Clinics of Surgery

Research Article

ISSN 2638-1451 | Volume 4

Determinants of Mortality for Digestive Emergency Surgery in Low-Income Countries: The Case of Senegal

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Received: 06 Feb 2021
Accepted: 25 Feb 2021
Published: 01 Mar 2021

Citation:

Ba PA, Determinants of Mortality for Digestive Emergency Surgery in Low-Income Countries: The Case of Senegal. Clin Surg. 2021; 4(9): 1-8

1. Summary

1.1. Background: The high postoperative mortality rate in Sub-Saharan countries is often associated with the limitations of health systems. In Senegal, there is few data nationwide that allow to determine post-operative death factors after abdominal emergency surgery.

1.2. Methods: We did a national, prospective, observational study in Senegalese public hospitals performing emergency digestive surgery. We decided to focus on regions outside of the capital because the socio-economic profiles of those regions are different from Dakar and there are limited studies on surgical care in those regions. Our outcome measure was the 30 days in-hospital postoperative mortality. Self-selected investigators identified consecutive patients within the one-year duration of study and filled out a paper-based patient inquiry form for each. Descriptive and analysis statistics were performed in Stata.

1.3. Findings: 601 patients were recruited from five hospitals. They were mostly men (71.2%), and the mean age were 30·2 years. 54.4% of the patients arrived in hospital at least 48 hours after the beginning of their symptoms. The average time between admission and procedure was 15.6 hours, and the main cause of delayed intervention was a lack of money. Infection was the most common complication, and the mortality rate was 8.5%. Death was significantly associated with age under 5 years (p= 0.002), female gender (p=0.003), an ASA score of 3 and over (p= 0.000), surgical intervention duration over 60 minutes (p=0.049), and complications (p=0.000).

1.4. Interpretation: Mortality risk for patients undergoing abdominal emergency surgery in Senegal is mainly associated with the lack of resources, but many deaths could be avoided if some socio-cultural behaviors are address.

2. Introduction

Preventing death of patients undergoing abdominal emergency surgery is a daily challenge for Sub-Sahara African surgeons. There are many factors in these countries that could lead to patient's death, and the health system of many of these countries is fragile. The inadequacy between patients' needs and the supply of emergency abdominal surgery [1] makes the postoperative mortality rate for abdominal emergency surgery in developing countries 2 to 3 times higher compared with high-income countries (HICs) [2, 3].

The current trend is an increase of surgical procedures worldwide mainly in low- and middle-income countries (LMICs) that covert 1/3 of the world's population [2, 4, 5]. If the health system is not improved, this will inevitably lead to an increase of surgical complications, hence an increase in the number of deaths post-surgery in LMICs [6]. Moreover, Sub-Saharan countries are characterized by a scarcity of surgical data [7, 8]. Therefore, it is difficult to evaluate the quality of surgical care for improvement of surgical outcomes. Prospective audits in these resourced-limited environments are required to understand the specific determinants in individual countries [3, 9].

Senegal, a West African low-income country is also suffering from this lack of data for surgical care. In Senegal, data from the African Region of the World Health Organization (WHO) show a lack of enough health providers with 0·6 physician per 10 000 populations in 2016 [10], and there is an unfair repartition of the existent [11]. Few surgical care data are available in individual hospitals essentially outside of Dakar, the capital. Although WHO recommends strengthening emergency and essential surgical care and anesthesia as a component of universal health coverage (WHA68.15) [12], many people in Senegal as in most Sub-Saharan countries do not have access to emergency surgical care [7,13,14].

In this environment of resource-limited settings and a lack of data on surgical care outcomes, this study is aiming at closing some of the information gap. We conducted a prospective study to identify factors that determine postoperative death after abdominal emergency surgery in Senegal. Results from this study are intended to start the discussion around how to mitigate those risks and ensure a better-quality surgical care for patients.

