Surgical outcomes and risk factors affecting morbidity and mortality in patients undergoing emergency colorectal surgery

Abd-El-Aal A. Saleem, Ahmed G. Mahmoud, Mena Z. Helmy

Department of General Surgery, Faculty of Medicine, Sohag University, Sohag, Egypt

Correspondence to Abd-El-Aal A. Saleem, MD, Assistant Professor, Department of General Surgery, Faculty of Medicine, Sohag University, Sohag 82511, Egypt.
Tel: +0932156820/01001203179;
e-mail: dr.abdelaal@yahoo.com

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Objective
Emergency colorectal surgery has high rates of morbidity and mortality because of incomplete bowel preparation and bacterial contamination. The aim was to evaluate the surgical outcomes and the risk factors affecting morbidity and mortality in patients who underwent emergency colorectal surgery to treat various complicated colorectal diseases in hope that the results would help lower the perioperative mortality and morbidity rates through alleviation of the identified risk factors.
Patients and methods
This was a prospective study of 50 patients who were admitted to the emergency Department of General Surgery in Sohag University Hospital. The study analyzed the surgical outcomes and risk factors in patients with emergency colorectal diseases who were found in need for emergency colorectal surgery within 24 h. Data were collected for each patient by us and our residents in the emergency department of general surgery. The collected data included the preoperative, intraoperative, and postoperative parameters.
Results
This was a prospective study of 50 patients who underwent emergency colorectal surgery in the Emergency Department of Sohag University Hospital. The data of these studied patients were as follows: 29 (58%) males and 21 (42%) females, with a mean age of 68.92 ± 9.73 years. Perforation (40.0%) was the commonest indication of surgery. Sigmoid colon was the commonest site of lesions (32%). Malignancy was the commonest cause of diseases (28%). Hartmann's procedure was the commonest operation done (50%). Regarding univariate analysis, age more than or equal to 70 years old, presence of two or more comorbidities, preoperative hypotension, the more the grade of American Society of Anesthesiologist (ASA) score (grades III and IV), perioperative blood transfusion, operative time more than or equal to 170 min, and ischemic colitis were significantly associated with major morbidity [Clavien-Dindo classification grade III or more=23 (46%) patients] and mortality [11 (22%) patients]. With respect to multivariate analysis, age group more than or equal to 70 years, presence of two or more comorbidities, preoperative hypotension, ASA classification grade IV, perioperative blood transfusion, and ischemic colitis were identified as independent risk factors for both major morbidity and mortality.
Conclusion
In this study, emergency colorectal surgery showed relatively high morbidity and mortality rates. Furthermore, the independent risk factors for major morbidity and mortality were age group more than or equal to 70 years, presence of two or more comorbidities, preoperative hypotension, ASA classification grade IV, perioperative blood transfusion, and ischemic colitis. Thus, patients with these characteristics need to be evaluated more carefully and receive better care if the morbidity and mortality rates are needed to be reduced.

Keywords:
colorectal surgery, emergency, morbidity, mortality, outcome

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Introduction

Recently, owing to the aging of society and the Westernization of dietary behaviors, the number of cases involving not only colorectal cancer but also benign colorectal diseases, such as ischemic bowel disease and diverticulitis, has been increasing [1]. For colorectal emergency surgeries, many studies have estimated the overall mortality and complication rates (morbidity) in patients who received emergency colorectal resections to be 10–25 and 30–50%, respectively, depending on the underlying pathology, timing of presentation (early or

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late), and the associated comorbidities (cardiovascular, respiratory, metabolic, infectious, or obesity-related comorbidities). These factors substantially increase the incidence of mortality. Moreover, emergency presentation is regarded as an independent risk factor for postoperative mortality and morbidity [2]. The proportions of patients with colorectal cancer who were associated with intestinal obstruction or perforation not receiving timely treatment have been reported to be 8–29 and 3–8%, respectively. Despite the recent development of antibiotics and conservative treatment being used for benign diseases including diverticulitis and ischemic bowel disease, surgery is still considered to be an important treatment modality for patients with severe peritoneal contamination or severe sepsis [3,4]. Owing to recent improvements in diagnostic methods such as abdominal computed tomography and colonoscopy, the average treatment outcome continues to improve [5]. However, various benign colon diseases are often diagnosed and treated when complications such as perforation and obstruction occur. In such cases, emergency surgery is usually required, and the morbidity and mortality rates are high owing to the performance of the emergency surgery itself, incomplete bowel preparation, bacterial proliferation, and contamination [6]. This research study aims to identify risk factors and outcomes of patients who underwent emergency surgery to treat complicated colorectal diseases in hope that the results would help lower the perioperative mortality and morbidity rates through alleviation of identified risk factors.

Aim

The aim was to identify the risk factors for morbidity and mortality in patients who underwent emergency surgery to treat various complicated colorectal diseases and their outcome in hope that the results would be helpful for lowering the perioperative mortality and morbidity rates through alleviation of identified risk factors.

Patients and methods

Study design

This prospective study was conducted at the Emergency Department of general surgery in Sohag University Hospital in the period from December 1, 2020 to November 30, 2021.

Ethics approval and consent to participate

The Institutional Review Board approved this study, and informed written consent was taken from all participants or their legal guardians. Ethical approval was obtained from the medical research ethics committee under IBR Registration number: S20-165.

Study population

This prospective study was conducted on 50 patients of both sexes of any age having emergency colorectal diseases. They were admitted to the emergency department of general surgery in Sohag University Hospital in the period from December 1, 2020 to November 30, 2021. Surgical outcomes and risk factors were analyzed for patients who were found in need of emergency colorectal surgery within 24 h. All patients underwent emergency colorectal surgery under general anesthesia. Data were collected for each patient by the authors and residents in the emergency department of general surgery. The collected data included the following:

(1) The preoperative data included sociodemographic data in the form of age (<70 and ≥70 years), sex, occupation, special habits, and residence; general examination; local examination; vital signs (pulse, blood pressure, temperature, and respiratory rate), especially hypotension (defined as a systolic blood pressure of ≤90 mmHg); and comorbidities (0=no underlying disease, 1=one underlying disease, and >2=two or more underlying diseases) [hypertension, diabetes, chronic obstructive pulmonary disease, end-stage renal disease, BMI ≥35 kg/m^2, and cerebrovascular stroke (accident), liver cirrhosis, and severe cardiac disease]. All patients were investigated regarding (a) laboratory data, such as complete blood count [white blood cell (WBC) count [10^3/μl (<4.0, 4.0–10.0, and >10)], kidney and liver functions, coagulation profile, serum sodium, potassium, amylase, lipase, and blood sugar levels; (b) radiologically, such as chest radiograph, radiograph abdomen and pelvis (erect and supine positions), pelvi-abdominal ultrasound, pelvi-abdominal computed tomography, and colonoscopy. In addition, a survey was conducted using the American Society of Anesthesiologist classification score (ASA score) [7]; the score is based on the physical condition of patients undergoing the surgery and anesthesia.
   ASA PS classification grade [7] is as follows:
   ASA 1: a normal healthy patient.
   ASA 2: a patient with mild systemic disease.
   ASA 3: a patient with a severe systemic disease that is not life-threatening.
   ASA 4: a patient with a severe systemic disease that is a constant threat to life.
   ASA 5: a moribund patient who is not expected to survive without the operation. The patient is not expected to survive beyond the next 24 h without surgery.
(2) Intraoperative parameters included the indications for surgery (perforation, obstruction, ischemic colitis, and megacolon), the operating surgeon (trainee, general surgeon, or colorectal surgeon),

location of lesions (cecum, ascending colon, transverse colon, descending colon, sigmoid colon, rectum, or whole colon), types of surgery [diversion only (Stoma), primary repair without diversion, resection with primary anastomosis with proximal diversion, resection with primary anastomosis without diversion, and Hartmann's operation], amount of blood transfused (perioperative blood transfusion), and operative time (<170 or ≥170 min). All of these data were recorded and evaluated.

(3) Postoperative parameters included postoperative complications (wound infection, wound dehiscence, intestinal obstruction, intra-abdominal sepsis, pneumonia, pulmonary embolism, intra-abdominal hemorrhage, re-exploration, and acute renal failure), length of hospital stay (in days), and surgical outcome, where overall morbidity according to the Clavien-Dindo classification [8] (severe pneumonia, sepsis, renal failure, hemorrhage, and pulmonary embolism) and mortality (operative death was defined as death occurring while in the hospital following surgery) were recorded. The etiology was recorded as colorectal cancer, diverticulitis, obstruction owing to impacted feces or other causes, ischemic colitis, volvulus, and megacolon.

The Clavien-Dindo classification [8]

The therapy used to correct a specific complication is the basis of this classification to rank a complication in an objective and reproducible manner.

It consists of five grades (I, II, III, IV, and V). The introduction of the subclasses a and b allows the classification into seven grades (I, II, IIIa, IIIb, IVa, IVb, and V) depending on the size of the population observed or the focus of a study.

Complications that have the potential for long-lasting disability after a patient is discharged (e.g. paralysis of a voice cord after thyroid surgery) are highlighted in the present classification by a suffix 'd,' for disability. This suffix indicates that a follow-up is required to comprehensively evaluate the outcome and related long-term quality of life.

Grades	Definition
Grade I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions Allowed therapeutic regimens are drugs such as antiemetics, antipyretics, analgesics, diuretics and electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside
Grade II	Requiring pharmacological treatment with drugs other than those allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included
Grade III	Requiring surgical, endoscopic, or radiological intervention
Grade IIIa	Intervention not under general anesthesia
Grade IIIb	Intervention under general anesthesia
Grade IV	Life-threatening complications (including central nervous system complications)a requiring IC/ICU management
Grade IVa	Single organ dysfunction (including dialysis)
Grade IVb	Multiorgan dysfunction
Grade V	Death of a patient

[a]Brain hemorrhage, ischemic stroke, subarachnoid bleeding, but excluding transient ischemic attacks.

Statistical analysis

Data were analyzed using STATA version 14.2 (Stata Statistical Software: Release 14.2; StataCorp LP, College Station, Texas, USA). Quantitative data were represented as mean, SD, median, and range. Qualitative data were presented as numbers and percentages and compared using either χ^2 test or Fisher exact test. Odds ratios were obtained from logistic regression analysis. Graphs were produced using the Excel program. *P* value was considered significant if it was less than 0.05.

Results

This was a prospective study on 50 patients who underwent emergency colorectal surgery in the emergency department of general surgery in Sohag University Hospital. The preoperative data of these studied patients were as follows: 29 (58%) males and 21 (42%) females, with a mean age of 68.92 ± 9.73 years. Regarding comorbidities, 22 (44%) patients had two or more comorbid diseases, 14 (28%) patients had one disease, and also 14 (28%) patients had no comorbid disease. Hypertension was the commonest comorbid disease involving 22 (44%) patients, followed by diabetes mellitus in 16 (32%) patients and then heart diseases in 14 (28%) patients. Of 50 patients, 19 had preoperative hypotension. A total of 32 (64%) patients had white blood cell count more than or equal to 10^3/μl, 12 (24%) patients had WBC count from 4 to 10^3/μl, and lastly, six (12%) patients had WBC count less than less than 4×10^3/μl. Regarding ASA classifications, eight (16%) patients ranked as grade I, 13 (26%) as grade II, 15 (30%) as grade III, and lastly, 14 (28%) as grade IV, as shown in Table 1 and Figs 1 and 2.

Concerning the indications of surgery, 20 (40%) patients had peritonitis owing to perforation, followed by intestinal obstruction [which may be due to malignancy, bands, adhesions, fecal impaction, and volvulus], then ischemic colitis, and lastly, megacolon. Regarding qualification of surgeons, 22 (44%) patients underwent surgery by colorectal surgeons, 21 (42%) patients were operated by a general surgeon, and seven

(14%) by a trainee (resident). Respecting the location of the diseases, the sigmoid colon was the commonest affected site by lesions (32%), followed by the rectum (20%), descending colon (18%), cecum (16%), ascending colon (8%), and lastly, transverse colon (6%). A total of 27 (54%) patients received a perioperative blood transfusion. Hartmann's procedure was the most common surgical technique employed, followed by resection with primary anastomosis without diversion. Regarding the operative time, 30 (60%) patients had operative time more than or equal to 170 min, whereas the other 20 (40%) patients had operative time less than or equal to 170 min, with a mean±SD of 164.12 ± 22.17, as shown in Table 2 and Figs 3 and 4.

