



Hospital admission for complicated diverticulitis is increasing in Italy, especially in younger patients: a national database study

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Abstract

Background Epidemiological studies show an increasing trend of hospitalization for acute diverticulitis (AD), but data regarding the trend in hospitalization for complicated AD in Italy are scarce. The aim of this study was to analyze the Italian trend in hospitalization for complicated AD, from 2008 to 2015.

Methods Using the Italian Hospital Information System, we identified all patients with complicated colonic AD as a discharge diagnosis. Age- and sex-specific rates for AD as well as type of hospital admission (emergency/elective), type of complication (peritonitis, obstruction, bleeding, abscess, fistula, perforation, sepsis) and type of treatment (medical/surgical), were analyzed.

Results A total of 41,622 patients with a discharge diagnosis of complicated AD were identified. Over the study period the admission rate grew from 8.8 to 11.8 per 100,000 inhabitants.

The hospitalization rate was highest for patients ≥ 70 years, but the increase in the admission rate was higher among patients aged ≤ 60 years. There were more males in the group < 60 years and more females in the group ≥ 60 years old. The rate of emergency admissions associated with surgery showed a significant mean annual increase (+ 3.9% per year) in the rate of emergency admissions associated with surgery, whereas elective admissions for surgery remained stable. Peritonitis was the most frequent complication (35.5%). The rate of surgery increased in AD complicated by peritonitis (+ 5.1% per year), abscess (+ 5.8% per year) and decreased for obstruction (− 1.8% per year).

Conclusions From 2008 to 2015, we documented an increasing rate of hospitalization for complicated AD, especially for younger patients, with an increase in surgery for peritonitis and abscess. Further studies are needed to clearly assess the risk factors for complications and risk of surgery.

Keywords Diverticulitis · Epidemiologic studies · Risk factors · Peritonitis · Abscess · Sepsis · Italy · Hospitalization

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Introduction

Acute diverticulitis (AD) is a common cause of hospital admission in Western countries and its incidence is rising, making AD a heavy burden on the health care systems [1–5]. It is estimated that 15–20% of patients with diverticulitis develop complications during their lifetime, including potentially life-threatening complications such as colonic perforation, abscess formation, bleeding or bowel obstruction [6]. After a diagnosis of complicated diverticulitis, an excess 1-year mortality compared with the general population has been reported, ranging from a 2.5-fold to a 4.5-fold increase for fistula/stricture and perforation/abscess, respectively [7]. The primary endpoint of our study was the trend in hospitalization for complicated diverticulitis in Italy from 2008 to 2015, using administrative data from the national health system. Secondary endpoints were the age- and sex-specific incidence as well as the type of complications, hospital admission (elective/urgent) and treatment (medical/surgical).

Materials and methods

A nationwide administrative register-based cohort study was conducted by extracting data from the Italian Hospital Information System (HIS) which includes all public and private hospitals. The characteristics and management of HIS have been described previously [5]: the database collects clinical and administrative information of every patient hospitalized in Italy. Discharge diagnoses are categorized according to the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM).

All patients hospitalized in Italy between 2008 and 2015 with a diagnosis of colon diverticulitis according to ICD-9-CM codes 562.11 (diverticulitis without hemorrhage) and 562.13 (diverticulitis with hemorrhage), either as a primary diagnosis, or as a secondary diagnosis only if associated with a complication of diverticulitis as primary diagnosis, were initially selected. Among them, those with one or more of the following ICD-9-CM codes were subsequently identified as patients with complicated diverticulitis: intestinal obstruction (codes 560.0, 560.1, 560.2, 560.89, 560.9); peritonitis (codes 567.0–567.3, 567.9); diverticular bleeding (codes 578.0–578.9), intestinal/peritoneal abscess (code 569.5); diverticular fistula (intestinal fistula, code 569.81) (colovesical fistula, code 596.1); intestinal perforation (code 569.83); sepsis or septic shock (codes 785.52, 995.90, 995.92).

Parameters assessed for the cohort with complicated diverticulitis and for each complication category included

the following: age of patient at the time of hospitalization, sex, type of admission (urgent or elective), type of treatment (medical or surgical) and type of surgery (emergency or elective). Since in 2009 the codification of surgical procedures was updated from version ICD-19 to version ICD-24, making previous classification of surgical treatment no longer reliable, we analysed surgical parameters from 2009 to 2015.

Statistical analysis

Admission rates are reported per 100,000 individuals over 18 years. Population data were extracted from the national demographic report provided by the Italian National Institute of Statistics. Trends have been calculated using Negative Binomial Distribution test, assuming as dependent variable the number of admissions for complicated AD weighted for the population over 18 years. A *p* value < 0.05 was considered statistically significant. Statistical analysis was performed using Stata 13 Software [8].