3. Methods

3.1. Study Design and Procedures

This is a prospective, observational study that would ideally be conducted in all Senegalese public hospitals performing emergency digestive surgery outside of the capital Dakar. We decided to focus on regions outside of the capital because the socio-economic profiles of those regions are different from Dakar and there are limited studies on surgical care about those regions. This study did not benefit from any funding, and, given our limited resources, we had to resort to voluntary participation of the surgeons in the 18 eligible hospitals nationwide (Annex 1). We contacted them by phone and ask them about willingness to participate in the study. The obtained sample included five hospitals located in four regions (Figure 1).

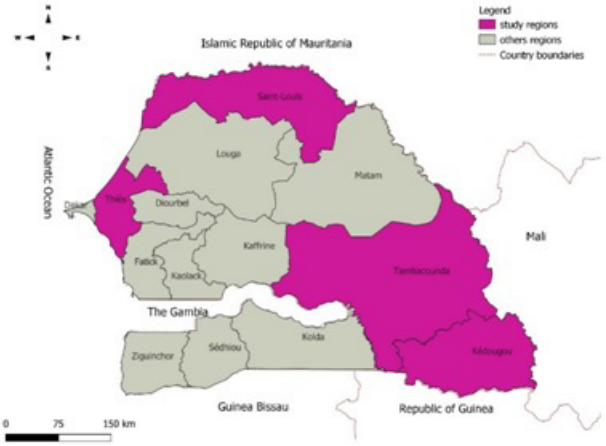

Figure 1: Senegal map showing participating regions

Annex 1: Eligible public hospitals performing abdominal emergency surgery in 2016*.

Region	Population in 2016**	Public hospital performing abdominal emergency surgery 2016			
		District hospital	Level 1	Level 2	Level 3
Dakar	3 330 694		1		5
Diourbel	1 591 593			1	1
Fatick	761 713			1	
Kaffrine	609 643		1		
Kaolack	1 021 657			1	
Kedougou	161 530	1			
Kolda	703 779			1	
Louga	924 047			1	
Matam	607 231			1	

Sedhiou	483 768		1		
St Louis	957 600		1	2	
Tambacounda	730 475			1	
Thies	1 889 320		2	1	
Ziguinchor	583 525			1	
Total	14 356 575	1	6	11	6

*data from Senegalese Health Ministry

** data from National Agency for Statistics and Demography, Senegal.

3.2. Data and Participants

The study included all consecutive patients undergoing digestive emergency surgery in these hospitals during twelve consecutive months from September 2015 to August 2016. Digestive emergency surgery was defined as any unplanned operation by any open, laparoscopic or converted laparoscopic procedure that entered the peritoneal cavity and concerned any organ of the digestive system or the intraperitoneal cavity. Patients who were not operated, caesarean section, gynecological, urogenital, and vascular emergency surgical procedures were excluded. There was no age restriction. Clinical aspects concerning patients and the surgical procedure were registered. Hospital's resources and safety processes were not explored. Patients' comorbidities and a medical history of diabetes, high blood pressure, stroke and cardiovascular disease, smoking or Chronic Obstructive Pulmonary Disease (COPD), alcoholism, previous abdominal surgery were systematically collected. The American Society of Anesthesiologists (ASA) score was considered at the point where the surgical decision was made. The diagnosis was confirmed during the surgical procedure and categorized into three main digestive surgical emergencies: peritonitis, bowel obstruction and appendicitis. Any other diagnosis was ranged in the group of "other diagnosis". In each hospital in our sample, the self-selected investigators identified consecutive patients within the one-year study duration and filled out a paper-based patient inquiry form for each. The form was prepared by the lead investigator. Each 30 days, they summarized and validated the data related to the patient, his medical story and the disease, his treatment and his outcome before sending it to the lead investigator. Each hospital investigator was contacted for missing or unclear information as needed. The principal investigator consolidated all hospital data in a Microsoft Excel master database.