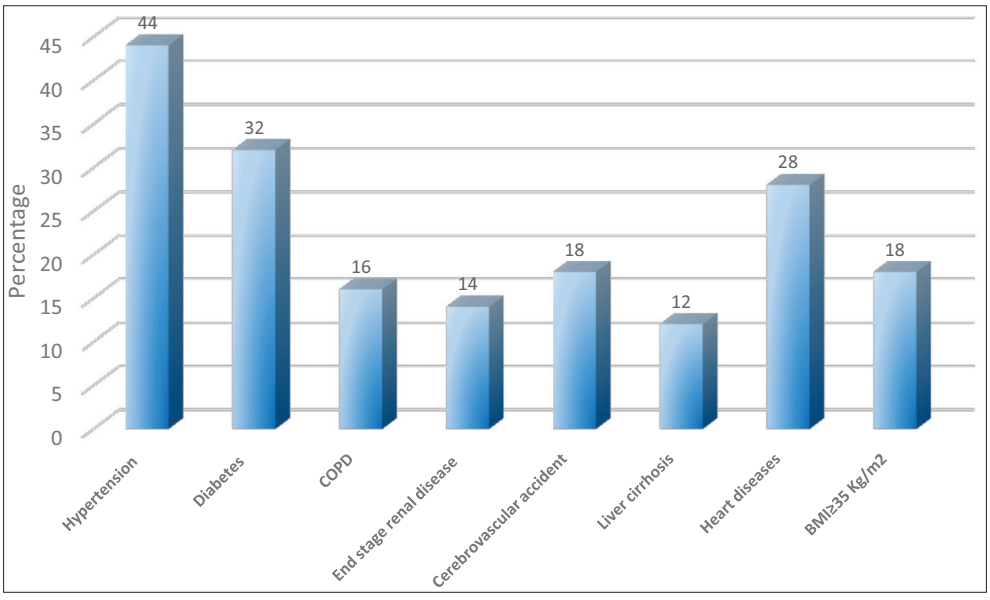
Table 1 Preoperative data of studied population

Variables	Summary statistic [*n* (%)]
Age (years)	
Mean±SD	68.92 ± 9.73
Median (range)	70.5 (38–85)
Age group (years)	
<70	21 (42.00)
≥70	29 (58.00)
Sex	
Female	21 (42.00)
Male	29 (58.00)
Hypertension	22 (44.00)
Diabetes	16 (32.00)
COPD	8 (16.00)
End-stage renal disease	7 (14.00)
Cerebrovascular accident	4 (18.00)
Liver cirrhosis	6 (12.00)
Heart diseases	14 (28.00)
BMI≥35 (kg/m^2)	9 (18.00)
Number of comorbidity	
None	14 (28.00)
One	14 (28.00)
Two or more	22 (44.00)
Preoperative hypotension	19 (38.00)
WBC count (10^3/μl)	
<4	6 (12.00)
4–10	12 (24.00)
≥10	32 (64.00)
ASA classifications	
I	8 (16.00)
II	13 (26.00)
III	15 (30.00)
IV	14 (28.00)

ASA, American Society of Anesthesiologist; COPD, chronic obstructive pulmonary disease; WBC, white blood cell.

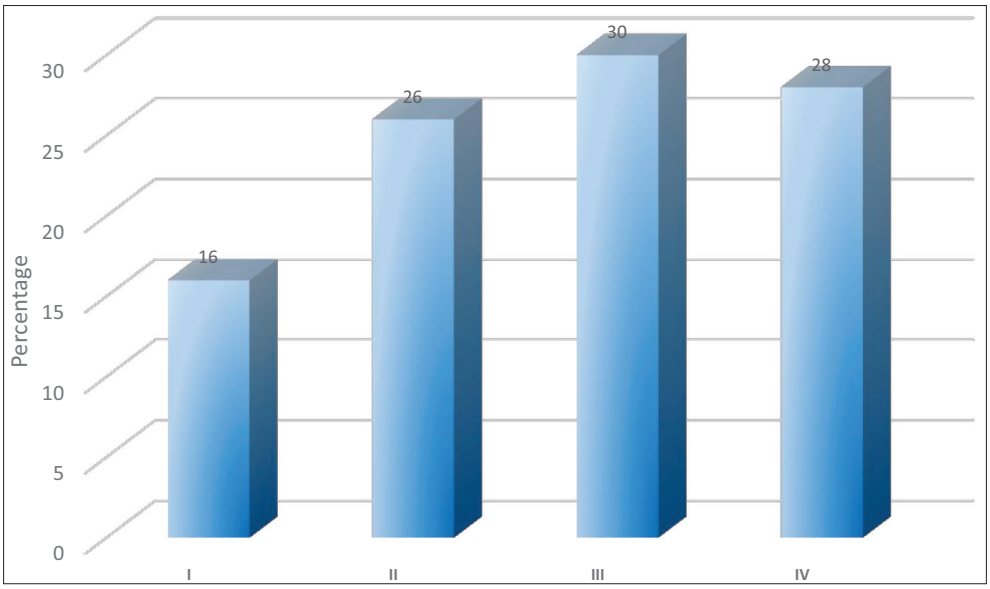
Regarding major complications affecting the morbidity and mortality rates, nine (18%) patients required urgent dialysis owing to acute renal failure, six (12%) patients had intra-abdominal sepsis, three (6%) patients had intra-abdominal hemorrhage, wound dehiscence occurred in four (8%) patients, and intestinal obstruction occurred in three (6%) patients. In addition, pneumonia and pulmonary embolism were occurred in eight (16%) and five (10%) patients, respectively. Moreover, eight (16%) had surgical site infection. Re-exploration was done in 11 (22%) patients owing to intra-abdominal hemorrhage, intestinal obstruction, wound dehiscence, and in some patients owing to intra-abdominal sepsis. In this study, the patients were classified based on their complications according to the Clavien-Dindo classification scheme, where 15 ranked as grade I, 12 as grade II, seven as grade III, five as grade IV, and 11 patients as grade V. Grades III, IV, and V were considered as major morbidities, and 23 (46%) patients were affected with these grades. Regarding the cause of the disease, 14 (28%) patients had malignancy, 12 (24%) had diverticulitis, 11 (22%) had ischemic colitis, seven (14%) experienced stercoral (inflammatory colitis caused by increased intraluminal

Figure 1



Comorbidity of studied population.

Figure 2



Distribution of patients according to ASA classifications (grade). ASA, American Society of Anesthesiologist.

