The American Journal of Surgery 218 (2019) 248–254

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Outcomes of emergency abdominal surgery in octogenarians: A single-center analysis

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ARTICLE INFO

Article history:
Received 21 August 2018
Received in revised form
17 October 2018
Accepted 15 November 2018

Presented at the Annual Swiss Trauma and Acute Care Surgery Days, March 16–17 2018, Bern, Switzerland, at the European Congress for Trauma & Emergency Surgery, May 6–8 2018, Valencia, Spain and at the Annual Meeting of the Swiss Society of Surgery, May 16–18 2018, Basel, Switzerland.

Keywords:
Emergency abdominal surgery
Octogenarians
Mortality
Early mortality
Loss of independency

ABSTRACT

Background: The aim of this study was to assess outcomes of octogenarians undergoing emergency abdominal surgery (EAS).

Methods: Octogenarians undergoing EAS 12/2011-12/2016 were retrospectively analysed. The outcomes were assessed by univariable and multivariable regression analysis.

Results: One-hundred-forty patients with a median age of 83.9 years were included. EAS was performed for cholecystitis (27.1%), ileus (22.1%), hollow viscus perforation (16.4%), diverticulitis (12.9%), mesenteric ischemia (10.0%), incarcerated hernia (9.3%), and appendicitis (2.1%). The overall and early (within 7 days from surgery) mortality rate was 16.4% and 10.0%, respectively. Multivariable analysis revealed age (OR 1.24,CI95% 1.04–1.47,$p = 0.015$), ASA scores$\geq$4 (OR 11.15,CI95% 2.39–52.02,$p = 0.002$), mesenteric ischemia (OR 52.60,CI95% 8.93–309.94,$p < 0.001$) and ICU admission (OR 9.23,CI95% 1.74–49.04,$p = 0.009$) as independent predictors for mortality. Postoperative withdrawal of care accounted for 36% of early mortalities.

Conclusions: One third of early mortality in octogenarians was due to postoperative withdrawal of care. An interdisciplinary decision-making including patients' and relatives' wishes may avoid ethically questionable interventions in octogenarians.

Introduction

As life expectancy is increasing worldwide, societies are challenged to adapt health care systems to the aging population.[1] There is an ongoing discussion whether the evolution of medicine and health technology will be able to compensate for the increasing age-related burden of disease.[2] Adding to the problem, increasing life expectancy actually is one of the main drivers for increasing health care expenditures.[3] Therefore the effectiveness of medical treatments in patients with extensive treatment needs, such as surgery in the elderly,[4] is of utmost importance for a fair allocation of resources.

In a large retrospective cohort study including 1.8 million individuals, over 18% of patients underwent surgery in the last month of their life.[5] Among other factors, higher age has been shown to be associated with deficits in surgical decision making.[6] Multidimensional patient-centred approaches[7] and best communication practices[8,9] have been discussed to facilitate decision making in elderly patients with surgical emergencies. Recent studies investigated outcomes of patients >80 years of age undergoing cardiovascular or neurosurgical interventions.[10–12] However, literature on outcomes of octogenarians undergoing emergency abdominal surgery (EAS) is scarce.[13] Therefore, this study opted to assess the overall and early in-hospital mortality rate, loss of independence, and factors associated with these outcomes in octogenarians undergoing EAS.

Material and methods

This study is reported in accordance with the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) statement[14] and was approved by the cantonal ethics committee of Bern, Switzerland (KEK 2017-01284).

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https://doi.org/10.1016/j.amjsurg.2018.11.023
0002-9610/

Abbreviations

ASA	American society of Anesthesiologists
BMI	body mass index
CCI	Charlson Comorbidity Index
EAS	emergency abdominal surgery
HLOS	hospital length of stay
ICU	intensive care unit
ICU LOS	intensive care unit length of stay

Study design

This is a single centre retrospective observational study including patients ≥80 years of age that underwent non-trauma emergency abdominal surgery at the Bern University Hospital from 01/12/2011 to 31/12/2016. Patients with malignant disease and those who underwent non-operative treatment for acute abdominal disease were excluded (Fig. 1).