3.3. Outcomes

The outcome measure was the in-hospital postoperative mortality. Deaths after hospital discharge were not registered as we could not observe them. Complications were described according to the European Perioperative Clinical Outcome (EPCO) definitions [15] and graded as mild, moderate, or severe. Both outcomes were observed for up to 30 days' post-surgery or up to discharge, if it occurred earlier.

3.4. Statistical Analysis

There was no predefined sample size for the study as the ideal would have been to recruit all eligible public hospitals in Senegal and consequently all the patients who received digestive emergency surgery for our study period. With the five hospitals included in the study, we had a sample of 601 patients. Such a sample size should be able to provide estimates of mortality given the assumed determinants but is not powered to detect differences across hospitals.

Descriptive statistics of the data were performed. In a first stage univariate analysis of mortality relative to the clinical and other characteristics was done. For that part we tested the difference in proportions for categorical variables and used the Student test for checking the difference in means for continuous variables. A multivariate analysis in the form of a logistic regression were then performed and included all potential factors associated with mortality post-surgery identified through the univariate analysis. These included age, gender, admission mode, preoperative medical comorbidities, previous abdominal surgery, evolution time, American Society of Anesthesiologists (ASA) score, diagnosis, surgical time, surgical procedures, surgical duration, intensive care unit stay, and complications. The regression results are expressed as odd ratios. The analysis was performed in Stata.

3.4. Ethical Approval

This study was exempted of Ethical Committee review by the Health Ministry given the collected data were anonymously extracted from patient records.

4. Results

A total of 601 patients were recorded from the five hospitals. Patients characteristics are described in (Table 1). There were mostly men (71.2%). The mean age was 30.2 years, and ages ranged from 2 days to 90 years. Patients in the age group 16 – 35 were the more numerous (37.6%). Patients were transferred in 354 cases (58.9%), mainly from health facilities where emergency surgeries were not available. The average evolution time of the condition was 76 hours. The patients were admitted in the emergency room 48 hours after the onset of their symptoms in 327 cases (54.4%). 123 patients had comorbidities and 47 had a story of previous digestive surgery. The patients were classified ASA1 in 438 cases (72.9%), ASA2 in 122 cases (20.3%), ASA3 in 38 cases (6.2%), and ASA4 in 3 cases (0.5%). The average time between admission and procedure was 15.6 hours and the median 7 hours.

The main causes of delayed surgical intervention were a delay of

lab tests results, imagery results or unavailability of drugs for the surgical procedures. All patients were operated by laparotomy. The most common diagnosis was a bowel obstruction (233 cases; 38.8%), followed by peritonitis (175 cases; 29.1%) and appendicitis (163 cases; 27.1%). The others abdominal emergencies represented 5 percent of diagnosis (31 cases) and included 19 cases abdominal traumatism with lesions concerning the spleen, the liver, the mesentery, and the diaphragm; one case of intestinal lesion during a uterine rupture; 11 cases of acute abdominal pain.

In terms of techniques, 103 intestinal resections and 43 stomies were performed. The surgical intervention duration ranged from 15 to 230 minutes with a mean time of 66.5 minutes and a median of 60 minutes. Seventy-six patients were admitted in critical care immediately after surgery. A total of 123 (20.5%) patients developed postoperative complications. Infections were the most common complication (Table 2). We recorded 51 deaths during the 30 days' postoperative period hence a mortality rate of 8.5 per cent. Causes of death were dominated by multi-organ failure and cardiac arrest. Among patients who died, 56.8 percent had been admitted in intensive care unit after surgery, and 50.9% died in the first 48h following surgery.

On multivariate analysis, the logistic regression showed that 30-day mortality was associated with age under 5 years (OR 9.31; 95% CI [2.29 – 37.70]; p= 0.002), female gender (OR 6.11; 95% CI [1.83 – 20.36]; p=0.003), transfer(OR 4.29; 95% CI [0.99 – 18.43]; p= 0.050), an ASA score of 3 and over (OR 52.52; 95% CI [10.82 – 254.89]; p= 0.000), a stomy (OR 34.88; 95% CI [7.85 – 154.97]; p=0.000), a duration of surgical intervention over 60 minutes (OR 1.02; 95% CI [1.00 – 1.04]; p=0.049), an intensive care unit admission (OR 4.16; 95% CI [1.35 – 12.75]; p=0.013), and complications (OR 42.36; 95% CI [9.68 – 185.24]; p=0.000) (Table 3).