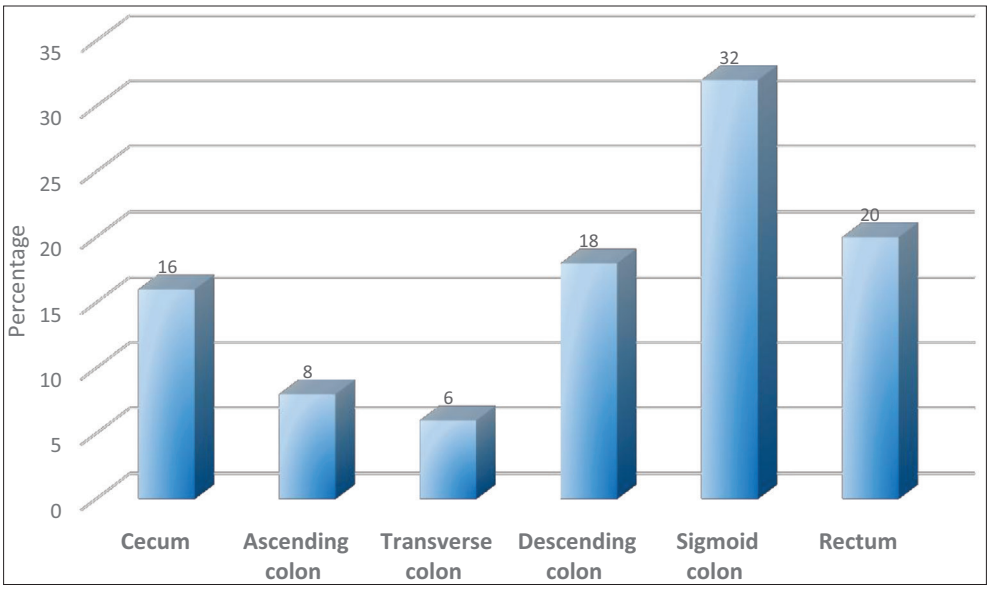
Table 2 Intraoperative data of studied population

Variables	Summary statistic [*n* (%)]
Indication of surgery	
Perforation	20 (40.00)
Obstruction	18 (36.00)
Ischemia	10 (20.00)
Megacolon	2 (4.00)
Qualification of surgeon	
Colorectal surgeon	22 (44.00)
General surgeon	21 (42.00)
Trainee (resident)	7 (14.00)
Location	
Cecum	8 (16.00)
Ascending colon	4 (8.00)
Transverse colon	3 (6.00)
Descending colon	9 (18.00)
Sigmoid colon	16 (32.00)
Rectum	10 (20.00)
Type of surgery	
Diversion only (stoma)	7 (14.00)
Primary repair without diversion	4 (8.00)
Resection with primary anastomosis with proximal diversion	3 (6.00)
Resection with primary anastomosis without diversion	11 (22.00)
Hartmann's operation	25 (50.00)
Perioperative blood transfusion	
No	23 (46.00)
Yes	27 (54.00)
Operative time	
Mean±SD	164.12±22.17
Median (range)	170 (110–200)
Operative time	
<170 min	20 (40.00)
≥170 min	30 (60.00)

pressure from impacted fecal material in the colonic segments causing intestinal obstruction), four (8%) had volvulus, and two (4%) had megacolon. The mean length of hospital stay was 13.26±4.84. A total of 11 (22%) patients died in the hospital following surgery, as shown in Table 3 and Figs 5–8.

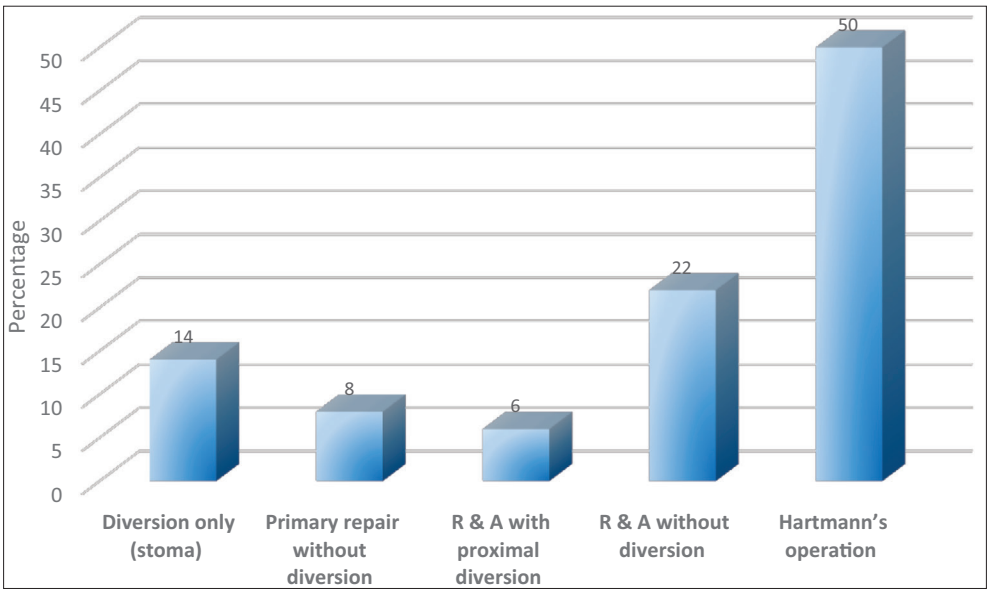
Regarding univariate analysis of factors related to Clavien-Dindo classification (morbidity) and mortality during the hospital stay, the results showed that patients more than or equal to 70 years of age showed a higher rate of morbidity (P<0.0001) and mortality (P=0.02), patients were having two or more comorbid diseases displayed a higher rate of morbidity (P<0.0001) and mortality (P<0.0001), and also those patients who had preoperative hypotension had a higher rate of morbidity (P=0.002) and mortality (P<0.0001). It was observed that the higher the ASA score grades, the higher the rate of morbidity (P=0.01) and mortality (P=0.001). Regarding indications of surgery, only patients experiencing ischemia had a higher rate of mortality (P=0.03). Patients who received perioperative blood transfusion displayed a higher rate of morbidity (P<0.0001) and mortality (P=0.001). Operative time more than or equal to 170 min had a higher rate of morbidity (P=0.02) and mortality (P=0.03), and also patients with ischemic colitis had a higher rate of morbidity (P=0.04) and mortality (P=0.048). The net result is that the age equal to or more than 70 years old, presence of two or more comorbidities, preoperative hypotension, the more the grade of ASA score, perioperative blood transfusion, operative time more than or equal to 170 min, and ischemic colitis were significantly associated with major morbidity (Clavien-Dindo classification grade III or more) and mortality. However, sex, WBC count (10^3/μl), indication of surgery (perforation, obstruction, and megacolon), qualification of the surgeons, location, type of surgery, and etiology (malignancy, diverticulitis,

Figure 3



Distribution of patients according to location of the diseases.

