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ORIGINAL ARTICLE

Emergency laparotomy for peritonitis in the elderly: A Multicentre observational study of outcomes in Sub-Saharan Africa☆

Aloysius Ugwu-Olisa Ogbuanya [a,b,c,d,e,*], Nonyelum Benedett Ugwu [c,k], Vincent C Enemuo [a,f,g], Ugochukwu U Nnadozie [a,b], Uche Emmanuel Eni [a,b], Richard L Ewah [b,d,h], Uzoamaka E Ajuluchuku [a,b], Daniel A Umezurike [a,b], Livinus N Onah [i,j]

[a] Department of surgery, Alex Ekwueme Federal University Teaching Hospital, Abakaliki (AEFUTHA), Ebonyi State, Nigeria
[b] Department of Surgery, Ebonyi State University, Abakaliki (EBSU), Ebonyi State, Nigeria
[c] Department of surgery, Bishop Shanahan Specialist Hospital, Nsukka, Enugu state, Nigeria
[d] Department of Surgery, Mater Misericordie Hospital, Afikpo, Ebonyi State, Nigeria
[e] Department of Surgery, District Hospital, Nsukka, Enugu State, Nigeria
[f] Department of surgery, University of Nigeria, Nsukka, Enugu State, Nigeria
[g] Department of surgery, University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu State, Nigeria
[h] Department of Anaesthesia, Alex Ekwueme Federal University Teaching Hospital, Abakaliki (AEFUTHA), Ebonyi State, Nigeria
[i] Department of Obstetric and Gynaecology, Enugu State University Teaching Hospital Enugu, Nigeria
[j] Department of Obstetric and Gynaecology, Enugu State University of Science and Technology, Enugu, Nigeria
[k] Department of Anaesthesia, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria

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ABSTRACT

Background: Globally, interest in surgical diseases in the elderly was rekindled recently mainly due to a surge in the aging population and their increased susceptibility to infections. In sub-Saharan Africa, infective diseases are major causes of high morbidity and mortality especially in elderly cohorts, hence this study was set to evaluate current status of this scourge in the elderly in our environment.

Aim: To document the aetiologic factors and analyze the impact of selected clinical and perioperative indices on mortality and morbidity rates of peritonitis in the elderly.

Methods: This was a multicenter prospective study involving elderly patients aged 65years and above managed between October 2015 and September 2021 in Southeast Nigeria.

Results: Of the 236 elderly patients examined, approximately two-third (150, 63.6%) were aged 65–74years. The rest were aged ≥ 75years. There were 142(60.2%) males and 94(39.8%) females. Perforated peptic ulcer (89,37.7%) was the most common cause of peritonitis followed by ruptured appendix (59, 25.0%), then typhoid perforation (44,18.6%). However, typhoid perforation was the deadliest with a crude mortality rate of 40.9%. Overall, morbidity and mortality rates were 33.8% and 28.5% respectively. The main independent predictors of mortality were peritonitis arising from typhoid perforation ($p = 0.036$), late presentation ($p = 0.004$), district location of hospital ($p = 0.011$) and intestinal resection ($p = 0.003$).

Conclusion: Generalized peritonitis is a cause of significant morbidity and mortality in the elderly patients in our environment. Perforated peptic ulcer was the most common cause, but typhoid perforation remains the deadliest. Late presentation, district hospital setting and bowel resection were associated with elevated mortality.

☆ Institutions where this study was done: 1. Department of surgery, Alex Ekwueme Federal University Teaching Hospital, Abakaliki (AEFUTHA), Ebonyi State, Nigeria 2. Department of surgery, Bishop Shanahan Specialist Hospital, Nsukka, Enugu state, Nigeria 3. Department of Surgery, Mater Misericordie Hospital, Afikpo, Ebonyi State, Nigeria. 4. Department of Surgery, District Hospital, Nsukka, Enugu State, Nigeria.

* Corresponding author at: Department of surgery, Alex Ekwueme Federal University Teaching Hospital, Abakaliki (AEFUTHA), Ebonyi State, Nigeria.
E-mail address: ogbuanyaa92@gmail.com (A.U.-O. Ogbuanya).

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African relevance

- This study presents the first data from southeast geopolitical zone of Nigeria on generalized peritonitis in the elderly.
- It also presents the largest regional series in Nigeria on generalized peritonitis in the elderly.
- It presents the first regional scholarly report that evaluated outcome of generalized peritonitis in the elderly following emergency exploratory laparotomy.
- This study may be used by policy makers in our environment to develop strategic plans for improvements on diagnostic and therapeutic facilities needed to manage this condition.

