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Open abdomen and age; results from IROA (International Register of Open Abdomen)

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ABSTRACT

Introduction: No definitive data exist regarding epidemiology and outcomes of patients treated with open abdomen (OA) linked to age.
Methods: This is a prospective, observational, cohort study that includes patients treated with OA. Patients were divided into 4 age groups: group 1: 16–40 y.o.; group 2: 41–60 y.o.; group 3:61–80 y.o.; group 4:> 80 y.o.
Results: 760 patients were enrolled. Average age was 60 ± 18aa; 57.2% were males. Most frequent indication was peritonitis (50.9%). Mean open duration of open abdomen was8±18 days. Definitive closure was reached in 81.1% of patients. Complications were recorded in 84.8% of patients with significant differences between groups ($p = 0.001$). Overall mortality was41.2% with significant differences between groups ($p < 0.001$) (group 1 25.6%, group 2 36.1%, group 3 44.5%, group 4 67.1%) 1 month follow-up mortality post-OA was 9.2% and 1 year follow-up mortality was 11.6%;
Conclusions: Open abdomen treatment is feasible at every age. Diseases requiring treatment with OA are differently distributed in relation to the different age groups. Advanced age has negative effect on complications and mortality rate.

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Introduction

The open abdomen (OA) procedure is defined as the intentional creation of a large defect in the abdominal wall in which the wound edges are leaved unapproximated. The abdomen is then temporarily closed with different techniques. The OA was firstly described in 1897 by Andrew J. McCosh,[1] then officially reutilized by WH Ogilvie in 1940.[2] From that moment this technique has been utilized more and more. Nowadays it represents an established treatment option in many critically ill patients where intra-abdominal conditions pose the necessity for a re-exploration of the peritoneal cavity or where is not indicate to conclude the index operation in a definitive manner. Moreover all those situations may require OA even in order to treat or to prevent the onset of abdominal compartment syndrome (ACS) may require OA.

Although the OA is based on strong patho-physiological principles, still now do not exist definitive scientific evidences supporting its use. Multicenter international studies regarding the OA, and especially in abdominal sepsis patients are ongoing.[3–6] To overcome the lack of evidence-based data about the indications, management, definitive closure and follow-up of OA the World Society of Emergency Surgery (WSES) is running the International Register of Open Abdomen (IROA). The aim of the present study is give an epidemiological overview and description of the use of open abdomen with the stratification by age of the IROA enrolled patients in order to evaluate the effect of age on OA procedures and outcomes.

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Methods

This is a prospective observational cohort study including patients over the age of 15 with an open abdomen treatment. There were no exclusion criteria whereas the only inclusion criterion was the OA treatment. Data were recorded on a web platform (Clinical Registers®) through a dedicated website: www.clinicalregisters.org. Data were recorded according to the study protocol, approved by the coordinating centre Ethical Committee (Papa Giovanni XXIII Hospital, Bergamo, Italy) and also registered to ClinicalTrials.gov (ClinicalTrials.gov Identifier: NCT02382770). For each patient the following data were recorded: demographical data, indication to the treatment, temporary abdominal closure technique (TACT), duration of the treatment and number of dressing changes, complications, the development of entero-atmospheric fistula and mortality before and after closure, according to the study protocol. Indications were organized into seven groups (peritonitis, pancreatitis, ischemia, vascular emergencies and hemorrhage, post-operative ACS, trauma and other). TACTs were summarized in six subgroups (Bogotà bag, Barker vacuum pack, negative pressure wound therapy (NPWT), NPWT + tension, skin closure and Wittmann patch).

For the present study patients were divided into 4 groups:

Group 1: 16–40 yrs, Group 2: 41–60 yrs, Group 3: 61–80 yrs, Group 4: >80 yrs.

Continuous variables were expressed as mean and standard deviation and were compared with the ANOVA test; categorical data were expressed as proportions and were compared with the chi square test. All the statistical analyses were performed with IBM SPSS 20 (IBM Corp. Released 2011. IBM SPSS Statistics or Windows, Version 20.0. Armonk, NY: IBM Corp.).

