is the standard imaging evaluation for the diagnosis and staging of diverticulitis, a step-up approach with CT scan performed after an inconclusive or negative ultrasound (US), has been suggested for patients with suspected AD [10]. Differently, the ASCRS suggested that ultrasound and magnetic resonance imaging (MRI) "can be useful alternatives in the initial evaluation of a patient with suspected AD" [9]. In the common clinical practice, these protocols may be not feasible [51]; in effect, the CT scan might be difficult to perform in every Emergency Department during the first 24 h after admission [49]. For this reason, multidisciplinary hospital teams should develop local protocols based on the available hospital resources.

The CT scan selection criteria are very different between the studies; a lower failure rate is reported only in the patients without abscesses. The presence of a small amount of pericolic air is not associated with a higher incidence of failure. It is not possible to determine if some laboratory markers can be an index for the severity of diverticulitis; no study has reported the evaluation of white blood cell (WBC) or C-reactive protein (CRP) levels. Yoo et al. [32] evaluated WBCs and CRP as severity markers, but this analysis does not show any significant prediction of outcome. However, Joung et al. reported that a level of CRP ≥ 200 mg/L is associated with a severe clinical course. The patients who have outpatient management were followed up in the outpatient clinic, with the exception of studies from Spain, where a home care service is active so that therapy administration and follow-up take place in a patient's home. The results of the home care service are not significatively better than the standard ambulatory service. The intravenous antibiotic therapy does not cause significant improvement compared to oral antibiotic treatment [52–55]. These results are in line with those of the literature. In effect, some RCTs reported that oral antibiotics are not inferior to intravenous antibiotics in achieving resolution of clinically diagnosed diverticulitis [56]. The antibiotic therapy is not superior to no-antibiotic therapy. Our results agree with the Cochrane systematic review and meta-analysis published from Shabanzadeh and Wille-Jørgensen [57] and with the statement of some societies:

- The Italian Society of Colorectal Surgery (SICCR) suggests avoiding antibiotic therapy in acute uncomplicated diverticulitis since it may not improve short- or long-term outcomes. Use on a case-by-case basis should possibly be considered.
- The World Society of Emergency Surgery (WSES) reported "antimicrobial therapy can be avoided in immunocompetent patients with uncomplicated diverticulitis without systemic manifestations of infection".

Our results are similar to those of other systematic reviews concerning the ambulatory management of AD in selected patients. In our systematic review the number of studies ($n = 21$) is the largest in effect the study reporting a greater number is that published by van Dijk et al. [58] reported only 19 studies. In other two systematic reviews, Balasubramanian et al. [59] reported ten studies and Jakson et al. [60] reported nine studies. Balasubramanian et al. do not report differences in failure rates of medical treatment (6.5 versus 4.6%) or in recurrence rates (13.0 versus 12.1%) between outpatients and inpatients. Ambulatory treatment is associated with a lower hospital cost (savings of between 600 versus 1900 euros). Four studies [23, 35, 40, 41] reported a cost-saving ranging from 42 to 82%. Our review does not compare the results of inpatient versus outpatient management and analyses, like Jakson and van Dijk. Differently from Van Dijk et al. we performed a subgroup analysis for the failure of the outpatient setting. The major limitation is the high risk of bias of the reported papers.

Malpractice claims are increasingly important aspects of medical practice and frequently of emergemcy medicine. The Institute of Medicine (IOM) report estimated the total cost of medical error as USD 17–29 billion per annum [61]. In medical malpractice cases, the defendant's behavior is compared to the standard of care for that specific situation [62]. The standard of care is most commonly defined as, "that reasonable and ordinary care, skill, and diligence as physicians and surgeons in good standing in the same neighborhood, the same general line of practice, ordinarily have been exercising in like cases".

With regard to outpatient management in patients with AD, management should be standardized to reduce medical malpractice and to increase patient safety. Accurate selection of patients (uncomplicated versus complicated AD) is mandatory [63]. Medical records should be accurately and clearly compiled. Any medical prescriptions should be listed in detail. The patient should be given correct and clear information and should be advised to return to the emergency room as soon as symptoms worsen.

In this meta-analysis there is a high statistical heterogeneity ("larger differences in the outcome of the individual studies than could expected to result from chance alone") [64], which may result from clinical ("differences in patient populations and treatment protocol") [64] or methodological heterogeneity ("differences in study design and risk of bias") [64].