Table 1: Patient characteristics

Variables	Total		# complications	Alive		Died	
	# patient	%		# patient	%	# patient	%
Gender							
M	428	71·2	91	398	93	30	7
F	173	28·8	32	152	87·8	21	12·2
Age (years)							
[0 - 5]	44	7·3	7	33	75	11	25
[6 - 15]	128	21·3	19	128	100	0	0
[16 - 35]	226	37·6	48	213	94·2	13	5·8
[36 - 59]	125	20·8	34	111	88·8	14	11·2
[+ 60 [	78	13	15	65	83·3	13	16·7
Admission mode							
Self							
Transfer							
	247	41	48	239	96·7	8	3·3
	354	59	75	311	87·8	43	12·2
History							
Medical comorbidity	123	20·5	26	104	84·6	19	15·4
Surgical	47	7·8	12	44	93·6	3	6·4
Evolution time (hours)							
[0 - 12]	124	20·6	21	119	96	5	4
]12 - 24]	57	9·5	10	54	94·7	3	5·3
]24 - 48]	93	15·5	11	90	96·7	3	3·3
] + 48 [	327	54·4	81	287	87·7	40	12·3
ASA score							
1	438	72·9	84	426	97·3	12	2·7
2	122	20·3	26	107	87·7	15	12·3
3	38	6·3	13	17	44·7	21	55·3
4	3	0·5	0	0	0	3	100
Admission to procedure time (hours)							
≤ 6	272	45·3	48	257	94·5	15	5·5
]6 - 12]	127	21·1	27	117	92·1	10	7·9
> 12	202	33·6	48	176	87·1	26	12·9
Diagnosis							
Occlusion	233	38·8	39	203	87·1	30	12·9
Peritonitis	175	29·1	57	156	89·1	19	10·9
Appendicitis	163	27·1	22	163	100	0	0
Others	30	5	5	28	93·3	2	6·7
Therapeutic aspects							
Resection	103	17·1	29	83	80·6	20	19·4
Stomy	43	7·1	7	26	60·5	17	39·5
Operative incident							
No	580	96·5	114	535	92·3	45	7·7

Yes	21	3·5	9	15	71·4	6	28·6
Acute anemia							
No	555	92·4	108	520	93·7	35	6·3
Yes	46	7·6	15	30	65·2	16	34·8
Duration of surgery (minutes)							
[0 - 30]	41	6·8	1	40	97·6	1	2·4
[31 - 60]	301	50·1	41	281	93·3	20	6·7
[61 - 90]	161	26·8	51	150	93·2	11	6·8
[91 - 120]	54	9	16	47	87	7	13
[+ 120[	44	7·3	14	32	72·7	12	27·3
Intensive care stay							
No	525	87·4	94	503	95·8	22	4·2
Yes	76	12·6	29	47	61·8	29	38·2

Table 2: Postoperative complications

Type of complications	Number	Severity of complications		
		Mild	Moderate	Severe
Superficial surgical site infection	65	60	2	3
Deep Surgical site infection	3	0	2	1
Body cavity infection	14	0	0	14
Anastomotic leak	13	6	0	7
Arrhythmia	5	0	2	3
Paralytic ileus	12	11	0	1
Postoperative hemorrhage	3	0	1	2
Others	8	5	2	1
Total	123	82	9	32

Table 3: Factors associated with 30-day mortality on multivariate analysis.