Irrespective of age, the treating surgical team assessed all patients that potentially require EAS. The goals of care were discussed with the patients and their relatives. Non-curative treatment was initiated only if the patients specifically expressed their wish for palliative care.

Data were extracted from the Bern University Hospital administrative database and electronic patient charts. The following variables were collected: age, sex, body mass index (BMI), vital signs and laboratory values at admission, American Society of Anesthesiologists (ASA) score,[15] Charlson Comorbidity Index (CCI),[16] diagnoses, type of surgery (open, laparoscopic), intensive care unit length of stay (ICU LOS), hospital length of stay (HLOS), nursing effort (hours of nursing per hospital day), complications according to Dindo Clavien classification,[17] origin of admittance/discharge (home, nursing facility, other hospital), and in-hospital mortality.

The main outcome was overall in-hospital mortality. Secondary outcomes included early mortality and loss of independence. Early mortality was defined as death ≤7 days from surgery. Loss of independence was defined as being admitted from home and being discharged to a nursing facility or other hospital.

The association of clinically important variables, including patient and treatment characteristics, on outcomes was assessed in univariable and multivariable regression analysis.

Statistical analysis

Normality of distribution was assessed using histograms and the Shapiro-Wilk test. Results were reported as numbers and percentages or medians and interquartile ranges, as appropriate. Categorical variables were compared using Chi-Square or Fisher's