Results

A total of 760 patients were considered for the analysis, 435 were males (57.2%). Patients were distributed based on age as follows: group 1(16–40yrs): 117 patients, (80 males - 68.4%); group 2(41–60yrs): 233 patients(131 males - 56.2%); group 3(61–80yrs): 337 patients(184 males - 54.6%); group 4(>80yrs): 73 patients(40 males - 54.8%). The mean age was 60 ± 18 and the mean BMI was 27.04 ± 5.73. The ASA class most represented in each group was ASA IV (36.8% overall)(group 1: 32.5%; group 2: 32.6%; group 3: 40.1%; group 4: 42.5%).

Table 1 shows as the different indications varied in a statistical significant way through the different age classes (<0.001). Trauma reduces with the increase of the age while peritonitis increases. The overall principal indication to OA was peritonitis (50.9%) (in group 1 it was trauma (50.4%) while in the other 3 groups was peritonitis: group 2: 46.4%; group 3: 59.6%; group 4: 61.6%). Acute mesenteric ischemia and vascular emergencies also incremented with the increase of the age (Table.1).

The most utilized TACT was NPWT (65.1%) and no significant difference in the usage of the various TACTs was observed among the 4 groups (Table.2).

The mean duration of open abdomen was 8 ± 18 days and it varied within the different groups (group 1: 14 ± 33 days; group 2: 9 ± 20 days; group 3: 6 ± 7 days; group 4: 5 ± 6 days) ($p < 0.001$). Total LOS was18 days and ICU length of stay was 16.8 days. To close the abdominal wall was implanted a prosthesis in 16.4% of patients with significant differences between groups ($p = 0.009$)(group 1: 9.2%; group 2: 14.1%; group 3: 21.7%; group 4: 10.5%)Data are shown in detail in Table 2 (Fig. 1).

Definitive abdominal closure was obtained in the 81.1% of patients with no statistical differences between groups. The overall complications rate was 84.8% with significant differences among groups (group 1: 74.6%; group 2: 82.8%; group 3: 89.5%; group 4: 86.1%; $p = 0.001$).

In particular, the complications occurred during the open time (61.3%) and after the definitive closure (60.4%) were evaluated: in the first case no statistically significant difference was found between groups, unlike the second in which was found (group 1: 48.5%, group 2: 55.0%, group 3: 69.5%, group 4: 55.4%; $p < 0.001$). In Table 3 are shown complications in detail. The entero-atmospheric fistula rate (EAF) was globally 9.3% with no significant differences between groups (Fig. 2).

Open abdomen was associated with high overall mortality (42.2%) with differences between groups (group 1 25.6%, group 2 36.1%, group 3 44.5%, group 4 67.1%; $p < 0.001$); in Table 3 are shown results in detail. After a follow-up of one year mortality increased significantly with age; incisional hernia was recorded in 8.9% of patients.

Study outcomes were also provided in detail for patients treated for Trauma and Peritonitis; Table 4 shows results in detail.

Table 1
Patientsepidemiology and OA indications.

		Age class										
		16–40		41–60		61–80		>80		Total		
		n	%	n	%	n	%	n	%	n	%	P
Gender	Female	37	31.6	102	43.8	153	45.4	33	45.2	325	42.8	0.067
	Male	80	68.4	131	56.2	184	54.6	40	54.8	435	57.2	
ASA	ASA I	21	17.9	23	9.9	7	2.1	0	0.0	51	6.7	<0.001
	ASA II	23	19.7	51	21.9	32	9.5	6	8.2	112	14.7	
	ASA III	17	14.5	60	25.8	130	38.6	26	35.6	233	30.7	
	ASA IV	38	32.5	76	32.6	135	40.1	31	42.5	280	368	
	ASA V	18	15.4	23	9.9	33	9.8	10	13.7	84	11.1	
Indication	ACS	6	5.1	12	5.2	8	2.4	1	1.4	27	3.6	<0.001
	Ischemia	1	0.9	13	5.6	34	10.1	11	15.1	59	7.8	
	Pancreatitis	7	6.0	19	8.2	17	5.0	1	1.4	44	5.8	
	Peritonitis	33	28.2	108	46.4	201	59.6	45	61.6	387	50.9	
	Trauma	59	50.4	39	16.7	16	4.7	2	2.7	116	15.3	
	Vascularemergencies and hemorrage	4	3.4	30	12.9	51	15.1	11	15.1	96	12.6	
	Other	7	6.0	12	5.2	10	3.0	2	2.7	31	4.1	
		avg	sd	avg	sd	avg	sd	avg	sd	avg	sd	
Age		29	7	52	6	71	6	84	3	60	18	<0.001
BMI		25.42	4.93	28.51	6.93	27.09	5.27	25.18	3.40	27.04	5.73	0.089