Variables	**# Alive**	**# Died**	**Multilevel analysis**		
			OR	**95% IC**	**P**
Gender					
M	398	30			
F	152	21	6·116	[1·837 - 20·362]	0·003
Age (years)					
≤ 5	33	11	9·312	[2·299 - 37·703]	0·002
[6 - 15]	128	0			
[16 - 35]	213	13			
[36 - 59]	111	14			
≥ 60	65	13	0·647	[0·191 - 2·190]	0·485
Admission mode					
Self	239	8			
Transfer	311	43	4·29	[0·998 – 18·437]	0·05
History			2·804	[0·640 - 12·275]	0·171
Medical	104	19			
Surgical	44	3			
Evolution time (hours)					
[0 - 12]	119	5			
]12 - 24]	54	3	4·378	[0·664 - 28·862]	0·125
]24 - 48]	90	3	0·3	[0·044 - 2·035]	0·218
] + 48 [	287	40	2·406	[0·746 - 7·758]	0·141
ASA score					
1	426	12			
2	107	15	4·924	[1·266 - 19·140]	0·021
≥3	17	24	52·528	[10·824 - 254·899]	0·000
Admission to procedure time (hours)			1·013	[1·002 - 1·024]	0.·013

≤ 6	257	15			
]6 - 12]	117	10			
> 12	176	26			
Diagnosis					
Occlusion	203	30	2·343	[0·399 - 13·753]	0·346
Peritonitis	156	19	1·499	[0·324 - 6·937]	0·604
Appendicitis	163	0			
Others	28	2			
Therapeutic aspects					
Resection	83	20	1·68	[0·529 - 5·332]	0·378
Stomy	26	17	34·889	[7·854 - 154·973]	0·000
Acute anemia			7·763	[2·284 - 26·379]	0·001
Yes	30	16			
No	520	35			
Intervention duration			1·022	[1·000 - 1·045]	0·049
[0 - 30]	40	1			
[31 - 60]	281	20			
[61 - 90]	150	11			
[91 - 120]	47	7			
[+ 120[	32	12			
Rea			4·16	[1·356 - 12·759]	0·013
Yes	47	29			
No	503	22			
Complication			42·36	[9·686 - 185·245]	0·000
Yes	102	21			
No	448	30			

Wald chi2(21) = 85·26 Prob > chi2 = 0·0000 Pseudo R2 = 0·6917 Log pseudolikelihood = -53·81575

5. Discussion

Our study is in line with the literature findings that postoperative mortality for abdominal emergency surgery in Sub-Saharan African countries, such as Senegal, is two to three time higher than in high-income countries [2, 4, 16]. Although patients receiving abdominal emergency surgery in these countries have a lower-risk profile [3], they are more likely to die because of multiple factors related to the limitations of the health systems [17-19]. In our study, almost all factors related to patient or treatment characteristics potentially raises the death risk, but we want to point out four factors which have a significant impact on the postoperative mortality rate: the delay of transfer (p=0.05), an ASA score of 3 and over (p=0.000), the delay of surgical procedure (p=0.013), and the occurrence of complications (p=0.000). These four factors are linked together and reflect some of the health system limitations in Senegal.

Abdominal emergency surgeries are serious no matter the patient's age or socio-economic rank. Patients should be seen the earliest possible by a surgeon and timely treated. Unfortunately, because of cultural believes and lack of financial resources [20, 21], most patients in Senegal are very likely to first consult with traditional health practitioners [22], as traditional medicine is perceived as more affordable [23], and only go to the clinical facilities for last resort. Another reason for delayed surgical treatment is the misunderstanding of surgical care in general by many people, including some health providers at the primary health facilities who are undertrained to diagnose emergency patients which can delay patient transfer. In a context of poverty and high level of out of pocket expenditures for health, 51.8% in 2016 according to data from Word bank [24], abdominal pain is often neglected, and patients consult emergency room late.