Results

General occurrence and trends

Between 2008 and 2015, 174,436 hospitalizations for AD were registered in Italy. Among them, AD with one or more complications accounted for 41,622 admissions (23.9%). Considering the overall number of hospitalizations in Italy during the same period, complicated diverticulitis accounted for 0.59/1000 admissions.

The number of hospital admissions for complicated diverticulitis increased by 39.6%, from 4280 in 2008 to 5975 in 2015, significantly more than uncomplicated diverticulitis (26.5%) (*p* < 0.001). Year by year variations were as follows: 2008–2009, + 5.5%; 2009–2010, + 7.4%; 2010–2011, + 4.1%; 2011–2012, + 8.8%; 2012–2013, + 3.4%; 2013–2014, + 1.9%; 2014–2015, + 3.2%. During the study period the admission rate rose from 8.8 to 11.8 per 100,000 inhabitants (Fig. 1).

Demographic features

Demographic features are summarized in Table 1. Admission for complicated diverticulitis per 100,000 inhabitants over 18 years was more frequent in patients aged 70–79 years (mean 24.23 ± 1.15, median 23.89 years) and over 80 years (mean 38.99 ± 1.97, median 39.06 years) than in the other age groups (Fig. 2).

There was an increase over time in hospitalizations for complicated AD, especially in younger age groups: in particular, from 2008 to 2015, hospitalizations for AD

Fig. 1 Trends of hospitalizations of the entire cohort, the group without referred complication and the group with referred complications. AD acute diverticulitis

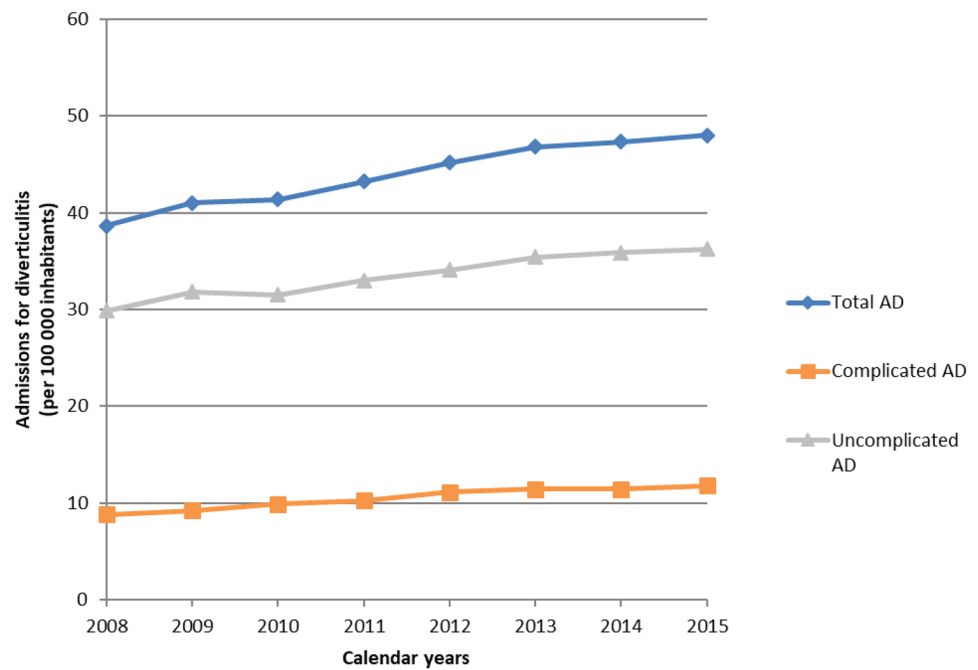


Table 1 Demographic characteristics, type of admission and treatment of patients hospitalized for complicated diverticulitis

Demographic characteristics	No. of admissions
Sex	
Males (%)	19,726 (47.4)
Females (%)	21,896 (52.6)
Age categories	
Mean years [IQR]	71 [57–80]
Age group	
18–39 years (%)	1973 (4.7)
40–49 years (%)	4013 (9.6)
50–59 years (%)	5802 (13.9)
60–69 years (%)	7817 (18.8)
70–79 years (%)	10,783 (25.9)
≥ 80 years (%)	11,234 (27.0)
Type of admission	
Emergency (%)	34,488 (82.9)
Elective (%)	7134 (17.1)
Type of treatment (recorded since 2009)	
Surgical treatment (%)	20,513 (54.9)
Medical treatment (%)	16,830 (45.1)
Surgery according to type of admission (recorded since 2009)	
Surgery in emergency admissions (% of emergency admissions)	16,104 (51.8)
Surgery in elective admissions (% of elective admissions)	4409 (70.8)