Table 2
Data related to the treatment.

		Age class										P
		16–40		41–60		61–80		>80		Total		
		n	%	n	%	n	%	n	%	n	%	
TACT	Barker vacuum pack	23	19.7	30	12.9	28	8.3	6	8.2	87	11.4	0.06
	Bogotà bag	19	16.2	40	17.2	69	20.5	15	20.5	143	18.8	
	NPWT	50	42.7	111	47.6	177	52.5	36	49.3	374	49.2	
	NPWT + tension	3	2.6	11	4.7	16	4.7	4	5.5	34	4.5	
	Skin closure	17	14.5	25	10.7	26	7.7	4	5.5	72	9.5	
	Wittmann patch	5	4.3	16	6.9	21	6.2	8	11.0	50	6.6	
NPWT	No	41	35.0	81	34.8	116	34.4	27	37.0	265	34.9	0.981
	Yes	76	65.0	152	65.2	221	65.6	46	63.0	495	65.1	
Prothesis	No	89	90.8	164	85.9	216	78.3	51	89.5	520	83.6	0.009
	Yes	9	9.2	27	14.1	60	21.7	6	10.5	102	16.4	
Kind of prothesis	No prothesis	108	92.3	206	88.4	277	82.2	66	90.4	657	86.4	0.081
	Biological	8	6.8	20	8.6	33	9.8	2	2.7	63	8.3	
	Composite	0	0.0	0	0.0	2	0.6	1	1.4	3	0.4	
	Not resorbable	0	0.0	3	1.3	8	2.4	1	1.4	12	1.6	
	Resorbable	1	0.9	4	1.7	17	5.0	3	4.1	25	3.3	
		avg	sd	avg	sd	avg	sd	avg	sd	avg	sd	
Open time (days)		14	33	9	20	6	7	5	6	8	18	0.023
ICU time (days)		17.6	20.7	18.8	20.5	16.5	22	11.2	11.4	16.8	20.6	0.176
Total LOS (days)		22	27	21	28	17	24	11	15	18	25	0.087

NPWT negative pressure wound therapy; LOS length of stay.

Discussion

The purpose of the study was to highlight the differences between age groups about characteristics, management and outcomes of adult patients treated with OA in order to evaluate the appropriateness of OA treatment in the different age groups and indications.

Our study highlighted the difference in indications: the prevailing indication in the younger group was trauma while in the remaining groups is represented by peritonitis and intra-abdominal infections. Data also revealed that the use of OA for peritonitis is widespread and prevalent in our cohort of patients despite the controversy around this indication are still not resolved.[7–11] The prevalence of peritonitis as the main indication for OA increased