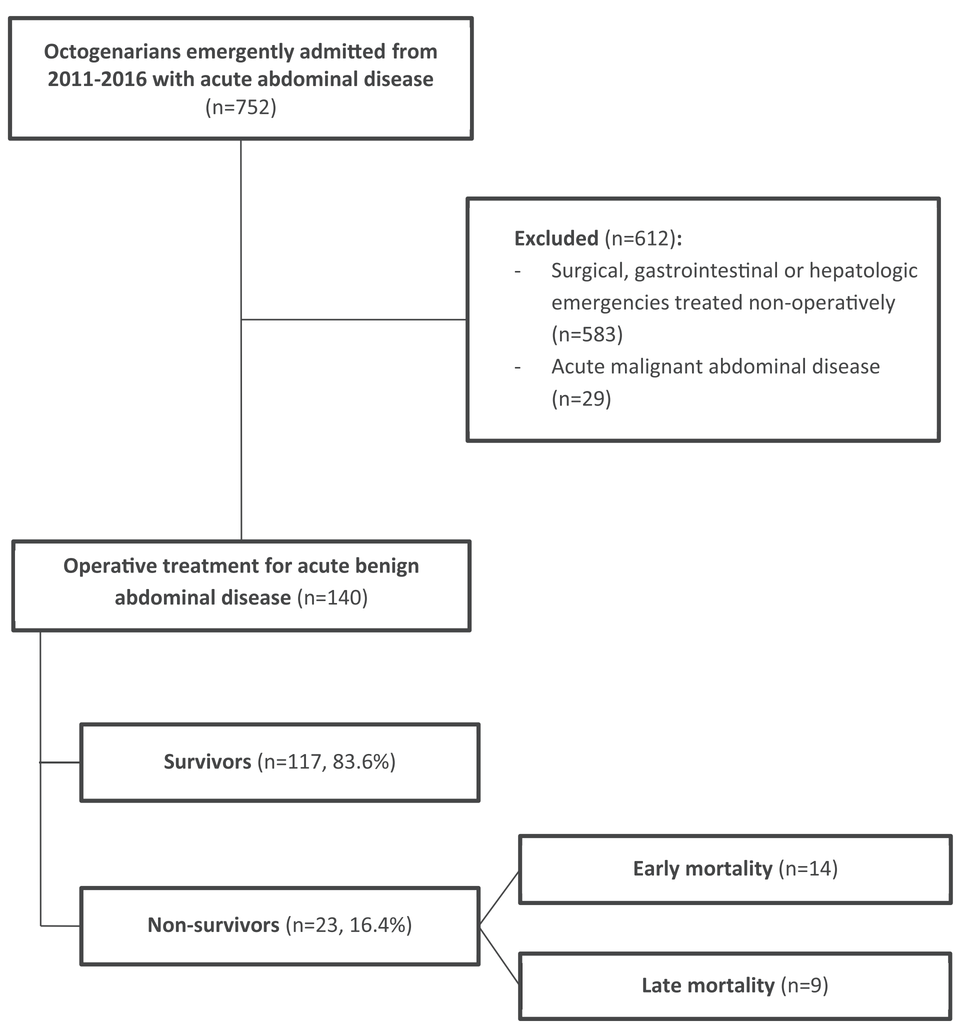

Fig. 1. Flow chart of the study outline.

exact test. Students' *t*-test or Mann-Whitney *U* test were used for analysis of continuous variables.

The impact of clinical variables on in-hospital mortality and loss of independency was assessed in univariable analysis. Clinical variables with a *p*-value ≤0.1 in univariable analysis were then included in a multivariable regression model in order to assess independency. Subsequently, forward logistic regression was performed to create an independent predictive model for mortality and loss of independency, respectively. Mortality rates were shown as Kaplan Meier curves. *P-values* ≤0.05 were considered statistically significant. Statistical analysis was performed using SPSS Statistics version 25 (IBM Corporation, Armonk, New York).

Results

Within the 61-months study period, 752 octogenarians with acute abdominal disease were screened. After the exclusion of patients treated non-operatively and those with malignant disease, a total of 140 octogenarians undergoing EAS were included in the analysis (Fig. 1).

Median age was 83.9 (IQR 81.9–87.2) years, 55.7% (n = 78) were female, and the median BMI was 24.5 (17.1–45.7) kg/m^2 (Table 1). An ASA score ≥4 was found in 40.7% (n = 57) and 47.2% (n = 66) had a CCI ≥3. Patients were treated for cholecystitis (27.1%, n = 38), small or large bowel obstruction (22.1%, n = 31), hollow viscus perforation (16.4%, n = 23), perforated diverticulitis (12.9%, n = 18), mesenteric ischemia (10.0%, n = 14), incarcerated hernia (9.3%, n = 13), and appendicitis (2.1%, n = 3). A total of 37 patients (26.4%) were operated laparoscopically, 73.6% underwent laparotomy (n = 103). The postoperative ICU-admission rate was 47.9%. Median HLOS and ICULOS was 9.0 (6.0–15.8) days and 2.0 (1.0–4.0) days, respectively. A total of 39 octogenarians (27.9%) revealed postoperative complications Dindo Clavien ≥ 3.

Overall mortality

Overall in-hospital mortality was 16.4% (n = 23). Table 1 outlines the demographics and characteristics of the study population stratified by mortality. When comparing survivors and non-survivors, a statistically significant age difference (83.6 vs. 86.4 years, $p = 0.024$) was found. Moreover, ASA scores ≥4 were significantly less frequent (32.5% vs. 82.6%, $p < 0.001$) and the ICU admission rate was significantly lower (41.0% vs. 82.6%, $p < 0.001$) in survivors than in non-survivors. On the other hand, survivors were significantly more often admitted from home compared to non-survivors (64.1% vs. 34.8%, $p = 0.010$). Regarding abdominal disease, acute cholecystitis was more frequent (32.5% vs. 0.0%, $p = 0.001$) and mesenteric ischemia less frequent (3.4% vs. 43.5%, $p < 0.001$) in survivors compared to non-survivors. Of note, survivors were more frequently operated laparoscopically compared to the non-survivors (29.9% vs. 8.7% $p = 0.039$). Multivariable forward regression analysis revealed following independent predictors for overall mortality: age, ASA scores ≥4, mesenteric ischemia and ICU admission (Table 2). The logistic regression model fit the data well (Nagelkerkes' $R^2 = 0.575$).