Introduction

Overall, disease conditions requiring emergency surgery carry high perioperative risks even in the hands of the most astute of surgeons and anaesthetists [1–3]. In recent time, interest in surgical diseases in the elderly was rekindled globally, mainly due to a surge in the proportion of aging people and improvements in surgical services that led to significant reduction in postoperative morbidity and mortality [1–3]. Published data from University of California, USA showed that 12.4% of North Americans are ≥65years and in 2050, the population of persons aged ≥65years is projected to exceed 20% of entire world's population [2]. Emerging evidence from the United Nations Department of Economic and Social Affairs (UNDESA) indicates that sub-Saharan Africa (SSA) has the smallest proportion of elderly persons at present, though the proportion is increasing albeit, slowly and is expected to grow by 2.3times between 2000 and 2030 [4].

Intra-abdominal infections in the elderly pose numerous challenges and take greater tolls compared to similar infections in the younger population mainly due to a variety of physiologic alterations, multiple comorbidities, atypical clinical presentation and higher propensity towards sepsis and bowel gangrene commonly seen in the elderly [2,3,5,6]. Therefore, advancing age in the context of improved diagnostic and therapeutic facilities presents the surgeon with increasing dilemma as whether to intervene or not in both emergency and elective set ups [2,3,5]. Nevertheless, studies have shown that not all elderly patients have poor operative outcomes and not all elderly persons are frail, though advancing age is a recognized predictor of increased postoperative morbidities, which in turn predict poor long term survival [1-3,5,7-10]. In Low-and Middle-Income-Countries (LMICs), the benefits derived from increased longevity are offset by equivalent economic, social and health challenges as the resource-constrained nations have to grapple with proportionately large numbers of geriatric surgical admissions which are associated with poorer outcomes [4,11]. This is particularly worrisome in SSA where adequate treatment facilities are scarcely available, patients present late, often with multiple, previously undetected comorbidities [8,11,12]. Importantly, other barriers like poverty and religious beliefs hamper effective management in SSA [8,11,12]. The growing interest in geriatric emergency surgery has been attributed to emerging facts that elderly patients ≥ 65year make up to 50% of patients admitted to the general surgery unit and this rate is rising steadily [3,14]. Other reasons proposed were related to improvements in anesthetic and surgical techniques, patients' expectations and increasing evidence of improved outcomes following operative treatment even in extremely old patients [1-3,13,14].

Worldwide, acute abdomen including peritonitis represents frequent indication for emergency laparotomy in the elderly [13–17]. Globally, acute generalized peritonitis is a major contributor to non-trauma deaths despite improvements in diagnosis, surgical treatment and intensive care management [11,18]. Published studies show that generalized peritonitis affects 9.3 patients per 1000 hospital admissions, though it has been reported to disproportionally affect LMICs especially SSA both in terms of prevalence and mortality rates [19,20]. Across the globe, postoperative mortality of generalized peritonitis varies between 8.4%−60.0% [11,21,22]. A recent publication from Southeast Nigeria showed that a quarter (24.7%) of elderly patients who received inguinal hernia surgery had emergency abdominal operation due to complicated hernia [13]. In the emergency arm, morbidity (63.7%) and mortality (15.1%) rates were considerably higher compared to values recorded in the elective group (morbidity 19.5%; mortality 0.8%) [13]. In a study from two regional hospitals in neighboring Cameroon, Chimchom-Mefire et al. reported on a large series of 305 cases of generalized peritonitis [11]. The authors found that, though patients aged over 50 years accounted for 11.8% of the cases, morbidity and mortality were higher in those with high Mannheim Peritonitis Index (MPI) [11]. The MPI, a potent and reliable postoperative risk calculator in patients with generalized peritonitis utilizes age >50years as a key component; hence advancing age contributed to raised morbidity and mortality in that study [11]. A recent Italian study showed that MPI score and advanced age were independent predictors of mortality in a multivariate analysis [3]. In the subgroup of patients with MPI score ≥21, mortality rate was 46.4% for those older than 80years and 38.3% for younger patients ($P = 0.070$) [3]. The authors concluded that age older than 80years is strongly related to major increase in mortality and should be taken into consideration with MPI score in planning the surgical approach and the postoperative care for patients with perforation peritonitis [3].