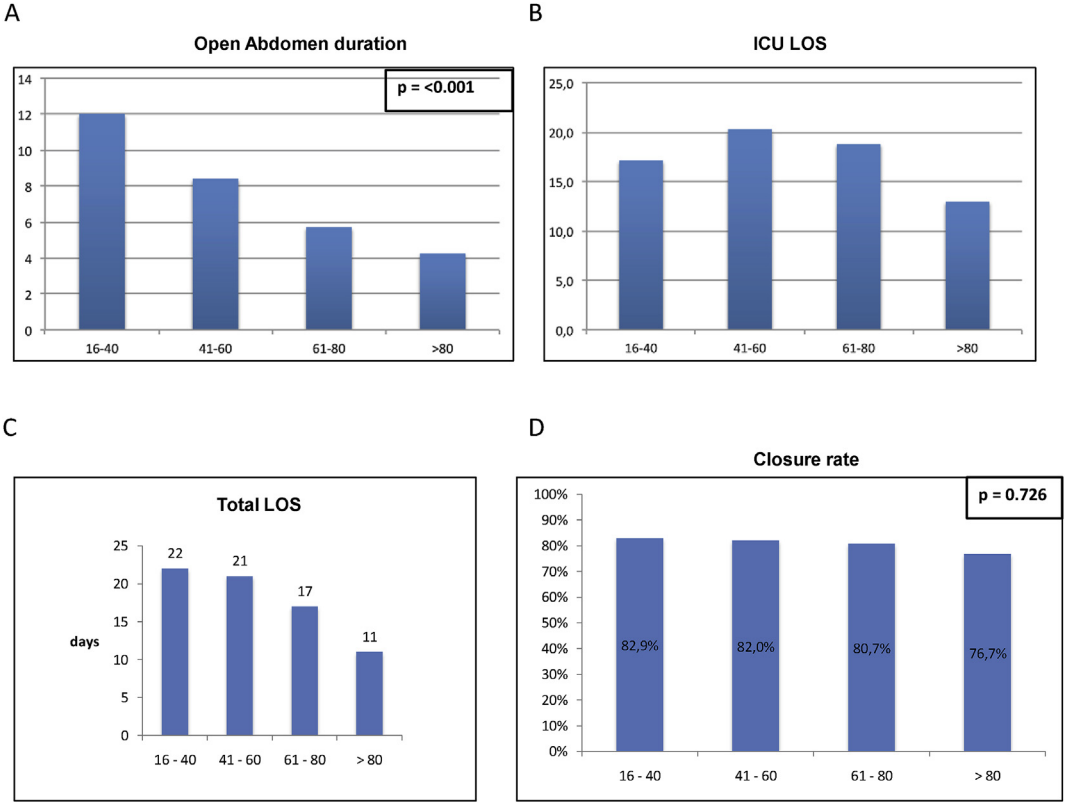

Fig. 1. Admission data: (A) Open abdomen duration (days), (B) ICU admission duration (days), (C) Length of stay duration (days), (D) Open abdomen closure rate.

Table 3
Patient's Outcomes (EAF entero-atmospheric fistula).