It was impossible to avoid the clinical heterogeneity using strict criteria of study selection, based on design, populations, severity of AD, type of antibiotic treatment and outcomes. Information such as comorbidities, CT staging, antibiotic treatment and clinical follow-up was often not available. Other limitations were the differences in measurement of exposure time and types of clinical evaluation (ambulatory or home care) and incomplete follow-up.

Furthermore, this heterogeneity may be due to the small sample size of the studies and overlooked unpublished data, especially regarding the failure of outpatient management.

Conclusions

The outpatient management of acute diverticulitis, performed in selected patients, can reduce the rate of emergency hospitalisation and the related costs. This is already part of the common clinical practice of many emergency departments, in which a standardized protocol is followed. The data reported suggests that outpatient management is safe if patients are properly selected (40%) with an overall pooled outpatient failure rate of only 4.3% (95% CI 2.64%, 6.28%); fewer of whom required percutaneous drainage for an abscess (0.13%) or emergency surgical treatment for perforation (0.06%).

No subgroup analysis demonstrated significant differences between groups (comorbidities, previous episode, diabetes, use of antibiotics).

The degree of heterogeneity between studies limits the strength of conclusions drawn but highlights the need for further work in this area with well-conducted studies and further randomized studies.

Acknowledgements The authors thank Nereo Vettoretto and Vito D'Andrea for their assistance.

Funding This study did not benefit of any source of funding.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent For this type of study a formal consent is not required.

References

1. Dixon MR, Trudel JL (2004) Diverticular disease of the colon. In: Cameron JL (ed) Current surgical therapy, 9th edn. Elsevier, Philadelphia, pp 166–170
2. Brook MA, Victorino GP (2018) Diverticular disease of the colon. In: Harken AH, Moore E (eds) Abernathy's surgical, 7th edn. Elsevier, Philadelphia, pp 224–226
3. Wu JS, Einstein DM (2004) Diagnosis and medical management of acute colonic diverticulitis. In: Fazio V, Church JM, Delaney CP Current therapy in colon and rectal surgery, 2nd edn. Elsevier, Philadelphia, pp 277–284
4. Nystrom PO (2010) Acute diverticulitis. In: Schein M, Rogers PN, Assalia A (eds) Schein's common sense emergency abdominal surgery. Springer, Berlin, pp 277–287
5. Reddy VB, Longo WE (2013) The burden of diverticular disease on patients and healthcare systems. Gastroenterol Hepatol 9:21–27
6. Shaheen NJ, Hansen RA, Morgan DR, Gangarosa LM, Ringel Y, Thiny MT, Russo MW, Sandler RS (2006) The burden of gastrointestinal and liver diseases. Am J Gastroenterol 101:2128–2138
7. Sandler RS, Everhart JE, Donowitz M, Adams E, Cronin K, Goodman C, Gemmen E, Shah S, Avdic A, Rubin R (2002)