Figure 4



Distribution of patients according to type of surgery.

volvulus, stercoral, and megacolon) were insignificantly associated with major morbidity (Clavien-Dindo classification grade III or more) and mortality, as shown in Table 4.

Regarding the multivariate analysis of factors related to Clavien-Dindo classification (morbidity) (using logistic regression analysis), age group (≥70 years), number of comorbidities (two or more), preoperative hypotension, ASA classifications (grades III and IV) and ischemic colitis were identified as independent predictors for morbidity using the Clavien-Dindo classification, as shown in Table 5.

With respect to the multivariate analysis of factors related to mortality (using logistic regression analysis), age group (≥70 years), numbers of comorbidities (two or more), preoperative hypotension, ASA classifications (grade IV), perioperative blood transfusion, and ischemic colitis were identified as independent predictors for mortality, as shown in Table 6.

Discussion

Results of previous studies for patients who underwent emergency colorectal surgery for various reasons showed mortality and morbidity rates of 10–25% and

30–50%, respectively [1]. In our study, the results for patients who underwent emergency colorectal surgery for various reasons showed mortality and morbidity (Clavien-Dindo classification grade III or more) rates of 22 and 46%, respectively.

Table 3 Postoperative data of studied population

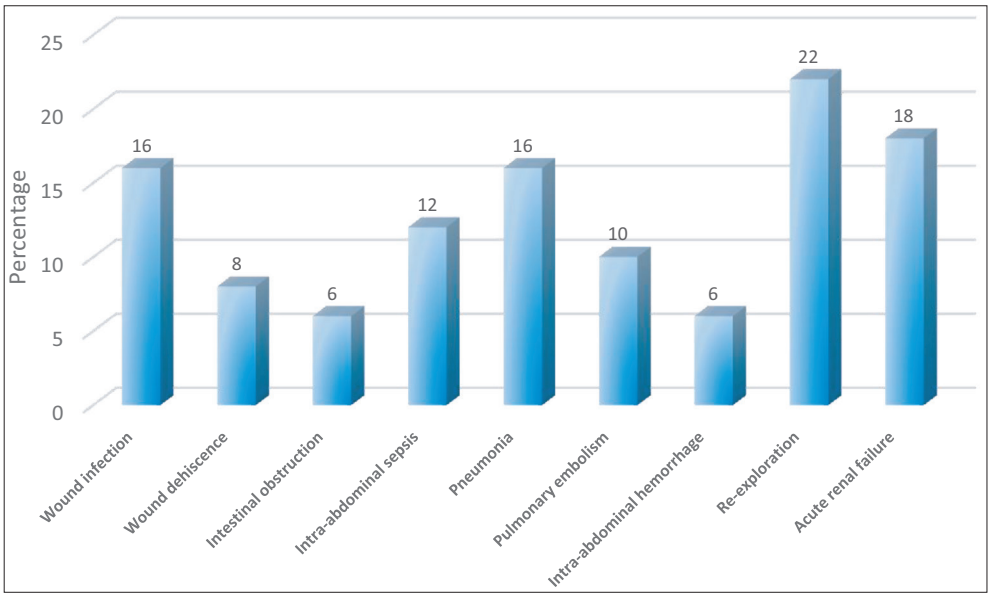
Variables	Summary statistic [*n* (%)]
Postoperative complication	
Wound infection (surgical site infection)	8 (16.00)
Wound dehiscence	4 (8.00)
Intestinal obstruction	3 (6.00)
Intra-abdominal sepsis	6 (12.00)
Pneumonia	8 (16.00)
Pulmonary embolism	5 (10.00)
Intra-abdominal hemorrhage	3 (6.00)
Re-exploration	11 (22.00)
Acute renal failure	9 (18.00)
Clavien-Dindo classification (morbidity)	
Grade I	15 (30.00)
Grade II	12 (24.00%)
Grade IIIa	5 (10.00)
Grade IIIb	2 (4.00)
Grade IVa	3 (6.00)
Grade IVb	2 (4.00)
Grade V	11 (22.00)
Etiology of the disease	
Malignancy	14 (28.00)
Diverticulitis	12 (24.00)
Ischemic colitis	11 (22.00)
Volvulus	4 (8.00)
Stercoral colitis	7 (14.00)
Megacolon	2 (4.00)
Length of hospital stay (in days)	
Mean±SD	13.26±4.84
Median (range)	14 (3–23)
Mortality	
No	39 (78.00)
Yes	11 (22.00)

Regarding age, studies have reported that the univariate analysis identified age older than 70 years to be associated with a high mortality rate after emergency surgery, but the multivariate analysis did not identify old age as an independent factor associated with mortality [9]. Another study found that mortality and morbidity increased with age because of low physiological reserve and pre-existing comorbidities, which affected patient outcomes [10]. Other researchers also observed that older patients aged over 60 years who undergo colorectal surgery have numerous factors that are associated with high rates of mortality and morbidity, especially in emergency settings [11]. In our presentation, univariate analysis showed that patients more than or equal to 70 years of age showed a higher rate of morbidity (P<0.0001) and mortality (P=0.02), and also multivariate analysis identified that age group more than or equal to 70 years was an independent predictor for morbidity and mortality.

With respect to comorbidities, other studies found that the presence of comorbidities, including diabetes and chronic kidney disease, is widely known to be associated with the prognosis after surgery [12]. This concurs with our study, where patients who have two or more comorbid diseases displayed a higher rate of morbidity (P<0.0001) and mortality (P<0.0001).