		Age class										P
		16–40		41–60		61–80		>80		Total		
		n	%	n	%	n	%	N	%	N	%	
Death during open treatment	No	97	82.9	191	82.0	272	80.7	56	76.7	616	81.1	0.726
	Yes	20	17.1	42	18.0	65	19.3	17	23.3	144	18.9	
Definitive closure	No	20	17.1	42	18.0	65	19.3	17	23.3	144	18.9	0.726
	Yes	97	82.9	191	82.0	272	80.7	56	76.7	616	81.1	
Fascial closure	no closure (death)	20		42		65		17		144		0.685
	No	12	12.4	30	15.3	51	18.8	10	17.8	102	16.5	
	Yes	85	87.6	161	84,6	221	81.2	46	81.1	514	83.4	
Post-closure death	No	91	93.8	174	91.1	220	80.9	33	58.9	518	84.1	<0.001
	Yes	6	6.2	17	8.9	52	19.1	23	41.1	98	15.9	
Open and post-closure death	No	91	77.8	174	74.7	220	65.3	33	45.2	518	68.2	<0.001
	Yes	26	22.2	59	25.3	117	34.7	40	54.8	242	31.8	
Overall complications	No	29	25.4	39	17.2	34	10.5	10	13.9	112	15.2	0.001
	Yes	85	74.6	188	82.8	290	89.5	62	86.1	625	84.8	
complications during open treatment	No	47	41.2	82	36.1	120	37.0	36	50.0	285	38.7	0.158
	Yes	67	58.8	145	63.9	204	63.0	36	50.0	452	61.3	
	anastomosis dehiscence	4	3.5	10	4.40	24	7.40	4	5.55	42	5.69	
	Bleeding	31	27.1	33	14.53	48	14.81	7	9.72	119	16.14	
	Myocardual infarction	0	0	3	1.32	6	1.85	4	5.55	13	1.76	
	pulmunary embolism	1	0.87	2	0.87	1	0.30	1	1.38	5	0.67	
	arithmia and other cardiological complications	9	7.89	21	9.25	26	8.02	6	8.33	62	8.41	
	Ongoing Sepsis	18	15.78	33	14.53	41	12.65	11	15.27	103	13.97	
	Pneumonia and vetilator dependence	17	14.91	24	10.57	26	8.02	4	5.55	71	9.63	
complications after definitive closure	No	50	51.5	85	45.0	83	30.5	25	44.6	243	39.6	<0.001
	Yes	47	48.5	104	55.0	189	69.5	31	55.4	371	60.4	
	Bleeding	6	7.05	9	5.45	28	11.15	1	2.43	44	8.11	
	Myocardual infarction	1	1.17	1	0.60	5	1.99	1	2.43	8	1.47	
	pulmunary embolism	1	1.17	1	0.60	0	0.0	0	0.0	2	0.36	
	arithmia and other cardiological complications	1	1.17	7	4.24	27	10.75	6	14.63	41	7.56	
	peritonitis and intra-abdominal abscess	1	1.17	4	2.42	12	4.78	2	4.87	19	5.50	
	Pneumonia and vetilator dependence	8	9.41	21	12.72	34	13.54	8	19.51	71	13.09	
	Wound infection	9	10.58	21	12.72	27	10.75	4	9.75	61	11.25	
EAF	No	105	89.7	216	92.7	301	89.3	67	91.8	689	90.7	0.554
	Yes	12	10.3	17	7.3	36	10.7	6	8.2	71	9.3	
Incisional hernia	No	65	98.5	98	83.8	138	94.5	18	85.7	319	91.1	0.002
	Yes	1	1.5	19	16.2	8	5.5	3	14.3	31	8.9	
mortality at 1 month follow-up	No	80	97.6	133	90.5	169	89.9	22	78.6	404	90.8	0.021
	Yes	2	2.4	14	9.5	19	10.1	6	21.4	41	9.2	
mortality at 1 year follow-up	No	40	95.2	77	87.5	100	87.7	12	80.0	229	88.4	0.381
	Yes	2	4.8	11	12.5	14	12.3	3	20.0	30	11.6	
Overall mortality	No	87	74.4	149	63.9	187	55.5	24	32.9	447	58.8	<0.001
	Yes	30	25.6	84	36.1	150	44.5	49	67.1	313	41.2	

with age, with the higher proportion in the elderly patients; in literature no data are available about the crude mortality rates of intra-abdominal infections and peritonitis divided for ages in patients treated conventionally and therefore no comparative analysis are feasible. The present study also shows that acute mesenteric ischemia and vascular emergencies increased as well proportionally with increasing age. The ASA group stratification suggest a case mix of critically ill patients needing an OA, the most represented group in fact was ASA IV. As a counterpart among the 4 groups, the ASA class V is mostly represented in younger patients (group 1: 15.4%): this is mainly due to the rate of traumatic events occurring in this age group, rather than to the possible comorbidities of the patients. Existing data reported a mortality rate in trauma of 14.8% in patients over 65 years old, 17.1% in patients older than 74 and 10% in older of 80 years.[12–15] Present data confirmed the lower proportion of patients treated with OA for trauma (resulting from of lower incidence of trauma in elderly people) with similar results among different age classes (Table.4, Fig. 3). However all existing data abut open abdomen in trauma are from different and non-comparable cohorts of patients; to stratify trauma patients only by age could be considered an oversimplification and moreover no other data about age distribution and age effect in open abdomen in trauma patients exist in literature.