in the 18- to 39-year age group increased from 1.1 to 1.7 (+54.5%, $p < 0.001$) in the 18- to 39-year age group, from 3.8 to 6.4 (+68.4%, $p < 0.001$) in the 40- to 49-year age group, from 7.3 to 11.1 (+52.1%, $p < 0.001$) in the 50- to 59-year age group, increased from 12.3 to 15.6 (+26.8%, $p < 0.001$) in the 60- to 69-year age group, from 23.3 to

25.4 (+9.0%, $p = 0.020$) in the 70- to 79-year age group, it increased, and from 35.2 to 39.0 (+10.8%, $p = 0.008$) in patients aged 80 years and over.

A slightly higher hospitalization rate was registered for females (52.6%). There was a significant male predominance in the under 60 years group and a significant

Fig. 2 Hospitalization for acute diverticulitis (AD) with complications by age categories

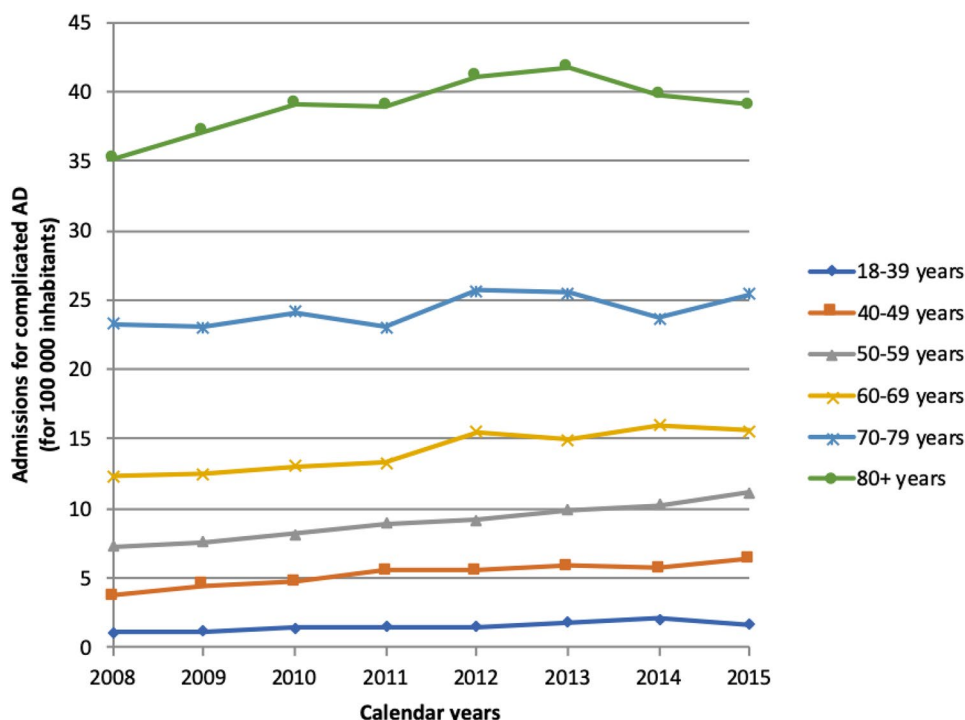
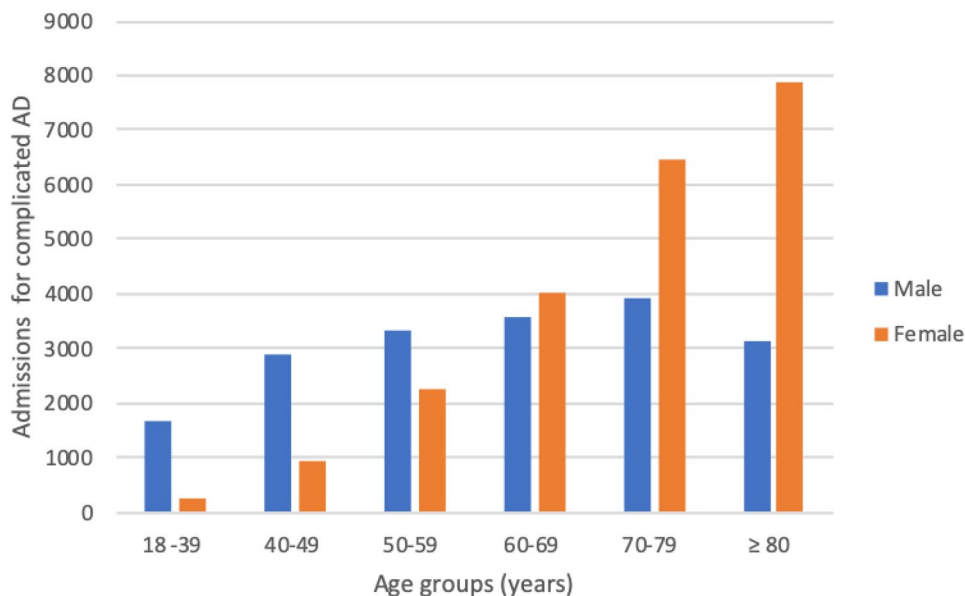