Early mortality

Fourteen of 23 non-survivors died within 7 days and were defined as early mortalities. Ultimately, multi-organ failure (n = 7, 50%), postoperative withdrawal of care (n = 5, 36%), cardiac arrest (n = 1, 7%), and respiratory insufficiency (n = 1, 7%) led to the early deaths. The reasons for postoperative withdrawal of care were as following: patients' will (n = 2) and relatives' wishes (n = 3). The demographics of this subgroup of patients are presented in Table 3. Fig. 2 A-C are showing the Kaplan Meier survival curves stratified by the categorical independent predictors for mortality. Of note, octogenarians with an ASA score ≥4 or with mesenteric ischemia showed earlier mortality (Fig. 2 A and 2 B).

Loss of independency

A total 76 of the 117 patients (54.3%) that survived their hospital stay were admitted from home. Of these, 29 patients (38.2%) were subsequently discharged to a nursing facility or another hospital and were defined as patients with loss of independency. Table 4 outlines the demographics and characteristics of the study population stratified by loss of independency. Patients with loss of independency showed significantly higher temperatures (37.2 vs. 36.8 °C, p = 0.040) and respiratory frequencies (22 vs. 18, p = 0.007) on admission, had a higher nursing intensity during their hospital stay (8.9 vs. 7.1 h per day, p = 0.002) and were significantly more often admitted to the ICU (48.3% vs. 23.9%, p = 0.044) compared to patients without loss of independency. In multivariable logistic regression analysis the worst lactate level within 24 h from admission was independently associated with a loss of independency (Nagelkerkes' $R^2 = 0.322$).

Discussion

In the current study, a total of 140 octogenarians undergoing EAS were retrospectively assessed. The overall in-hospital mortality was 16.4%. Age, ASA scores ≥4, mesenteric ischemia and ICU admission were independently associated with mortality. Of those that survived and were admitted from home, loss of independency was seen in 38.2% of patients. The worst lactate level within 24 h of admission was independently associated with a loss of independency.

Overall mortality

The current population revealed a 16% mortality rate, which is in accordance with two currently available studies showing a 15–33% mortality rate in an emergency surgery population ≥80 years.[18,19] In the current study, acute mesenteric ischemia was identified as a strong independent predictor for mortality, whereas acute cholecystitis was associated with decreased mortality. This should be taken into account when therapeutic decisions are made in this age group. Furthermore, the severity of pathophysiological derangements as indicated by an ASA score ≥4 or postoperative ICU admission, was independently associated with significantly higher mortality.

In the current study, ICU admission was an independent predictor for mortality. The pathophysiologic derangement should carefully be assessed before admitting a patient to the ICU. ICU admission may lead to overtreatment. Of note, a large trial including patients aged ≥75 years showed a significantly higher rate of ICU admission and consecutively increased in-hospital mortality in the group of patients that were preoperatively systematically evaluated by intensivists.[20]

Surprisingly, in the current series, the CCI did not predict mortality. This might be due to equally distributed co-morbidities in surviving and non-surviving octogenarians. Similarly, a previous study showed that comorbidities do not accurately predict mortality in octogenarians undergoing EAS. However, in this study detailed information on abdominal pathologies were not reported.[19]

Age was independently associated with mortality. This underlines the fact that age persists to be a strong predictor for worse outcomes even in octogenarians. This is of particular relevance in

Table 1
Patient's baseline characteristics and comparison of survivors with non-survivors.