A UK emergency laparotomy network study involving 35 National Health Scheme (NHS) hospitals and 1853 patients showed a raised perioperative mortality rate (POMR) of 24.4% in patients aged 80years and above compared to an overall mortality rate of 14.9% [21]. The authors noted that there was a direct relationship between increasing age and POMR; from a mortality of just under 10.0% for patients in their 50 s, mortality increased by approximately 4.0% for every additional 10years of age [21].

It is noteworthy that several studies from high resource settings identified advancing age as an independent predictor of poor outcome following emergency laparotomies for intra-abdominal sepsis despite improvements in intensive care and diagnostic facilities [1,2,5,7,8,10]. In Africa, however, there are mixed reports with some reporting no correlation between advanced age and poor outcomes [23–25], but others, advanced age was found an important predictive variable of poor operative outcomes in patients with generalized peritonitis [11,26-28].

From the foregoing, the role of age as a predictor of outcomes in patients with peritonitis has not been clearly defined by most African authors, however their works suggest that the impact appears to be related to etiology of the peritonitis [11]. Therefore, the relevance of a local or regional study which aims to evaluate the treatment outcomes of peritonitis in elderly patients cannot be over-emphasized. Majority of the previous discussions on this subject in Africa were based on "all age ranges or limits" and not on standardized chronological age entities like elderly, middle-aged or young patients [23-25,29,30]. This study was carried out in four selected hospitals in Southeast Nigeria. They include one tertiary hospital (located in an urban center) and three secondary hospitals (one in urban, another in semi-urban and the remaining in rural areas). The centres were selected from a pool of other hospitals because they show a fairly good representation of geographical distribution of hospitals in Southeast Nigeria, they have large patients volume and are centres where at least one or more authors practice. The aim of this study was to analyze the impact of etiologic factors, clinical and perioperative indices on mortality and morbidity rates of generalized peritonitis in the elderly.

Methods

Design and setting

This was a multicenter cross-sectional study of cases of generalized peritonitis in elderly patients managed at four hospitals in southeast Nigeria between October 2015 to September 2021. We determined the

etiological spectrum of peritonitis in the elderly and the frequency of key clinical variables at the time of presentation. We also assessed the impact of several clinical and operative techniques on outcomes. We further evaluated the severity of postoperative complications using Clavien-Dindo [31] classification.

Study participants' characteristics/Procedure

All consecutive elderly patients with clinical and radiological features of peritonitis were initially interviewed. Only elderly patients aged 65years and above who had exploratory laparotomy for generalized peritonitis were selected. Those who died before detailed clinical and radiological examinations and who subsequently did not undergo laparotomy to exclude other lesions were equally excluded. Patients who died before laparotomy were excluded because the focus of the study was on those who had surgical treatment of peritonitis (laparotomy). This part was included in the design to ensure other differentials were not included in error. Only those who gave informed consent were included. Consent was provided by patients or adult relatives (if patient was deemed incapable to consent). Each patient was resuscitated and interviewed. The sociodemographic data and other relevant clinical details were extracted via structured questionnaires and entered into a proforma. Emphasis was on the mode of onset, duration of illness, initial timing and location of abdominal pain before it became generalized, associated risk factors for each cause of generalized peritonitis and presence of comorbidities. Abdominopelvic ultrasound scan was routinely done. Only very few patients had abdominal computed tomography (CT) before surgery. Temperature, respiratory rate and haemodynamic parameters were recorded. Hourly urine output estimation was done for each patient. Basic investigations like serum electrolytes, urea and creatinine, full blood count, random blood sugar, urinalysis and chest x-ray were ordered. Preoperatively, patients were optimized. Anesthetic assessment was sought routinely.

Intra-operatively, peritoneal exudate specimens were taken routinely. The choice of procedures was based on intra-operative findings and patients' fitness. Postoperatively, patients were monitored in intensive care unit (ICU) or a "dedicated section" in the general ward. The main outcome measures were morbidity, length of hospital stay (LOHs) and mortality. Ultimately, relevant clinical data were collected preoperatively, intraoperatively and postoperatively using structured questionnaires. Due to the large fixed available samples from cases of generalized peritonitis within the study period, consideration of sample size determination was informal. For the quantitative variables, degree of delay 12–24 h was considered mild, 25–48 h moderate and >48 h prolonged. Similarly, hourly urine output ≥30 ml was considered normal while <30 ml was low. Patients were followed up for a variable period of 3–48 months. Telephone conversations were arranged for those that defaulted from clinic appointments.