Fig. 3 Hospitalization for complicated acute diverticulitis (AD) in age categories, stratified by sex



female predominance in the over 60 years group ($p < 0.001$) (Fig. 3).

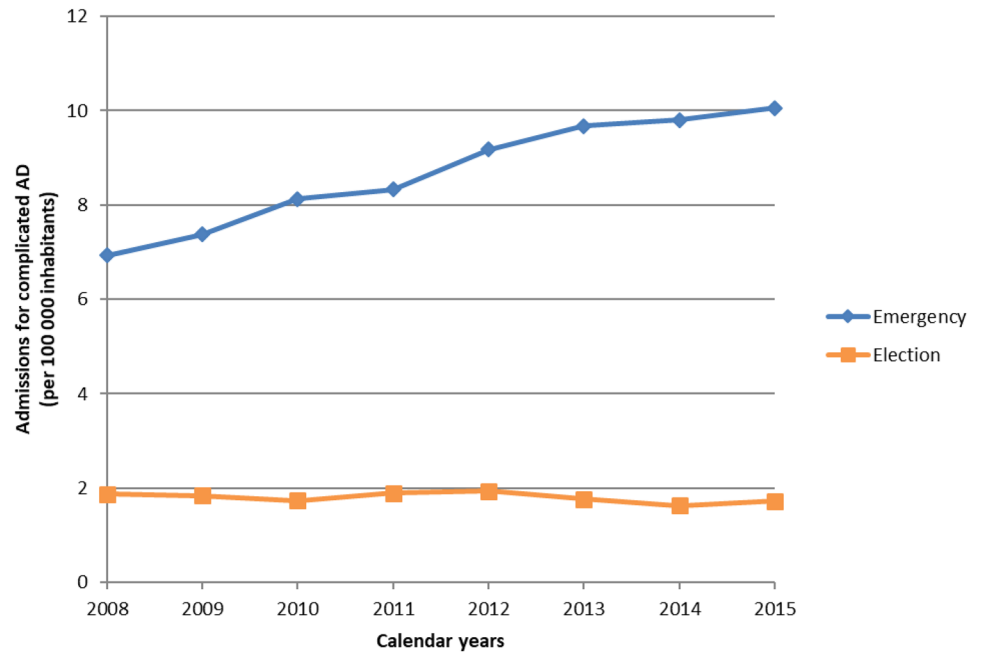
Rate of surgery with respect to urgent or elective admission

Clinical management is summarized in Table 1. In patients with complicated AD the chance of emergency admission was fourfold higher than elective hospitalization. There

was no significant change in the rate of elective hospitalizations in the study period, whereas the number of emergency admissions increased from 3370 in 2008 to 5101 in 2015 with a cumulative increase of 51.4% and a rising admission rate from 6.9 to 10.1 per 100,000 inhabitants ($p < 0.001$) (Fig. 4).

Most patients (54.9%) with complicated AD had surgery (Table 1), 51.8% after emergency admission and 70.8% after elective admission. From 2009 to 2015, no significant

Fig. 4 Type of hospitalizations for complicated acute diverticulitis (AD)



difference was found in the number of patients with complicated AD having surgery. The rate of emergency surgical treatment for complicated AD showed a 3.9 per 100,000 inhabitants annual increase ($p < 0.01$), whilst rates of operation remained stable among electively admitted patients (Fig. 5). During the study period, the cumulative number of in-hospital days was 569,628, with a mean length of stay of 13.7 ± 11.8 days (median 10 days), representing almost half of the whole burden of AD consisting of 1,114,593 days with a mean length of stay of 9.7 ± 8.9 days (median 8 days).

Trend of AD complications

A total number of 50,091 complications of AD were recorded, a single complication in 33,398 (80.2%) patients and two or more complications in 8224 (19.8%) cases. The most frequent complication registered at the index admission was peritonitis (17,811, 35.5%), followed by obstruction (11,068, 22.1%) and perforation (10,712, 21.4%). Less frequently, fistula (2511, 5.0%), abscess (2143, 4.3%) and sepsis (760, 1.5%) were reported (Table 2).