	Overall (N = 140)	Survivors (n = 117)	Non-survivors (n = 23)	*p* value
Age, y, median (IQR)	83.9 (81.9–87.2)	83.6 (81.6–87.1)	86.4 (83.3–88.3)	0.024[a]
Sex, female/male, n (%)	78/62 (55.7/44.3)	67/50 (57.3/42.7)	11/12 (47.8/52.2)	0.493[b]
BMI, kg/m^2 median (IQR)	24.5 (22.4–27.7)	24.5 (22.5–28.0)	23.9 (21.4–26.2)	0.569[a]
ASA score, n (%)				
I	–	–	–	
II	7 (5.0)	7 (6.0)	–	
III	76 (54.3)	72 (61.5)	4 (17.4)	<0.001[b]
IV	49 (35.0)	37 (31.6)	12 (52.2)	
V	8 (5.7)	1 (0.9)	7 (30.4)	
Charlson Comorbidity Index, n (%)				
0	23 (16.4)	19 (16.2)	4 (17.4)	
1	20 (14.3)	17 (14.5)	3 (13.0)	
2	31 (22.1)	27 (23.1)	4 (17.4)	0.931[b]
3	25 (17.9)	20 (17.1)	5 (21.7)	
4	21 (15.0)	18 (15.4)	3 (13.0)	
≥5	20 (14.3)	16 (13.7)	4 (17.4)	
Diagnosis, n (%)				
Cholecystitis	38 (27.1)	38 (32.5)	–	0.001[b]
Small or large bowel obstruction	31 (22.1)	27 (23.1)	4 (17.4)	0.784[b]
Hollow viscus perforation	23 (16.4)	19 (16.2)	4 (17.4)	1.000[b]
Diverticulitis	18 (12.9)	14 (12.0)	4 (17.4)	0.498[b]
Mesenteric ischemia	14 (10.0)	4 (3.4)	10 (43.5)	<0.001[b]
Hernia	13 (9.3)	12 (10.3)	1 (4.3)	0.694[b]
Appendicitis	3 (2.1)	3 (2.6)	–	1.000[b]
Vital signs at admission, median (IQR)				
Temperature, °C	36.8 (36.5–37.3)	36.9 (36.5–37.4)	36.7 (36.3–37.1)	0.155[a]
Respiratory frequency,/min.	21 (17–24)	21 (17–24)	22 (19–27)	0.437[a]
Heart rate,/min.	87 (75–102)	85 (75–99)	96 (79–114)	0.103[c]
Systolic blood pressure, mmHg	134 (117–159)	135 (117–159)	130 (109–159)	0.869[a]
Laboratory values at admission, median (IQR)				
White blood cell count, G/l	12.5 (9.4–16.1)	12.2 (9.2–14.8)	16.1 (11.1–19.5)	0.024[a]
CRP, mg/l	47 (10–222)	57 (11–240)	27 (5–162)	0.031[c]
Creatinine, mmol/l	100 (77–137)	98 (75–131)	115 (94–182)	0.103[a]
Creatinine clearance,	51 (35–72)	55 (36–72)	38 (28–48)	0.047[a]
Lactate at admission, mmol/l	1.7 (1.2–2.6)	1.6 (1.2–2.5)	2.2 (1.5–4.4)	0.028[c]
Lactate, worst within first 24 h, mmol/l	2.0 (1.2–2.9)	1.8 (1.2–2.7)	3.3 (2.0–6.4)	0.001[a]
pH	7.40 (7.32–7.43)	7.40 (7.32–7.43)	7.41 (7.33–7.44)	0.727[a]
Sepsis at admission, n (%)	85 (60.7)	74 (63.2)	11 (47.8)	0.242[b]
Nursing effort, h per day, median (IQR)	9.2 (7.1–13.0)	8.8 (6.9–11.5)	15.5 (10.9–23.1)	0.215[c]
Admission from, n (%)				
Home	83 (59.3)	75 (64.1)	8 (34.8)	
Nursing home, rehab.	11 (7.9)	10 (8.5)	1 (4.3)	0.010[b]
Other Hospital	46 (32.9)	32 (27.4)	14 (60.9)	
Operation technique, n (%)				
Laparotomy	117 (83.6)	82 (70.1)	21 (91.3)	0.039[b]
Laparoscopy	23 (16.4)	35 (29.9)	2 (8.7)	
ICU admission, n (%)	67 (49.7)	48 (41.0)	19 (82.6)	<0.001[b]