The burden of selected digestive diseases in the United States. Gastroenterology 122:1500–1511
8. O'Connor ES, Smith MA, Heise CP (2012) Outpatient diverticulitis: mild or myth? J Gastrointest Surg 16:1389–1396
9. Feingold D, Steele SR, Lee S, Kaiser A, Boushey R, Buie WD, Rafferty JF (2014) Practice parameters for the treatment of sigmoid diverticulitis. Dis Colon Rectum 57:284–294
10. Sartelli M, Catena F, Ansaloni L, Coccolini F et al (2016) WSES Guidelines for the management of acute left sided colonic diverticulitis in the emergency setting. World J Emerg Surg 29:11–37
11. Binda GA, Cuomo R, Laghi A, Nascimbeni R, Serventi A, Bellini D, Gervaz P, Annibale B, Italian Society of Colon and Rectal Surgery (2015) Practice parameters for the treatment of colonic diverticular disease: Italian Society of Colon and Rectal Surgery (SICCR) guidelines. Tech Coloproctol 19:615–626
12. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. J Clin Epidemiol 62:1006–1012
13. Mizuki A, Nagata H, Tatemichi M, Kaneda S, Tsukada N, Ishii H, Hibi T (2005) The out-patient management of patients with acute mild-to-moderate colonic diverticulitis. Aliment Pharmacol Ther 21:889–897
14. Alonso S, Pera M, Parés D, Pascual M, Gil MJ, Courtier R, Grande L (2010) Outpatient treatment of patients with uncomplicated acute diverticulitis. Colorectal Dis 12(10 Online):e278–e282
15. Isacson D, Thorisson A, Andreasson K, Nikberg M, Smedh K, Chabok A (2015) Outpatient, non-antibiotic management in acute uncomplicated diverticulitis: a prospective study. Int J Colorectal Dis 30:1229–1234
16. Mali JP, Mentula PJ, Leppäniemi AK, Sallinen VJ (2016) Symptomatic treatment for uncomplicated acute diverticulitis: a prospective cohort study. Dis Colon Rectum 59:529–534
17. Joliat GR, Emery J, Demartines N, Hübner M, Yersin B, Hahnloser D (2017) Antibiotic treatment for uncomplicated and mild complicated diverticulitis: outpatient treatment for everyone. Int J Colorectal Dis 32:1313–1319
18. Sirany AE, Gaertner WB, Madoff RD, Kwaan MR (2017) Diverticulitis diagnosed in the emergency room: is it safe to discharge home? J Am Coll Surg 225:21–25
19. Isacson D, Andreasson K, Nikberg M, Smedh K, Chabok A (2018) Outpatient management of acute uncomplicated diverticulitis results in health-care cost savings. Scand J Gastroenterol 53:449–452
20. Etzioni DA, Chiu VY, Cannom RR, Burchette RJ, Haigh PI, Abbas MA (2010) Outpatient treatment of acute diverticulitis: rates and predictors of failure. Dis Colon Rectum 53:861–865
21. Al-Sahaf O, Al-Azawi D, Fauzi MZ, El-Masry S, Gillen P (2008) Early discharge policy of patients with acute colonic diverticulitis following initial CT scan. Int J Colorectal Dis 23:817–820
22. Ünlü Ç, Gunadi PM, Gerhards MF, Boermeester MA, Vrouenraets BC (2013) Outpatient treatment for acute uncomplicated diverticulitis. Eur J Gastroenterol Hepatol 25:1038–1043
23. Biondo S, Golda T, Kreisler E, Espin E, Vallribera F, Oteiza F, Codina-Cazador A, Pujadas M, Flor B (2014) Outpatient versus hospitalization management for uncomplicated diverticulitis: a prospective, multicenter randomized clinical trial (DIVER Trial). Ann Surg 259:38–44
24. Hunter JP, Saratzis A, Sutton AJ, Boucher RH, Sayers RD, Bown MJ (2014) In meta-analyses of proportion studies, funnel plots were found to be an inaccurate method of assessing publication bias. J Clin Epidemiol 67:897–903
25. Ioannidis JPA, Trikalinos TA (2007) The appropriateness of asymmetry tests for publication bias in meta-analyses: a large survey. CMAJ Can Med Assoc J 176:1091–1096
26. Higgins JPT, Green S (2011) Cochrane handbook for systematic reviews of interventions version 5.1.0 [updated March 2011]. The Cochrane Collaboration, London
27. Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J (2003) Methodological index for non-randomized studies (minors): development and validation of a new instrument. ANZ J Surg 73:712–716
28. Guyatt GH, Oxman AD, Vist G, Kunz R, Brozek J, Alonso-Coello P, Montori V, Akl EA, Djulbegovic B, Falck-Ytter Y, Norris SL, Williams JW Jr, Atkins D, Meerpohl J, Schünemann HJ (2011) GRADE guidelines: 4. Rating the quality of evidence—study limitations (risk of bias). J Clin Epidemiol 64:407–415
29. Zafer M, Horvath H, Mmeje O, van der Poel S, Semprini AE, Rutherford G, Brown J (2016) Effectiveness of semen washing to prevent human immunodeficiency virus (HIV) transmission and assist pregnancy in HIV-discordant couples: a systematic review and meta-analysis. Fertil Steril 105:645–655
30. Chan DKH, Tan KK (2018) Asian patients with Hinchey Ia acute diverticulitis: a condition for the ambulatory setting? Int J Colorectal Dis 33:61–64
31. Reynolds IS, O'Connell E, Heaney RM, Khan W, Khan IZ, Waldron R, Barry K (2018) Adherence to clinical guidelines and the potential economic benefits of admission avoidance for acute uncomplicated diverticulitis. Ir J Med Sci 187:59–64
32. Yoo T, Yang KH, Kim J, Park I, Cho H, Gwak G, Bae BN, Kim KH (2018) Predictive factors affecting the clinical course of patients with diverticulitis: who needs hospital management? Ann Coloproctol 34:23–28
33. Jaung R, Kularatna M, Robertson JP, Vather R, Rowbotham D, MacCormick AD, Bissett IP (2017) Uncomplicated acute diverticulitis: identifying risk factors for severe outcomes. World J Surg 41:2258–2265
34. Peláez N, Pera M, Courtier R, Sánchez J, Gil MJ, Parés D, Grandea L (2006) Applicability, safety and efficacy of an ambulatory treatment protocol in patients with uncomplicated acute diverticulitis. Cir Esp 80:369–372
35. Martín Gil J, Serralta De Colsa D, García Marín A, Vaquero Rodríguez A, Rey Valcárcel C, Pérez Díaz MD, Sanz Sánchez M, Turégano Fuentes F (2009) Safety and efficiency of ambulatory treatment of acute diverticulitis. Gastroenterol Hepatol 32:83–87
36. Rodríguez-Cerrillo M, Poza-Montoro A, Fernandez-Diaz E, Romero AI (2010) Patients with uncomplicated diverticulitis and comorbidity can be treated at home. Eur J Intern Med 21:553–554
37. Park HC, Kim BS, Lee BH (2011) Management of right colonic uncomplicated diverticulitis: outpatient versus inpatient management. World J Surg 35:1118–1122
38. Latuwak N (2012) Acute diverticulitis: a small retrospective study leaving many questions unanswered. Am J Clin Med 9:138–143
39. Rueda JC, Jimenez A, Caro A, Feliu F, Escuder J, Gris F, Spuch J, Vicente V (2012) Home treatment of uncomplicated acute diverticulitis. Int Surg 97:203–209
40. Moya P, Arroyo A, Pérez-Legaz J, Serrano P, Candela F, Soriano-Irigaray L, Calpena R (2012) Applicability, safety and efficiency of outpatient treatment in uncomplicated diverticulitis. Tech Coloproctol 16:301–307
41. Rodríguez-Cerrillo M, Poza-Montoro A, Fernandez-Diaz E, Matesanz-David M, Iñurrieta Romero A (2013) Treatment of elderly patients with uncomplicated diverticulitis, even with comorbidity, at home. Eur J Intern Med 24(5):430–432
42. Lorente L, Cots F, Alonso S, Pascual M, Salvans S, Courtier R, Gil MJ, Grande L, Pera M (2013) Outpatient treatment of uncomplicated acute diverticulitis: Impact on healthcare costs. Cir Esp 91:504–509
43. Mora Lopez L, Serra Pla S, Serra-Aracil X, Ballesteros E, Navarro S (2013) Application of a modified Neff classification to patients with uncomplicated diverticulitis. Colorectal Dis 15:1442–1447