Fig. 5 Trend of surgery for complicated acute diverticulitis (AD) according to type of hospitalization (emergent vs elective)

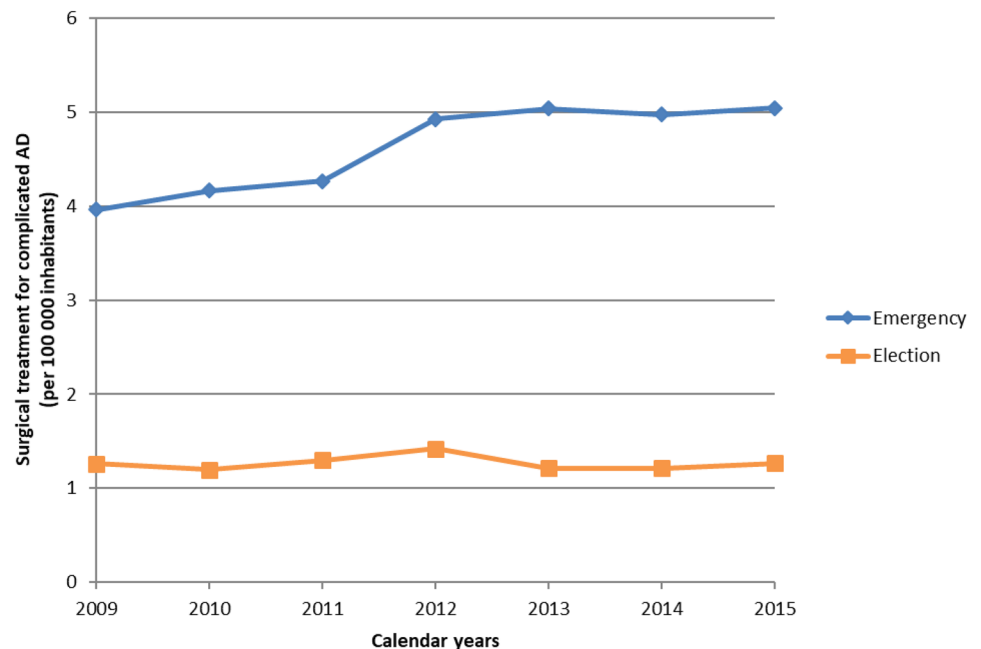


Table 2 Type of complications in patients admitted for complicated AD

Clinical variable	No. of admissions
Type of complications (total complications: 50,091)	
Peritonitis (%)	17,811 (35.6)
Obstruction (%)	11,068 (22.1)
Perforation (%)	10,712 (21.4)
Bleeding (%)	5086 (10.2)
Abscess (%)	2143 (4.3)
Fistula (%)	2511 (5)
Sepsis or septic shock (%)	760 (1.5)

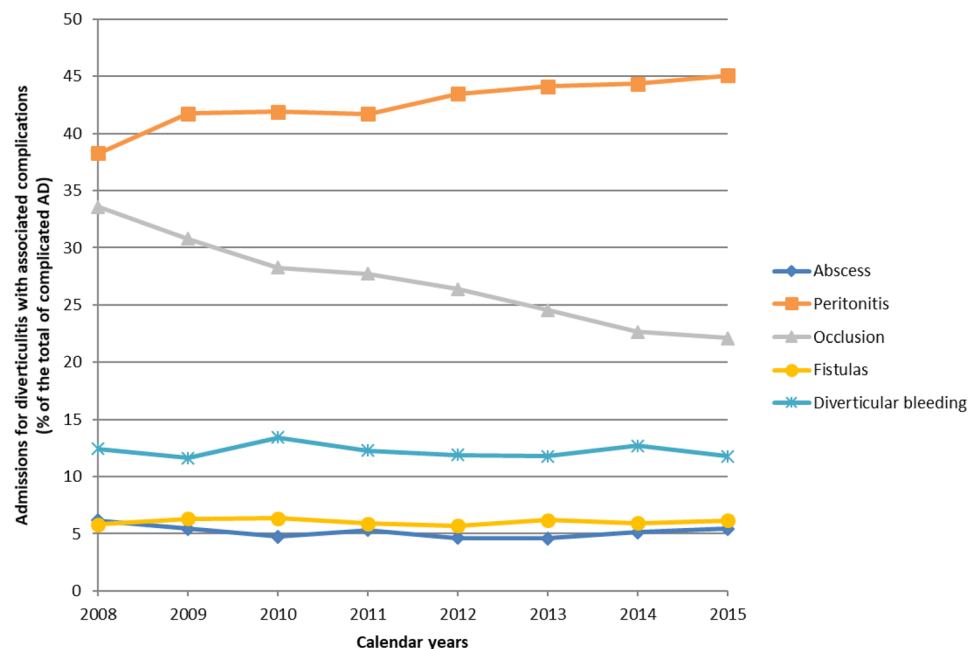
The incidence of peritonitis increased by 64.4% ($p < 0.001$) from 1638 cases in 2008 to 2693 in 2015. The diagnosis of peritonitis was frequently associated with other ICD complication codes, mainly intestinal perforation (28.5%) and sepsis or septic shock (4.2%).