Data analysis

Data analysis was performed using Statistical Package for Social Science (SPSS) Software version 22.0 (IBM, CHICAGO, IL, USA 2015). For the categorical variables, data were summarized in proportions and frequency tables. For continuous variables, we computed the ranges and mean. During analysis, we computed p-values for categorical variables using Chi-square and Fisher's exact test in accordance with the size of the dataset. We also determined the association between some selected clinical variables and morbidities/mortality using logistic regression analyses. Confidence interval was calculated at 95% level and significance at 5% probability level ($p<0.05$).

Reporting: Results were reported according to the "**Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) guidelines** [32,33]. The STROBE checklist and the page to page adherence to the items in the list is shown in Annex 1.

Ethical Approval: The protocol for this study was approved by the ethics and research board of the hospitals.

Results

At the outset, 316 elderly patients received clinical diagnosis of generalized peritonitis. Further assessment revealed that 14 (4.4%) had intra-abdominal pathologies mimicking peritonitis and were excluded. Nearly a tenth (30, 9.5%) were managed conservatively. Twenty-four (6.6%) died before operative treatment while 12 (3.8%) either declined further treatment or failed to give consent for the study. The remaining 236 (74.7%) patients were recruited and evaluated further (Fig. 1).

Socio-demographic and clinical presentation

The patients' ages ranged between 65 and 97years with a mean of 69.4±SD 16.56. Approximately two-third (150, 63.6%) were aged 65–74years, 76 (32.2%) were aged 75–84years and 10 (4.2%) aged >84years. There were 142(60.2%) males and 94(39.8%) females. Majority 184 (78.0%) reside in the rural or semi-urban area, the remaining 52(22.0%) were urban dwellers. Majority (83.1%) used over-the-counter steroids and non-steroidal anti-inflammatory drugs (NSAIDS) on chronic basis and over a quarter (64, 27.1%) consumed herbal concoctions for a long period of time. About one-fifth (48, 20.3%) and a third (80, 33.9%) of the patients had history of tobacco snuffing and local gin (alcohol) intake respectively for >6months before PPU developed. Four patients developed perforated peptic ulcer (PPU) in the course of long, dry fasting. The severity of the clinical presentations was varied and reflected the etiologic factors of peritonitis. The causes of peritonitis are shown below (Table 1). Nearly half (116, 48.5%) presented with shock and most of them (89, 76.7%) were those with peritonitis caused by typhoid perforation, PPU, ruptured appendix and neglected blunt abdominal trauma. Details of clinical parameters noted at the time of admission are shown below (Table 2).

Outcome of treatment

The outcome measures (morbidity, LOHS and mortality) in the three age groups were compared and statistically significant differences were found among them (Table 3a). The severity of the complications was also presented below using Clavein-Dindo [21] classification (Table 3b).

In the 65–74years group, 37 deaths occurred giving rise to mortality rate of 24.7%; in the >84 age group, four deaths occurred (mortality, 40.0%). Many clinical and perioperative variables were evaluated to establish their effects on the morbidity and mortality rates (Table 4). Comorbidity ($P = 0.000$) high ASA scores -IV and V ($P = 0.000$), late presentation ($P = 0.004$) and District hospital setting ($P = 0.011$) were associated with high morbidity and mortality rates. The impact of various operative techniques on morbidity and mortality is shown below (Table 5).

Discussion

Overview and brief synopsis of key findings

In recent time, discussions on disease conditions in the elderly received significant boosts on the global scale, but in Africa, research papers on this subject have been nearly absent from global health discourse [1,3,4,13]. In consideration of the higher incidence and deadlier forms of peritonitis in the tropics, it is surprising that only few indigenous workers have specifically looked in the direction of abdominal sepsis in the elderly patients in the region.