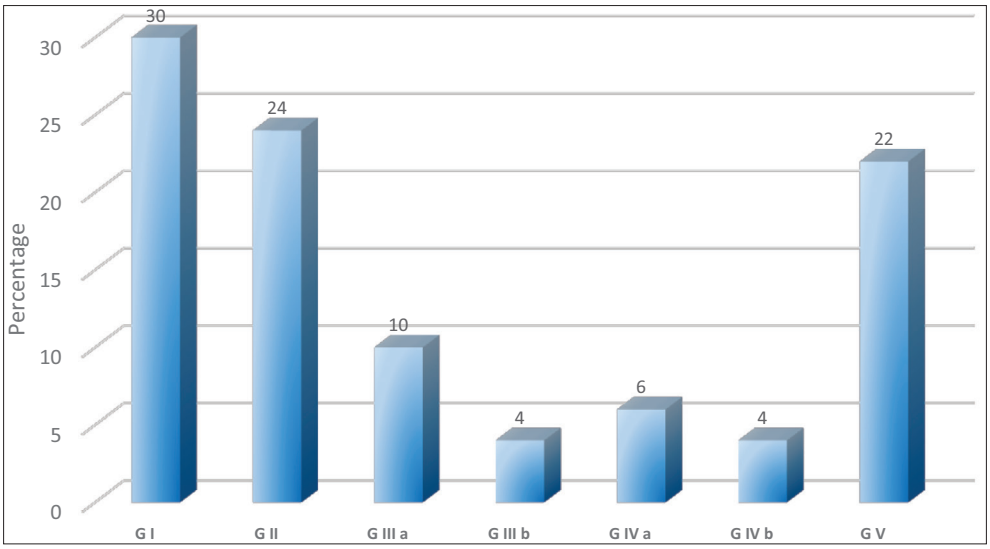
Regarding ASA score, other studies observed that in patients who underwent emergency colorectal surgery, the mortality rates differed from the ASA score. The higher the ASA score, the poorer the prognosis for the

Figure 5



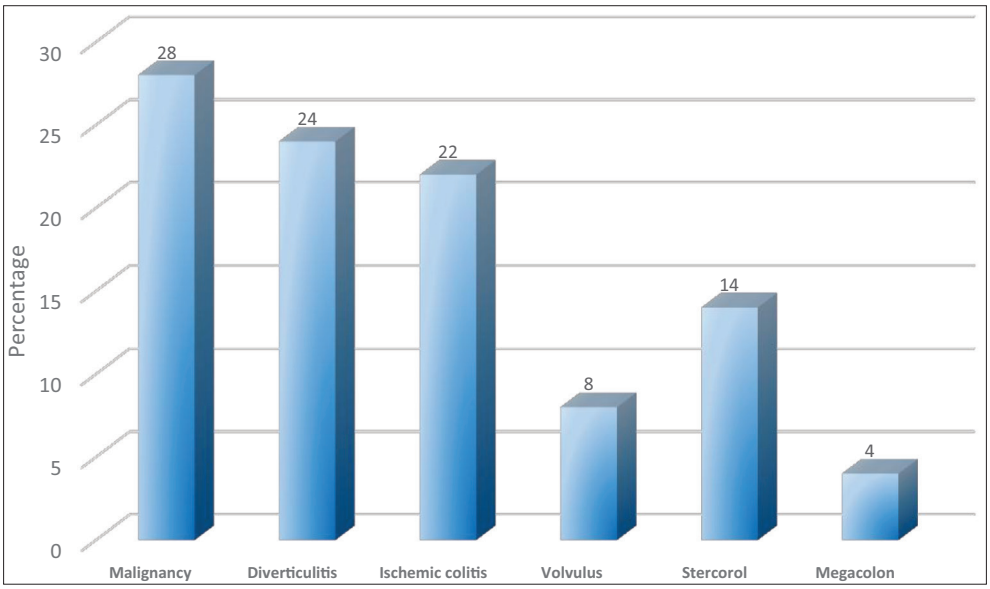
Distribution of patients according to postoperative complication.

Figure 6



Distribution of patients according to Clavien-Dindo classification (morbidity).

Figure 7

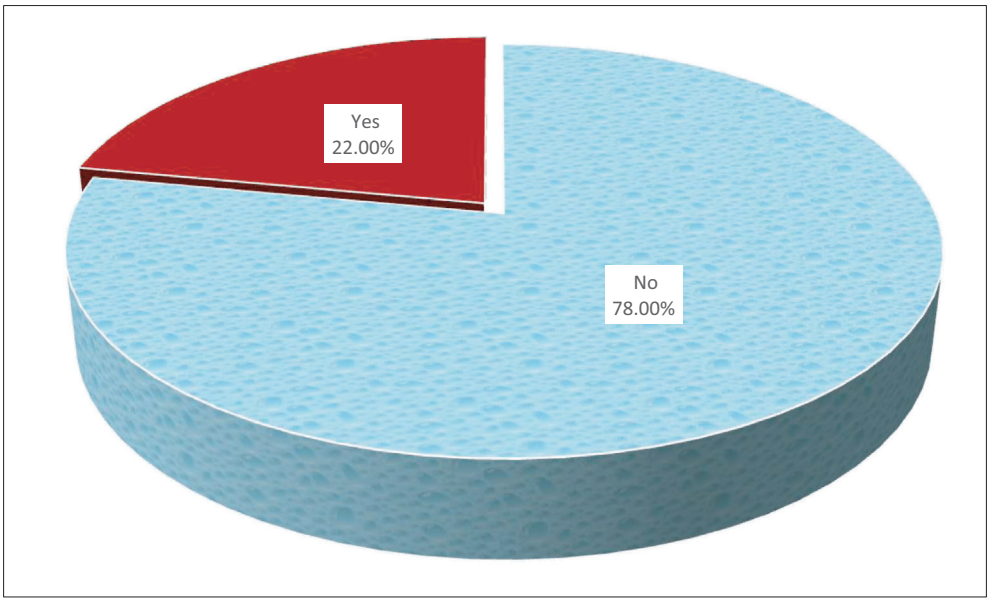


Etiology of disease of studied population.

patient. The ASA score was used to assess the physical condition of the patient as a predictor of patient outcome during and after surgery [12]. In addition, other studies observed that a higher preoperative ASA score was found to be associated with a poor prognosis [9]. More recently, a study by Soler *et al.* [13] showed that ASA in patients older than 75 years was a direct predictor of anastomotic leaks as well as strictly medical postoperative complications. In our presentation, it was observed that the higher the ASA score, the higher the rate of morbidity (P=0.01) and mortality (P=0.001). ASA classifications (grades III and IV) were identified as independent predictors for morbidity, and only grade IV was identified as an independent predictor for mortality.