44. Estrada Ferrer O, Ruiz Edo N, Hidalgo Grau LA, Abadal Prades M, Del Bas Rubia M, Garcia Torralbo EM, Heredia Budo A, Suñol Sala X (2016) Selective non-antibiotic treatment in sigmoid diverticulitis: is it time to change the traditional approach? Tech Coloproctol 20:309–315
45. Moya P, Bellon M, Arroyo A, Galindo I, Candela F, Lacueva J, Calpena R (2016) Outpatient treatment in uncomplicated acute diverticulitis: 5-year experience. Turk J Gastroenterol 27(4):330–335
46. Ribas Y, D'Hoore A (2016) Pushing the boundaries of the management of uncomplicated diverticulitis. Tech Coloproctol 20:269–270
47. Tursi A (2014) Efficacy, safety, and applicability of outpatient treatment for diverticulitis. Drug Health Patient Saf 6:29–36
48. O'Leary DP, Lynch N, Clancy C, Winter DC, Myers E (2015) International, expert-based, consensus statement regarding the management of acute diverticulitis. JAMA Surg 150:899–904
49. Kaiser AM, Jiang JK, Lake JP et al (2005) The management of complicated diverticulitis and the role of computed tomography. Am J Gastroenterol 100:910–917
50. Kaewlai R, Nazinitsky KJ (2007) Acute colonic diverticulitis in a community-based hospital: CT evaluation in 138 patients. Emerg Radiol 13:171–179
51. Paolillo C, Spallino I (2015) Is it safe to send home an uncomplicated diverticulitis? The DIVER trial. Intern Emerg Med 10:193–194
52. Unlü C, de Korte N, Daniels L et al (2010) Dutch Diverticular Disease 3D Collaborative Study Group. A multicenter randomized clinical trial investigating the cost-effectiveness of treatment strategies with or without antibiotics for uncomplicated acute diverticulitis (DIABOLO trial). BMC Surg 20:10–23
53. Daniels L, Ünlü Ç, de Korte N, van Dieren S, Stockmann HB, Vrouenraets BC, Consten EC, van der Hoeven JA, Eijsbouts QA, Faneyte IF, Bemelman WA, Dijkgraaf MG, Boermeester MA, Dutch Diverticular Disease (3D) Collaborative Study Group (2017) Randomized clinical trial of observational versus antibiotic treatment for a first episode of CT-proven uncomplicated acute diverticulitis. Br J Surg 104:52–61
54. Chabok A, Påhlman L, Hjern F, Haapaniemi S, Smedh K, AVOD Study Group (2012) Randomized clinical trial of antibiotics in acute uncomplicated diverticulitis. Br J Surg 99:532–539
55. De Korte N, Kuyvenhoven JP, van der Peet DL, Felt-Bersma RJ, Cuesta MA, Stockmann HB (2012) Mild colonic diverticulitis can be treated without antibiotics. A case–control study. Colorectal Dis 14:325–330
56. Ridgway PF, Latif A, Shabbir J, Ofriokuma F, Hurley MJ, Evoy D, O'Mahony JB, Mealy K (2009) Randomized controlled trial of oral vs intravenous therapy for the clinically diagnosed acute uncomplicated diverticulitis. Colorectal Dis 11:941–946
57. Shabanzadeh DM, Wille-Jørgensen P (2012) Antibiotics for uncomplicated diverticulitis. Cochrane Database Syst Rev 14;11:CD009092
58. Van Dijk ST, Bos K, de Boer MGJ, Draaisma WA, van Enst WA, Felt RJF, Klarenbeek BR, Otte JA, Puylaert JBCM, van Geloven AAW, Boermeester MA (2018) A systematic review and meta-analysis of outpatient treatment for acute diverticulitis. Int J Colorectal Dis 33:505–512
59. Balasubramanian I, Fleming C, Mohan HM, Schmidt K, Haglind E, Winter DC (2017) Out-patient management of mild or uncomplicated diverticulitis: a systematic review. Dig Surg 34:151–160
60. Jackson JD, Hammond T (2014) Systematic review: outpatient management of acute uncomplicated diverticulitis. Int J Colorectal Dis 29:775–781
61. Kohn LT, Corrigan JM, Donaldson MS (2000) To err is human: building a safer health system. Institute of Medicine, Committee on Quality of Health Care in America, National Academy Press, Washington
62. Robinson KJ, Nouhan PP (2018) Expert Witness. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK436001/. Accessed 20 Jul 2018
63. Huscher C, Mingoli A, Mereu A, Sgarzini G (2013) Single-access laparoscopic "lavage" for purulent diverticulitis in a 96-year-old patient: how to reduce surgical trauma and standardize surgical technique. Surg Innov 20:109–112
64. Melsen WG, Bootsma MC, Rovers MM, Bonten MJ (2014) The effects of clinical and statistical heterogeneity on the predictive values of results from meta-analyses. Clin Microbiol Infect 20:123–129