Generally, death and other outcomes of acute surgical illnesses are uniformly more grievous in the elderly than in younger patients, and for the abdominal sepsis, the adverse impact on outcome in the elderly is well recognized [2,3,5,10,11,15-17]. The higher mortality in the elderly

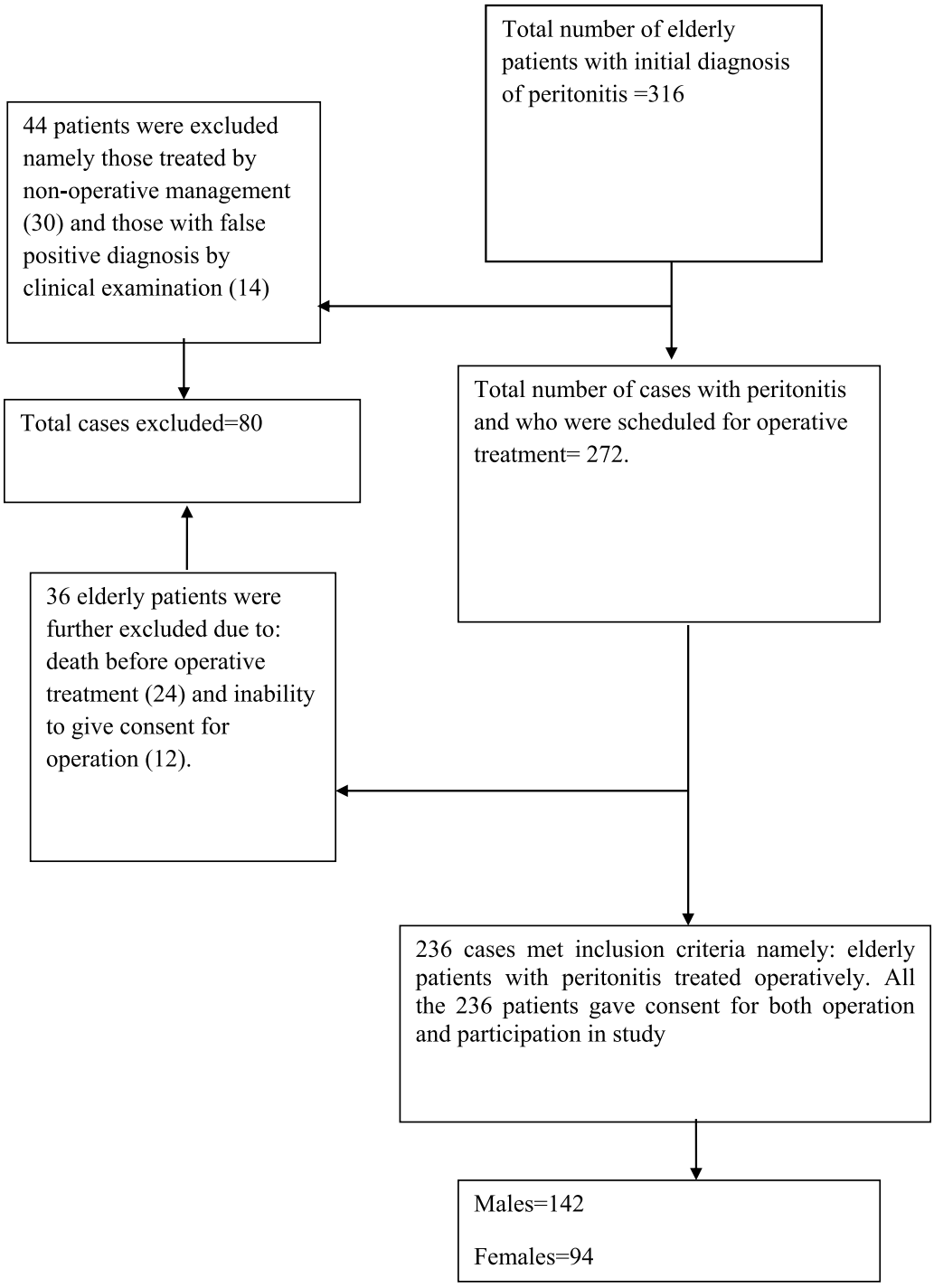

Fig 1. Flow diagram of patients' inclusion and exclusion.

reflects an increased prevalence of pre-existing cardiovascular, respiratory, endocrine, neoplastic and other comorbid diseases as well as a predictable decline in physiologic and immunologic functions [1-3,6, 14], These changes and other observations suggest that the clinical manifestations of peritonitis, local and systemic, may be altered in the elderly and lead to delay in initiating treatment as previously cited elswhere [2,3,6,14].

Our patients' population comprised elderly cohorts, predominantly males who were mostly rural or semi-urban dwellers. The frequencies of the etiologic causes in decreasing order were PPUD, ruptured/gangrenous appendix, typhoid perforation, postoperative peritonitis and others, but typhoid perforation was the deadliest. Morbidity and mortality rates increased as the age rises, being highest in those aged >84years. Other factors associated with raised mortality rates were comorbidity, delayed presentation, high ASA score and rural location of hospital.