In the study several TACTs were analyzed:data did not show differences in the frequencies of use of the different techniques between the 4 groups; the most adopted technique was the closure with negative pressure (65.1%) that reflects the preference for these procedures which, according to some authors, would guarantee more favorable fascial closure and fistula rates.[16–20]

The duration of open treatment was longer in group 1 and progressively decreased in the remaining age groups. The ICU length of stay was similar in the first 3 groups but was lower in group 4, while the total length of stay was higher in the first two groups compared to the second two. These results could be interpreted at the light of the different mortality among groups: the higher mortality in elderly patients could justify these differences with a selection of "better" patients who survives and need shorter OA and shorter care in ICU.

Open abdomen was related also with a high complications rate (84.8% of the patients have developed complications, during the open treatment or after the closure): complication rate increased progressively in the first 3 groups and then decrease in group 4. Similarly to the duration of treatment and length of stay the lower complication rate in elderly patients (80 years) could be attributed to the high mortality of patients in this group (67.1%) with the selection of survivors. Overall mortality was 41.2%; This data clearly show the

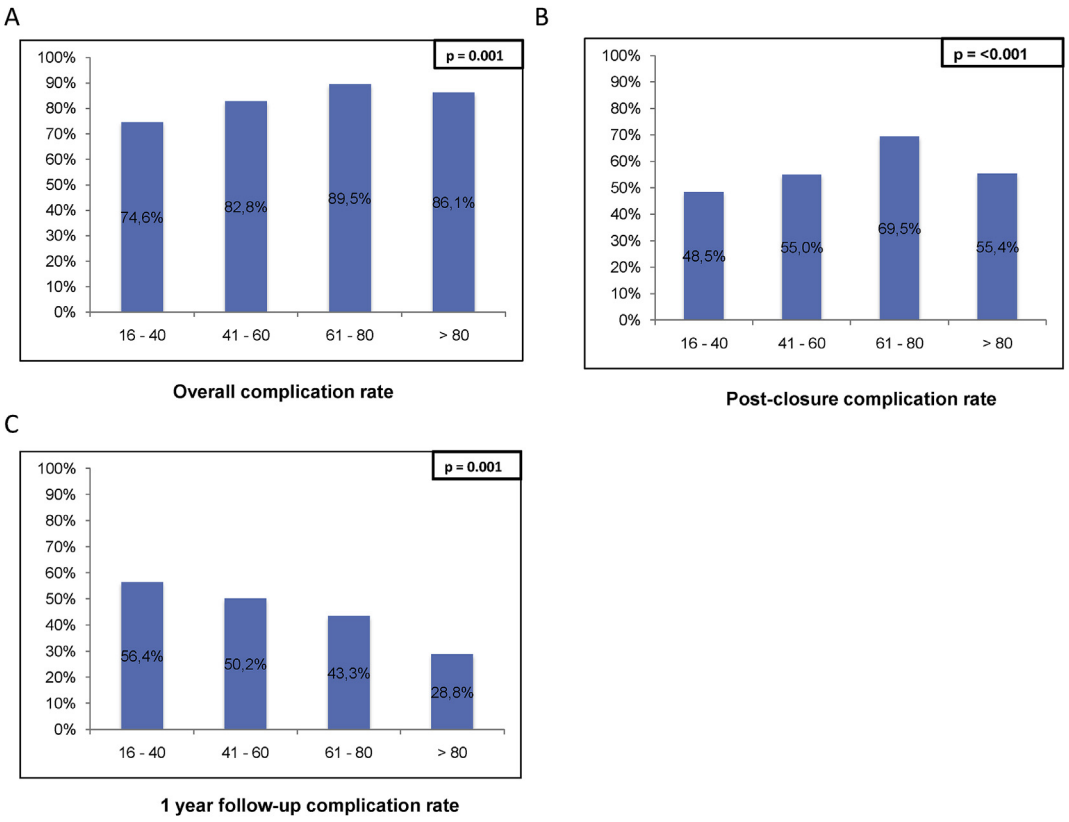

Fig. 2. Complication rate; (A) Overall complication rate, (B) Post-closure complication rate, (C) 1 year follow-up complication rate.