Affiliations

R. Cirocchi[1] · J. J. Randolph[2] · G. A. Binda[3] · S. Gioia[4] · B. M. Henry[5] · K. A. Tomaszewski[6] · M. Allegritti[7] · A. Arezzo[8] · R. Marzaioli[9] · P. Ruscelli[10]

✉ S. Gioia
saragioia.sg@gmail.com

R. Cirocchi
roberto.cirocchi@unipg.it

J. J. Randolph
randolph_jj@mercer.edu

G. A. Binda
gabinda@me.com

B. M. Henry
bmhenry55@gmail.com

K. A. Tomaszewski
krzysztof.tomaszewski@uj.edu.pl

M. Allegritti
m.allegritti@aospterni.it

A. Arezzo
alberto.arezzo@mac.com

R. Marzaioli
rinaldo.marzaioli@uniba.it

P. Ruscelli
ruscellipaolo@gmail.com

[1] Department of Surgical Science, University of Perugia, Perugia, Italy

[2] Georgia Baptist College of Nursing, Mercer University, Atlanta, GA, USA

[3] Department of Surgery, Galliera Hospital, Genoa, Italy

[4] Section of Legal Medicine, AOSP Terni, via T. di Joannuccio snc, 05100 Terni, TR, Italy

[5] Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA

[6] International Evidence-Based Anatomy Working Group, Kraków, Poland

[7] Interventional Radiology Unit, AOSP Terni, via T. di Joannuccio snc 05100 Terni, Italy

[8] Department of Surgical Sciences, University of Turin, Turin, Italy

[9] Department of Emergency and Organ Transplantation (DETO), University Medical School "A. Moro" Bari, Bari, Italy

[10] Emergency Surgery Unit, Faculty of Medicine and Surgery, Torrette Hospital, Polytechnic University of Marche, Ancona, Italy