From 2009 to 2015, 26.2% of AD patients with peritonitis were surgically treated, rising from 415 in 2009 to 813 in 2015 and the annual rate of surgery for peritonitis increased from 22.02 to 30.19% with a mean annual increase of 5.1% ($p < 0.001$).

Intestinal obstruction was reported in 11,068 hospitalizations without any significant change in incidence during the study period, ranging from 1436 admissions in 2008 to 1320 in 2015.

From 2009 to 2015, 58.2% of patients with intestinal obstruction had surgery, and reduced from 842 in 2009 to 721 cases in 2015, a mean annual decrease of 1.8% ($p = 0.009$).

Fig. 6 Trends of hospitalizations for acute diverticulitis (AD) with associated peritonitis, abscess, intestinal occlusion, fistula and diverticular bleeding



Colonic fistula was reported in 2511 patients, with an increase of 47.98% from 2008 (248 admissions) to 2015 (367 admissions) ($p < 0.001$). Colonic fistula was operated on in 281 cases with a mean annual decrease of 4.8% ($p = 0.140$).

Peritoneal abscess was reported in 2143 patients, with an increase of 23.1% from 2008 (264 admissions) to 2015 (325 admissions) ($p > 0.05$). Surgical treatment was required in 997 patients with abscess, the annual rate rising from 43.27 to 62.77% of abscess presentations, with a mean annual increase of 5.8% ($p < 0.001$).

Sepsis or septic shock were coded in few cases (760 admission, 1.5%), all of them associated with peritonitis.

Diverticular bleeding was diagnosed in 5086 (10.2%) cases and the incidence of diverticular bleeding rose by 32.14%, from 532 admissions in 2008 to 703 in 2015. Two hundred-fifty patients were operatively managed for bleeding with an annual rate that increased from 20 to 69% ($p = 0.126$).

The temporal trend of the relative rate of each complication of AD is given in Fig. 6.

Discussion

In this study we investigated the whole burden of hospitalization due to any complications of diverticular disease. In an earlier study we reported that in Italy between 2008 and 2015 the hospital admission rate for AD increased by 30% [5]. The current study shows that the increasing temporal trend of hospitalization for complicated diverticulitis (39.6%) was significantly higher than for all AD or for

uncomplicated diverticulitis (26.5%). These findings could be the result of an increasing incidence of complicated diverticulitis combined with a higher threshold for hospitalization of individuals with uncomplicated disease [9]. Similarly, a nationwide cohort study on the entire Danish population from 2000 to 2014 found a significant increase in the admission rate for complicated diverticulitis of 42.7% [10]. In our study at least one complication was reported in 23.9% of cases of AD. An international retrospective longitudinal 7-year study on unplanned admissions for AD registered a percentage of complicated diverticulitis of 32.4%, 25.2% and 24.3% in the USA, England and Australia, respectively [11], whereas uncomplicated diverticulitis accounted for 83–88% of all admissions in Denmark [10]. However, in the aforementioned studies the inclusion criteria often filtered out diverticular bleeding and potentially missed fistula or obstruction.

An increased incidence of perforated diverticulitis with increasing age in both sexes has been reported [12]. We documented that the rate of hospital admission for complicated diverticulitis was higher in individuals > 80 years of age, but significantly increased over the study period in all age groups. As we previously reported, in the same years the rate of hospitalization for AD was stable in patients over 70 years [5], and these findings suggest that AD is more often complicated in this age group.

Similarly to Morris et al. in a series of patients with perforated diverticulitis, we found a slight predominance of complicated diverticulitis in females with a female to male ratio of 1.1:1 [12]. Hong and colleagues reported a male predominance in Australia and a female predominance in the USA and England [11]. In accordance with data about AD previously reported in the literature, we found that complicated AD is male predominant in the younger patients and female predominant in the elderly; thus the mean age of the population could influence the overall sex distribution [2, 4, 5, 13].