IQR: interquartile range; BMI: body mass index; ASA score: American Society of Anesthesiology score; ICU: intensive care unit.
[a] Mann-Whitney-U test.
[b] Fisher's exact test.
[c] Students' *t*-test.

the context of Switzerland's high life expectancy, which is the second largest in the world.[1] A similar observation has been made in a Finnish population, however, in patients aged ≥65 years.[21]

Although not an independent predictor for mortality, preoperative independent living seems to influence outcomes of octogenarians undergoing EAS. In the current univariate analysis, octogenarians coming from home survived significantly more often. This has also been demonstrated in another study including patients aged ≥85 years, although this study analysed a mixed population of patients undergoing non-emergency and emergency abdominal surgery.[22] Similarly, an increased mortality of patients ≥65 years of age undergoing emergent and non-emergent abdominal surgery has been demonstrated for nursing home residents compared to patients admitted from home.[23]

Table 2
Multivariable analysis of outcomes.

	In hospital mortality		
	OR	95% CI	*p* value
Age, y	1.24	1.04–1.47	0.015
ASA score ≥4	11.15	2.39–52.02	0.002
Mesenteric ischemia	52.60	8.93–309.94	<0.001
ICU admission	9.23	1.74–49.04	0.009
	Loss of independency		
	OR	95% CI	*p* value
Lactate, worst within first 24 h, mmol/l	2.36	1.09–5.10	0.029
Nursing intensity, h per day	1.16	0.97–1.39	0.103

Forward stepwise logistic regression analysis.
ASA score: American Society of Anesthesiology score; ICU: intensive care unit; OR: Odds ratio; CI: confidence interval.

Early mortality

Ten percent of octogenarians died within 7 days of surgery and were defined as early mortalities. This subgroup of patients was separately analysed in order to investigate ethically questionable surgical interventions. When further investigating the ultimate reasons for the mortalities, it was found that over a third of early mortalities or a fifth of overall deaths were due to withdrawal of care. This observation emphasizes the importance to elaborate an interdisciplinary treatment plan in accordance with the patients' will and relatives' wishes before surgery is performed. Here, a clear communication containing the actual diagnosis, the pre-existing health conditions, and the risks and benefits of surgery is required to avoid unrealistic expectations by patients and families.[8] There are different frailty scores available, that possibly help to further improve decision making, however, they need to be carefully validated in this subgroup of very old patients.[24–26]

Loss of independency

To our knowledge, this is the first study assessing the predictors for loss of independency of octogenarians underdoing EAS. In this study, the highest lactate level within 24 h after admission was independently associated with loss of independency. Lactate level is a known predictor for mortality in EAS of elderly patients aged over 70 years[27] and a well-known surrogate marker for the severity of sepsis.[28] However, it has never been shown as a predictor for loss of independency. In the current study, higher lactate levels as a predictor for loss of independency rather reflect the overall severity of disease than a direct effect of lactate on the loss of independency.