proportional and progressive increase in mortality with increasing patients age as shown in Table 3. The trend of the rates related to post-closure mortality, mortality during open treatment + post-closure mortality and 1-month follow-up mortality post-OA confirmed and reinforced the evidence that mortality in these patients depends on age more than on OA by itself. The latter assumption is due to the numerous co-morbidities typical of the elderly patient that precipitate the highly critical clinical picture of the patients normally subjected to OA and to the OA method itself which is not free of complications. The relative weight that these two motivations have on mortality remains to be determined with more accurate and detailed dedicated studies. The present study has the limitation, as all the registries, of scarce and not completely exhaustive data; however it represents one of the larger prospective studies on open abdomen. Despite high mortality and morbidities this study confirms that OA is nowadays adopted even in elderly patients.

Contributors list

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Table 4
Study outcomes for patients treated for Trauma and Peritonitis. EAF: entero-atmospheric fistula.

			Age class										P
			16–40		41–60		61–80		>80		Total		
			n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	
Peritonitis	Open death	no	30	90,9	93	86,1	163	81,1	35	77,8	321	82,9	0.310
		yes	3	9,1	15	13,9	38	18,9	10	22,2	66	17,1	
	Definitive closure	no	3	9,1	15	13,9	38	18,9	10	22,2	66	17,1	0.310
		yes	30	90,9	93	86,1	163	81,1	35	77,8	321	82,9	
	Post-closuredeath	no	28	93,3	83	89,2	136	83,4	19	54,3	266	82,9	<0.001
		yes	2	6,7	10	10,8	27	16,6	16	45,7	55	17,1	
	Open and closed	no	28	84,8	83	76,9	136	67,7	19	42,2	266	68,7	<0.001
	death	yes	5	15,2	25	23,1	65	32,3	26	57,8	121	31,3	
	EAF	no	28	84,8	99	91,7	172	85,6	40	88,9	339	87,6	0.440
		yes	5	15,2	9	8,3	29	14,4	5	11,1	48	12,4	
	Fascialclosure		3	9,1	17	15,7	38	18,9	10	22,2	68	17,6	0.416
		no	3	9,1	15	13,9	33	16,4	9	20	60	15,5	
		yes	27	81,8	76	70,4	130	64,7	26	57,8	259	66,9	
	Days of Open abdomen		19	36	12	28	7	8	6	7	9	19	
	ICU length of stay		22,4	27,3	18,3	21,2	15,7	15,4	9,9	9,1	16,3	17,9	
	Total length of stay		24	33	28	34	19	28	10	12	20	29	
Trauma	Open death	no	54	91,5	29	74,4	14	87,5	2	100	99	85,3	0.113
		yes	5	8,5	10	25,6	2	12,5	0	0	17	14,7	
	Definitive closure	no	5	8,5	10	25,6	2	12,5	0	0	17	14,7	0.113
		yes	54	91,5	29	74,4	14	87,5	2	100	99	85,3	
	Post-closuredeath	no	53	98,1	28	96,6	13	92,9	1	50	95	96	0.008
		yes	1	1,9	1	3,4	1	7,1	1	50	4	4	
	Open and closed	no	53	89,8	28	71,8	13	81,3	1	50	95	81,9	0.087
	death	yes	6	10,2	11	28,2	3	18,8	1	50	21	18,1	
	EAF	no	54	91,5	38	97,4	16	100	2	100	110	94,8	0.418
		yes	5	8,5	1	2,6	0	0	0	0	6	5,2	
	Fascialclosure		5	8,5	10	25,6	2	1,8	0	0	17	14,7	0.380
		no	4	6,8	3	7,7	1	6,3	0	0	8	6,9	
		yes	50	84,7	26	66,7	13	81,3	2	100	91	78,4	
	Days of Open abdomen		6	7	7	11	5	4	4	2	6	8	
	ICU length of stay		13	11,7	18	18	34,8	76,8	21	15,6	17,6	30,6	
	Total length of stay		22	22	16	21	11	20	10	14	17	21	