Roughly four-fifths of patients were emergently admitted and a similar figure was reported in a study on the management of AD in USA in the past decade (78.3% emergent admissions) [14]. Kang et al. examined hospital admissions for diverticular disease in the English National Health Service, finding that operation rates increased significantly by 16.3% for males and by 13.5% for females [15]. Conversely, subsequent studies by Ricciardi et al. and Lamm et al. reported a significant decline in the number of patients receiving emergent surgery for complicated diverticulitis, (71–55.5% and from 58 to 47%, respectively), reflecting a gradual shift towards more conservative management of acute complications [16, 17]. These figures are comparable with our finding of 51.8% of surgical procedures among emergent admissions while Hong et al. reported a surgical intervention rate of 32–45% [11]. Analyzing our cohort

of patients emergently admitted both for complicated and uncomplicated AD, we found 17.2% were treated surgically. Rose et al. reported that the management of the first episode was medical in 85.4% of cases and surgical in 14.6% of cases and Masoomi et al. stated that 12.2% of emergently admitted patients had surgery [14, 18]. Other studies reported an emergency surgery rate of 10–22% but data are difficult to compare due to the heterogeneity of the cohort [3, 11, 18–21]. Furthermore, the health system model can influence the threshold for surgery, since insured patients are more likely to undergo an emergency operation for acute diverticulitis than those without insurance [22].

Over the study period, we registered a significant increasing trend of 5.9% of the number of surgical procedures in the emergent setting and a greater increase of emergent admissions by 7.4%, resulting in a slight decrease in the proportion of patients who had surgery. Similarly, an analysis of the US National Inpatient Sample from 2002 to 2007 showed that the annual emergency admission rate for AD increased by 9.5% while in the same period there was a 4.3% increase of the annual rate of surgical resection [14]. We found that the annual rate of surgical treatment was stable among electively admitted patients and that there was a decreasing trend of hospitalization for these patients (by 6.7%). Therefore, in this group there was a not negligible increase in the proportion of surgically treated patients that, although it is less than the 38% reported by Masoomi et al. is quite surprising considering the growing evidence supporting more restricted indications for elective surgery [14, 23].

The most frequent complications at index episode were peritonitis, showing a significantly increasing temporal trend, as well as perforation. The same trend was reported by Talabani et al. for purulent peritonitis and Makela et al. for diverticular perforation, whereas Ricciardi et al. found that the absolute number of free perforations rose during the study period but the ratio with all diverticulitis remained stable [4, 16, 24]. In our study the overall increase in the peritonitis rate was double that of complicated diverticulitis. Like Talabani et al. we found that the rate of diverticular abscess significantly rose across the study period and the surgical treatment rate rose year by year while other authors reported that the percutaneous drainage increased 3.3 times over a 5-year period [4, 14]. There was a decreasing rate of hospitalization for diverticular bleeding in the USA during the past decade [25].

This study has some limitations. As a hospital-based study, the analysis does not include outpatients who were managed medically, those treated solely in primary care or who were not treated by any physician at all. This may be uncommon in complicated disease, but the number of cases of uncomplicated diverticulitis could be potentially underestimated. Furthermore, data were extracted from an administrative database which translates diagnoses and procedures

into alphanumeric codes that are prone to subjectivity, variability and errors that could jeopardized the homogeneity of patient groups [26].

Conclusions

We demonstrated a true increase in the overall burden of complicated diverticulitis during the study period, which accounts for almost half of the total number of hospitalization days for AD. The temporal trend of complications such as bleeding and abscess showed an absolute rise in the number of hospitalized patients. There was both a significantly increasing absolute number of admissions for AD with peritonitis / perforation and a rising proportion of peritonitis / perforation among cases of complicated AD. The rate of surgical treatment seems higher than expected, especially in the elective cohort and in some subsets of emergent admissions such as abscess and hemorrhage.

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Compliance with ethical standards.

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

Ethical approval This article does not contain any studies with human participants performed by any authors.

Informed consent This type of study does not required any formal consent.