Limitations

Major limitation of this study is its retrospective design. Therefore, the dataset is limited to the variables available from the institutional electronic charts. In the literature there are multiple specific frailty indices described, however, in clinical practice these need to be applied prospectively.[24–26] Furthermore, the mortality after hospital discharge could not be obtained and therefore a long-term survival analysis was not available. Moreover,

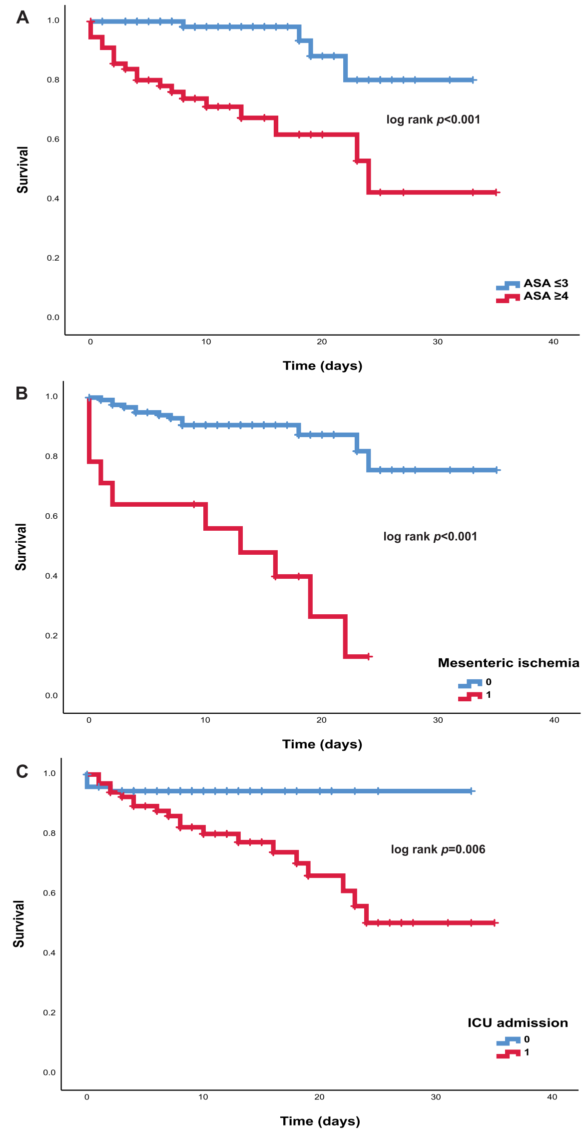

Fig. 2. Kaplan-Meier survival curves stratified by ASA score (Fig. 2 A), presence of mesenteric ischemia (Fig. 2 B) and ICU admission (Fig. 2 C).

Table 3
Characteristics of patients with withdrawal of care.

Patient	Age (years)	Sex	ASA score	Sepsis at admission	Diagnosis	Intervention	Time of withdrawal of care
1	91.5	Male	5	Yes	Colonic perforation (splenic flexure)	Subtotal colectomy, end ileostomy	POD 1 (by relatives)
2	88.3	Female	4	Yes	Mesenteric ischemia	Thrombectomy SMA, segmental small bowel resection	POD 1 (by patient)
3	95.6	Female	5	No	Small bowel obstruction	Adhesiolysis	POD 4 (by relatives)
4	86.4	Male	4	No	Small bowel obstruction	Adhesiolysis	POD 4 (by relatives)
5	88.1	Female	4	Yes	Colonic perforation (sigmoid colon)	Rectosigmoidectomy, end colostomy	POD 6 (by patient)

ASA score: American Society of Anesthesiology score; SMA: superior mesenteric artery; POD: Postoperative day.

Table 4
Comparison of patients stratified by loss of independency.