Other researchers reported that the univariate analysis revealed that preoperative WBC count, preoperative hypotension, and blood transfusion were significant risk factors for major morbidity and that preoperative hypotension and blood transfusion were risk factors for mortality. However, in the multivariate analysis, only preoperative hypotension and blood transfusion were identified as independent significant factors for morbidity and mortality [14]. However, the study conducted by Post *et al.* [15] reported that intraoperative hypotension was found to be highly related to complications after colorectal surgery. Further observational studies have shown correlations between preoperative hemodynamic parameters (pulse pressure<53 and >62 mmHg) and increased

Figure 8



Distribution of patients according to mortality.

Table 4 Univariate analysis of factors related to Clavien-Dindo classification (morbidity) and mortality

Variables	Clavien-Dindo classification (morbidity) [*n* (%)]		Mortality	
	III or more	*P* value	Death	*P* value
Age group (years)				
<70	3 (14.29)	<0.0001	1 (4.76)	0.02
≥70	20 (68.97)		10 (34.48)	
Sex				
Female	8 (38.10)	0.34	4 (19.05)	0.74
Male	15 (51.72)		7 (24.14)	
Number of comorbidities				
None	0	<0.0001	0	<0.0001
One	4 (28.57)		0	
Two or more	19 (86.36)		11 (50.00)	
Preoperative hypotension				
No	9 (29.03)	0.002	1 (3.23)	<0.0001
Yes	14 (73.68)		10 (52.63)	
WBC count (10^3/μl)				
<4	2 (33.33)	0.71	2 (33.33)	0.72
4–10	5 (41.67)		2 (16.67)	
≥10	16 (50.00)		7 (21.88)	
ASA classifications (grade)				
I	0	0.01	0	0.001
II	5 (38.46)		0	
III	8 (53.33)		3 (20.00)	
IV	10 (71.43)		8 (22.00)	
Indication of surgery				
Perforation	10 (50.00)	0.64	4 (20.00)	1.00
Obstruction	6 (33.33)	0.18	2 (11.11)	0.29
Ischemia	7 (70.00)	0.09	5 (50.00)	0.03
Megacolon	0	0.49	0	1.00
Qualification of surgeon				
Colorectal surgeon	13 (59.09)	0.23	6 (27.27)	0.13
General surgeon	7 (33.33)		2 (9.52)	
Trainee (resident)	3 (42.86)		3 (42.86)	

Table 4 Continued

Variables	Clavien-Dindo classification (morbidity) [*n* (%)]		Mortality	
	III or more	*P* value	Death	*P* value
Location				
Cecum	4 (50.00)	0.39	0	0.10
Ascending colon	1 (25.00)		1 (25.00)	
Transverse colon	1 (33.33)		1 (33.33)	
Descending colon	7 (77.78)		5 (55.56)	
Sigmoid colon	6 (37.50)		3 (18.75)	
Rectum	4 (40.00)		1 (10.00)	
Type of surgery				
Diversion only (stoma)	4 (57.14)	0.86	1 (14.29)	0.44
Primary repair without diversion	1 (25.00)		0	
R&A with proximal diversion	1 (33.33)		0	
R&A without diversion	5 (45.45)		2 (18.18)	
Hartmann's operation	12 (48.00)		8 (32.00)	
Peri-operative blood transfusion				
No	4 (17.39)	<0.0001	0	0.001
Yes	19 (70.37)		11 (22.00)	
Operative time				
<170 min	5 (25.00)	0.02	1 (5.00)	0.03
≥170 min	18 (60.00)		10 (33.33)	
Etiology				
Malignancy	6 (42.86)	0.78	3 (21.43)	0.95
Diverticulitis	5 (41.67)	0.73	1 (8.33)	0.26
Ischemic colitis	8 (72.73)	0.04	5 (45.45)	0.048
Volvulus	0	0.054	0	0.56
Stercoral	4 (57.14)	0.52	2 (28.57)	0.64
Megacolon	0	0.18	0	1.00

ASA, American Society of Anesthesiologist; WBC, white blood cell. R&A=resection with primary anastomosis.

Table 5 Multivariate analysis of factors related to Clavien-Dindo classification (morbidity)

Variables	Adjusted odds ratio (95% CI)	*P* value
Age group (years)		
<70	1	0.001
≥70	8.77 (2.80:45.51)	
Number of comorbidities		
None/one	1	0.02
Two or more	19.50 (1.55–246.3)	
Preoperative hypotension		
No	1	0.002
Yes	5.84 (1.10–19.76)	
ASA classifications (grade)		
I/II	1	0.01
III	2.65 (1.07–18.63)	0.007
IV	7.99 (1.62–38.08)	
Peri-operative blood transfusion		
No	1	0.41
Yes	2.40 (0.30–19.25)	
Operative time		
<170 min	1	0.21
≥170 min	3.96 (0.47–33.58)	
Ischemic colitis		
No	1	0.01
Yes	3.49 (1.04–16.35)	

ASA, American Society of Anesthesiologist; CI, confidence interval.

postoperative morbidity and mortality [16]. Moreover, others found that the prognosis was not good for patients who experienced the symptoms of shock owing to preoperative hypotension [9]. In our study, univariate analysis revealed that patients who had preoperative hypotension had a higher rate of morbidity

Table 6 Multivariate analysis of factor related to mortality

Variables	Adjusted odds ratio (95% CI)	*P* value
Age group (years)		
<70	1	0.03
≥70	8.96 (1.34–81.56)	
Number of comorbidities		
None/one	Odds ratio cannot calculated as all deaths occur in patients with two or more comorbidities	
Two or more		
Preoperative hypotension		
No	1	0.04
Yes	13.24 (1.08–162)	
ASA classifications (grade)		
I/II/III	1	0.001
IV	12.69 (2.59–58.99)	
Perioperative blood transfusion		
No	Odds ratio cannot calculated as all deaths occur in patients with blood transfusion	
Yes		
Operative time		
<170 min	1	0.13
≥170 min	7.31 (0.56–95.68)	
Ischemic colitis		
No	1	0.04
Yes	3.58 (1.05–17.64)	

ASA, American Society of Anesthesiologist; CI, confidence interval.