References

- Jeyarajah S, Faiz O, Bottle A et al (2009) Diverticular disease hospital admissions are increasing, with poor outcomes in the elderly and emergency admissions. *Aliment Pharmacol Ther* 30:1171–1182
- Nguyen GC, Sam J, Anand N (2011) Epidemiological trends and geographic variation in hospital admissions for diverticulitis in the United States. *World J Gastroenterol* 17:1600–1605
- Paterson HM, Arnott ID, Nicholls RJ et al (2015) Diverticular disease in Scotland: 2000–2010. *Colorectal Dis* 17:329–334
- Talabani A, Lyndersens S, Endreseth BH, Edna TH (2014) Major increase in admission and incidence rates of acute colonic diverticulitis. *Int J Colorectal Dis* 29:937–945
- Binda GA, Mataloni F, Bruzzone M, Carabotti M, Cirocchi R, Nascimbeni R, Gambassi G, Amato A, Vettoretto N, Pinnarelli L, Cuomo R, Annibale B (2018) Trends in hospital admission for acute diverticulitis in Italy from 2008 to 2015. *Tech Coloproct* 22:597–604
- Lopez DE, Brown CV (2010) Diverticulitis: The most common colon emergency for the acute care surgeon. *Scand J Surg* 99:86–89
- Humes DJ, West J (2012) Role of acute diverticulitis in the development of complicated colonic diverticular disease and 1-year mortality after diagnosis in the UK: population-based cohort study. *Gut* 61(1):95–100
- StataCorp (2013) Stata statistical software: release 13. StataCorp LP, College Station, TX
- 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(1):38–44
- Hupfeld L, Pommegaard HC, Burcharth J, Rosenberg J (2018) Emergency admissions for complicated colonic diverticulitis are increasing: a nationwide register-based cohort study. *Int J Colorectal Dis* 33(7):879–886
- Hong MKY, Skandarajah AR, Higgins RD, Faiz OD, Hayes IP (2017) International variation in emergency operation rates for acute diverticulitis: insights into healthcare value. *World J Surg* 41:212–2127
- Morris CR, Harvey IM, Stebbings WSL, Hart AR (2008) Incidence of perforated diverticulitis and risk factors for death in a UK population. *Br J Surg* 95:876–881
- Broad JB, Wu Z, Xie S, Bissett IP, Connolly MJ (2019) Diverticular disease epidemiology: acute hospitalisations are growing fastest in young men. *Tech Coloproct* 23:713–721
- Masoomi H, Buchberg BS, Magno C, Mills SD, Stamos MJ (2011) Trends in Diverticulitis Management in the United States From 2002 to 2007. *Arch Surg* 146(4):400–406
- Kang JK, Hoare J, Tinto A, Subramanian S, Ellis C, Majeed A, Melville D, Maxwell JD (2003) Diverticular disease of the colon—on the rise: a study of hospital admissions in England between 1989/1990 and 1999/2000. *Aliment Pharmacol Ther* 17:1189–1195
- Ricciardi R, Baxter NN, Read TE, Marcello PW, Hall J, Roberts PL (2009) Is the decline in the surgical treatment for diverticulitis associated with an increase in complicated diverticulitis? *Dis Colon Rectum* 52:1558–1563
- Lamm R, Mathews SN, Yang J, Kang L, Telem D, Pryor AD, Talamini M, Genua J (2017) 20-Year trends in the management of diverticulitis across New York State: an analysis of 265,724 patients. *J Gastrointest Surg* 21:78–84
- Rose J, Parina RP, Faiz O, Chang DC, Talamini MA (2015) Long-term outcomes after initial presentation of diverticulitis. *Ann Surg* 262:1046–1053
- Li D, Baxter NN, McLeod RS et al (2014) Evolving practice patterns in the management of acute colonic diverticulitis: a population-based analysis. *Dis Colon Rectum* 57:1397–1405
- Vather R, Broad JB, Jaung R et al (2015) Demographics and trends in the acute presentation of diverticular disease: a national study. *ANZ J Surg* 85(10):744–748
- Salem L, Anaya DA, Flum DR (2005) Temporal changes in the management of diverticulitis. *J Surg Res* 124:318–323
- Mills AM, Holena DN, Kallan MJ et al (2013) Effect of insurance status on patients admitted for acute diverticulitis. *Colorectal Dis* 15:613–662
- Binda GA, Arezzo A, Serventi A, Bonelli L (2012) Multicentre observational study of the natural history of left-sided acute diverticulitis. *Br J Surg* 99:276–285
- Makela J, Kiviniemi H, Laitinen S (2002) Prevalence of perforated sigmoid diverticulitis is increasing. *Dis Colon Rectum* 45:955–961
- Wheat CL, Strate LL (2016) Trends in hospitalization for diverticulitis and diverticular bleeding in the United States from 2000 to 2010. *Clin Gastroenterol Hepatol* 14(1):96–103

26. Nouraei SAR, Hudovsky A, Frampton AE, Mufti U, White NB et al (2015) A study of clinical coding accuracy in surgery: Implications for the use of administrative big data for outcomes management. *Ann Surg* 261(6):1096–1107

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