	No loss of independency (n = 47)	Loss of independency (n = 29)	*p* value
Age, y, median (IQR)	84.0 (81.9–87.1)	83.9 (81.2–86.9)	0.724[a]
Sex, female/male, n (%)	28/19 (59.6/40.4)	15/14 (51.7/48.3)	0.634[b]
BMI, kg/m^2 median (IQR)	24.7 (22.3–27.7)	24.0 (22.7–27.1)	0.817*
ASA score, n (%)			
I	–	–	
II	5 (10.6)	1 (3.4)	
III	33 (70.2)	17 (58.6)	0.166[b]
IV	9 (19.1)	11 (37.9)	
V	–	–	
Charlson Comorbidity Index, n (%)			
0	8 (17.0)	6 (20.7)	
1	8 (17.0)	2 (6.9)	
2	13 (27.7)	8 (27.6)	0.237[b]
3	7 (14.9)	6 (20.7)	
4	8 (17.0)	1 (3.4)	
≥5	3 (6.4)	6 (20.7)	
Diagnosis, n (%)			
Cholecystitis	18 (38.3)	7 (24.1)	0.222[b]
Small or large bowel obstruction	8 (17.0)	9 (31.0)	0.169[b]
Hollow viscus perforation	6 (12.8)	5 (17.2)	0.739[b]
Diverticulitis	4 (8.5)	2 (6.9)	1.000[b]
Mesenteric ischemia	–	3 (10.3)	0.052[b]
Hernia	8 (17.0)	3 (10.3)	0.517[b]
Appendicitis	3 (6.4)	–	0.283[b]
Vital signs at admission, median (IQR)			
Temperature, °C	36.8 (36.3–37.1)	37.1 (36.8–37.5)	0.045[a]
Respiratory frequency,/min.	18.5 (15–23)	22.0 (20–28)	0.010[a]
Heart rate,/min.	81.5 (71–96)	85.0 (75–99)	0.526[a]
Systolic blood pressure, mmHg	133.5 (120–160)	144.0 (127–162)	0.334[a]
Laboratory values at admission, median (IQR)			
White blood cell count, G/l	11.9 (8.8–15.1)	13.2 (10.2–14.8)	0.521[a]
CRP, mg/l	45 (8–165)	29 (6–213)	0.710[a]
Creatinine, mmol/l	91 (73–117)	105 (78–127)	0.171[a]
Creatinine clearance,	61 (42–76)	53 (38–70)	0.382[a]
Lactate at admission, mmol/l	1.5 (1.1–2.3)	1.6 (1.2–3.1)	0.170[a]
Lactate, worst within first 24 h, mmol/l	1.5 (1.1–2.3)	2.0 (1.2–3.1)	0.112[a]
pH	7.40 (7.33–7.42)	7.40 (7.35–7.44)	0.531[a]
Sepsis at admission, n (%)	26 (55.3)	19 (65.5)	0.473[b]
Nursing effort, h per day, median (IQR)	7.0 (5.0–8.9)	8.9 (7.2–11.4)	0.002[a]
Operation technique, n (%)			
Laparotomy	31 (66.0)	21 (72.4)	
Laparoscopy	16 (34.0)	8 (27.6)	0.619[b]
ICU admission, n (%)	11 (23.4)	14 (48.3)	0.043[b]
ICU LOS, median (IQR)	8.0 (6.0–13.0)	13.0 (9.0–20.0)	0.291[a]

IQR: interquartile range; BMI: body mass index; ASA score: American Society of Anesthesiology score; ICU: intensive care unit.
[a] Mann-Whitney-U test.
[b] Fisher's exact test.

the heterogeneity of the patient population and the relatively small number of patients does not allow for stratification and subgroup analysis. Therefore, the conclusions were drawn cautiously.

Conclusions

In octogenarians undergoing EAS, age, ASA score ≥4, mesenteric ischemia and ICU admission was independently associated with mortality. One third of early mortality was due to withdrawal of care. Therefore, to prevent ethically questionable acute surgical interventions, the deliberation of treatment options and the goals of care should involve emergency physicians, surgeons, anaesthesiologists, and intensivists. Furthermore, the treatment goals needs to be in consistency with the patients' will or with the relatives in their role as proxy decision makers for the patient.

Acknowledgements

The Authors Joël Lavanchy, Melanie Holzgang, Tobias Haltmeier, Daniel Candinas and Beat Schnüriger have no conflict of interest or financial ties to declare.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2018.11.023.

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