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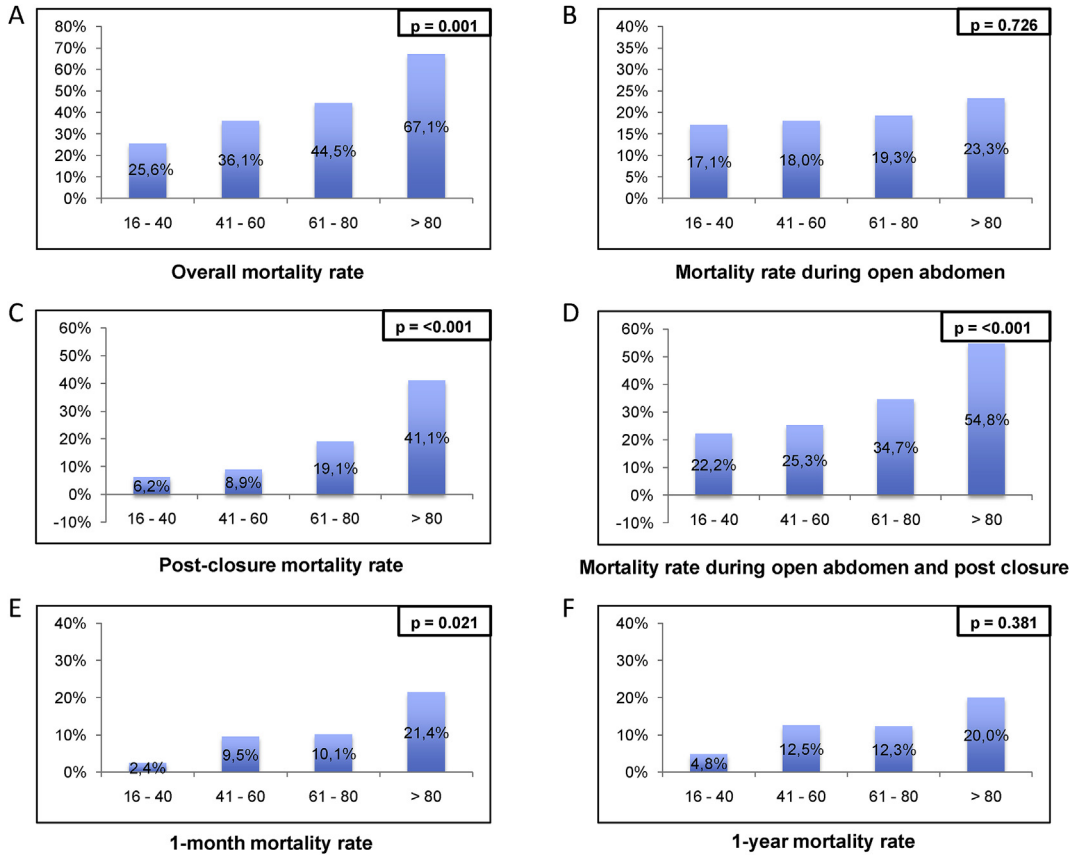

Fig. 3. Mortality rate: (A) overall mortality rates, (B) mortality rates during open abdomen rates, (C) post-closure mortality rates, (D) mortality during open abdomen and post closure(E)1-month mortality rates, (F) 1-year mortality rates.

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Ethics approval and consent to participate

Study has been approved by the coordinating centre Ethical Committee (Papa Giovanni XXIII Hospital, Bergamo, Italy) (Protocol number 0020776/15).

Availability of data and supporting materials

Not applicable.

Conclusions

The present study shows that Open abdomen treatment is largely adopted and seems to be feasible at every age. The indications to Open Abdomen are differently distributed in relation to the different age groups. Advanced age has a negative effect on complications and on mortality rates; further studies are needed to investigate the role of age in determining outcomes in patients treated with open abdomen.

Declaration of competing interest

All authors declare to have no competing interests.

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