We found that patients under 5 (p=0.002) and women (p=0.003) are at significant risk. Another African study [25] has found that female gender was significantly associated with a higher postoperative death risk. In Senegal, and probably in many other Sub-Saharan African countries, this finding could be explained by the fact that women arrive later in the ER with deeper physiological deterioration. In our study, the mean time for consultation was 99 hours for female patients, much more than that for male patients which was 66.3 hours. This difference in mean time of consultation between female and male was significant (p=0.000). For cultural reasons, women have higher tolerance to pain hence they mostly seek care only when it becomes unbearable. This pain is often miss

linked to a transient or recurrent gynecological problem, and, once in the hospital, women are then often firstly oriented in gynecological department and do not end up in the surgical emergency room until much later.

The delayed consultation increases physiological deteriorations [26, 27] and so the patient's ASA score. A score of 3 and over is significantly associated to a higher death risk (p=0.000) [28]. 50.9 percent of the deaths in our study occurred in the first 48h following the surgery. Previous studies have already demonstrated how much perioperative warning and intensive care is challenging in Africa [2, 3, 16, 29]. This challenge is more intense for patients aged under 5 as their immune defense is fragile. Their treatment requires skilled staff and rigorous monitoring, which the resource-limited health systems lack of.

For different reasons, patients are operated late. The main reason in our study was unavailability of lab tests, imagery, and/or drugs and consumables for surgery. Timely operations could prevent patients' complications which increase death risk (p=0.000). Our study reveals that one patient in five has a surgical complication. Delayed intervention contributes to further physiological deterioration, increases the risk of complication [4, 19, 30], and those complications lead to a higher risk of death.

Our study is limited by the numbers of patients and hospitals. Data from the Senegalese Health Ministry indicate that, hospitals that performed abdominal emergencies surgery at the period of our study were twenty-three nationwide: six of level 1, eleven of level 2, and six level 3. 73.9 per cent of these hospitals are outside of Dakar, and we deliberately wanted to focus on outside of Dakar hospitals given the socio-economic differences and the lack of medical studies on those hospitals. More hospitals of different level would increase the number of patients and further confirm our findings, but, as explained in the method section, we were limited by the voluntary nature of study participation with no funding to support data collection. Our experience with setting up this study shows the difficulties to conduct large scale medical study in resource-limited settings with weak health information systems [31] and lack of documentation of inpatient events. Moreover, the scarcity of health professionals (doctors) who are used to conducting medical studies and understands the importance of such studies [16, 29] is also a big constraint. However, despite all these difficulties, our study is the only one to our knowledge that has ever been done in Senegal on postoperative outcomes of abdominal emergency surgery using patients from several hospitals. We are confident that the study findings are representative of the situation, outside of the capital Dakar, where coverage of emergency surgical care is limited [7, 32].

The hospitals where the study was conducted are reference hospitals in their respective regions, and the population they serve represents 26.1 percent of the nation's population [11]. Furthermore, some patients in Saint Louis and Thies hospitals come from neighboring regions (Matam, Louga, Fatick and Diourbel) where the hospitals' surgical department have less advanced technical installations, and even from other neighboring countries (Republic of Guinea for Kedougou and Tambacounda hospital and Islamic republic of Mauritania for Saint-Louis hospital).

Despite sample size and data limitations, this study produced accurate and exploitable data that allow us to firmly believe that the postoperative mortality rate for abdominal emergency surgery in low-income countries such as Senegal could significantly be improved if emergency patients are identified and transferred to the right level of health facilities early, and treated without delays. This finding translates the urgency to address the problem of under-resourcing: limited skills of some health workers and lack of proper resources at the hospital level [3].

6. Conclusion

The postoperative mortality rate for abdominal emergencies is associated in Senegal with factors that reflect the weaknesses of the health system. However, our findings suggest that some socio-economic and cultural behaviors might also increase the death risk. Many patients arrive late in hospitals mainly because they do not have enough revenues to face the out–of –pocket expenses related to health care, but also because they follow their beliefs and consult first a traditional heath practitioner. Many of the observed deaths are preventable, and the outcomes could be significantly improved if patients are arrived sooner at hospitals, and the under-resourcing of hospitals were addressed.

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