(*P*=0.002) and mortality (*P*<0.0001) and also patients who received perioperative blood transfusion displayed a higher rate of morbidity (*P*<0.0001) and mortality (*P*=0.001), but WBC count (10^3/μl) was insignificantly associated with major morbidity (Clavien-Dindo classification grade III or more) and mortality. However, in the multivariate analysis, pre-operative hypotension and peri-operative blood transfusion were identified as independent predictors for morbidity and mortality.

Regarding indications of surgery, in a population-based study conducted by Kwan *et al.* [5], 54.3% of the patients had a bowel obstruction as their indication for emergency colorectal surgery, and 35.9% had peritonitis. In our study, we found that 40% of patients had perforation (peritonitis), 36% had a bowel obstruction, 20% had ischemia, and lastly, 4% had megacolon as indications for emergency colorectal surgery. Moreover, the commonest cause of morbidity was perforation (50%), whereas the commonest cause of mortality was ischemia (50%).

According to the study of Bernard *et al.* [17], perioperative blood transfusion was likely to cause an increase in mortality. However, in another study, perioperative blood transfusion was not significantly related to mortality [9], but in our research, we observed that the perioperative blood transfusion was highly significant regarding univariate and multivariate analyses of factors related to morbidity and mortality.

With respect to the qualification of the surgeon, other researchers observed that, regarding the qualifications of the surgeon, no statistically significant differences in either the mortality or the complication rates (morbidity) were observed. However, previous studies reported that intervention by a specialist in colorectal surgery helped to improve the long-term prognosis, although the short-term mortality was not significant [9]. A number of studies have shown specialist surgeons to have better outcomes than nonspecialists when it comes to both elective and emergency surgery [18]. The volume of emergency surgeries performed by a surgeon is also shown to correlate with improved outcomes [19]. In our results, there were insignificant differences regarding qualification of the surgeon according to univariate analysis of factors related to Clavien-Dindo classification (morbidity) and mortality.

Regarding location, other research studies found that lesions were more commonly located on the right side of the colon (41.57%) than on the left side (39.33%) [20]. However, in our study, we reported that the sigmoid colon was the most common site of lesions (32%) followed by the rectum (20%), then the descending colon (18%) (left side of colon=70%), cecum (16%), ascending colon (8%) (while the right side of colon=24%), and transverse colon (6%).

Regarding the type of surgery, other authors reported that with either right side, left side, or rectal lesions, we performed resection with primary anastomosis

(71.26%) to avoid colostomy formation, except in patients with high levels of contamination from perforation and those with septic shock, in whom we performed Hartmann's operation (12.64%) [21]. Santos *et al.* [22] reported that Hartmann's operation was the most common operation done (85%). In our presentation, Hartmann's procedure was the most common operation done (50%), followed by resection with primary anastomosis without diversion (22%) and then diversion only (stoma=14%).

Regarding the operative time, a study found that the average operative time was 170.98 ± 61.05 min [9]. In our study, the average operative time was 164.12 ± 22.17 min.Regarding the etiology of the lesions, Kwan *et al.* [5] reported that for the cause of disease, a majority of patients had colorectal cancer (63.8%), whereas the diverticular disease was observed to be the most common benign disease. However, others found that the rates of colorectal cancer, diverticular disease, and ischemic colitis were 19.2, 21.2, and 27.3%, respectively; 8.1% had an obstruction due to fecal impaction; and other causes were not identified in as many as 20.2% [14]. In other studies, ischemic colitis was the most frequent cause of emergency surgery among the patients who underwent emergency surgery for colorectal disease. According to other reports in the literature, many emergency colorectal surgeries are due to malignant diseases and perforation of diverticulitis [22]. In our presentation, with respect to the cause of the disease, malignancy was seen in 28%, diverticulitis in 24%, ischemic colitis in 22%, 14% had stercoral (inflammatory colitis caused by increased intraluminal pressure from impacted fecal material in the colonic segments causing intestinal obstruction), 8% had volvulus, and lastly 4% had megacolon.

According to studies addressing the patient's underlying disease and prognosis, the mortality rate for a patient who undergoes emergency colorectal surgery due to perforation is about 15–20% [23]. The mortality and complication rates (morbidity) associated with emergency colorectal surgery for acute obstruction are 15–20% and 40–50%, respectively [24]. Moreover, the mortality and the complication rates are higher for patients who undergo emergency surgery rather than regularly scheduled surgery; this is especially true for patients who undergo emergency colorectal surgery for cancer. The results of this study are similar, with mortality and complication rates of 20 and 30%, respectively [25]. Colon ischemia typically tends to improve naturally after a temporary ischemic attack and does not often progress to peritonitis. However, if gangrene or perforation occurs, then the patient's prognosis is very poor, with a mortality rate of more than 50% [26]. In our study, we found that major morbidity (Clavien-Dindo classification grade III or more) and mortality rates in all studied populations were 23 (46%) patients and 11 (22%) patients, respectively, in patients who underwent emergency surgery for colorectal disease. The morbidity and mortality rates due to malignancy were six (12%) patients and three (6%) patients, respectively; those due to diverticulitis were five (10%) patients and one (2%) patient, respectively; those due to ischemic colitis were eight (16%) patients and five (10%) patients, respectively; and those due to stercoral were four (8%) patients and two (4%) patients, respectively.

Conclusion

Emergency colorectal surgery showed relatively high morbidity (Clavien-Dindo classification grade III or more=46%) and mortality (22%) rates. The commonest causes of major morbidity and mortality were ischemic colitis (16 and 10%, respectively) followed by malignancy (12 and 6%, respectively). Furthermore, the independent risk factors for both major morbidity and mortality were age group more than or equal to 70 years, presence of two or more co-morbidities, preoperative hypotension, ASA classifications (grade IV), and ischemic colitis. Thus, patients with these characteristics need to be evaluated more carefully and receive better care if the morbidity and mortality rates are needed to be reduced. Moreover, the preoperative conditions of such patients should be carefully assessed, and a plan for surgery and postoperative management should be established based on those conditions.

Recommendation

For improvement of the outcomes, patients with these previous risk factors should undergo intensive monitoring and active postoperative management. Further research and studies with a larger sample size are needed to evaluate the independent risk factors for both major morbidity and mortality, and more efforts should be put into lowering the morbidity and mortality rates regarding these independent risk factors.

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Conflicts of interest

There are no conflicts of interest.

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