Etiology of peritonitis in the elderly in southeast Nigeria

The frequencies of the etiologic factors showed a remarkable trend (Table 1). We observed that the frequency of the causes of generalized peritonitis in a decreasing order was: PPU, ruptured appendix, typhoid perforation, postoperative peritonitis and others. The predominance of PPU as a cause of generalized peritonitis in the elderly has a long history

Table 1
Etiology and age distribution of peritonitis.

Etiologic factor	Age range (years)			
	65–74	75–84	>84	Total (%)
Perforated peptic ulcer disease	56	28	5	89 (37.2)
Ruptured/gangrenous Appendix	38	18	3	59 (24.7)
Typhoid perforation	22	20	2	44 (18.4)
Postoperative	8	4	0	12 (5.0)
Neglected blunt abdominal trauma	6	1	0	7 (2.9)
Perforated diverticular disease	6	1	0	7 (2.9)
Abdominal Tuberculosis	4	2	0	6 (2.5)
Perforated colonic tumor	5	1	0	6 (2.1)
Sigmoid perforation from colonoscopy	1	1	0	2 (0.8)
Ruptured Amoebic Abscess	2	0	0	2 (0.8)
Ruptured Splenic Abscess	2	0	0	2 (0.8)
Total	150(61.9)	76 (33.1)	10 (5.0)	236 (100.0)

Table 2
Clinical presentation at presentation.

Parameter	Frequency	Percent (%)	χ^2 (P-value)	OR (95% CI of OR)
Temperature (°C)				
36–37.2	61	25.8	6.53 (0.06)	9.44(0.74–7.32)
37.3–40.0	100	42.4		
>40.0	75	31.8(ref)		
Abdominal pain				
Present	54	22.9	2.49 (0.008)	4.39(9.27–41.35)
Absent	182	77.1(ref)		
Respiratory rate(b/min)				
>30	131	55.5(ref)	8.12 (0.013)	3.22(8.33–32.54)
23–30	64	27.1		
≤ 22	41	17.4		
Systolic BP (mmHg)				
<60	99	41.9(ref)	16.32(0.025)	6.47(3.61–22.31)
60–100	76	32.2		
>100	61	25.9		
SpO_2 (%)				
< 90	171	72.5(ref)	*17.40 (0.031)	5.71(11.75–58.21)
≥ 90	65	27.5		
Hourly urine output(ml)				
< 30	153	64.8(ref)	13.42 (0.044)	12.34(6.14–32.13)
≥ 30	83	35.2		

†Spo_2 = oxygen saturation; ‡b/min= breaths per minute;.
* Fisher's exact test used; °C= degree centigrade; BP= blood pressure.

notwithstanding the cultural, social and gender affiliations [11,34,35]. In the elderly, chronic use of NSAIDS and steroids to manage musculoskeletal diseases is common and has led to many cases of abuse, indiscriminate prescriptions, self-medication and overdose [34–36].

The permissive role of NSAIDS and steroids in the etiopathogenesis of PPU has been reported by several authors [34,35]. Epidemiological estimates showed that about a quarter of chronic NSAID users develop peptic ulcer disease (PUD) and 2–4% will bleed or perforate [34]. In the current discourse, we noted that majority (83.1%) of the subjects used over-the-counter steroids and NSAIDS on chronic basis and over a quarter (64, 27.1%) consumed herbal concoctions for a long period of time, suggesting a strong positive link between these ulcerogenic substances and peptic ulcer perforation. Published reports from Nigeria [35, 37], Tanzania [26] and India [38] overlapped with the above findings.

In addition to the foregoing, we observed that a fifth and third of the patients had history of tobacco snuffing and local gin (alcohol) intake respectively for >6months before PPU developed. The deleterious effects of smoking and alcohol on gastroduodenal mucosa have been described through a mechanism that creates imbalance between hostile and protective factors which ultimately leads to exposure of gastroduodenal mucosa to acid erosion, breaching of serosal lining and perforation [34,35,37]. The contributions of dry fasting (through similar etiopathogenic pathway described above) to PPU formation has been cited by previous workers and we share similar experience in four patients who developed PPU in the course of long, dry fasting [35,37,39]. In a referral hospital in Northern Nigeria, Gali and coworkers described a seasonal variation in PPU and reported that peak incidence coincided with the period of Ramadan fast by the Muslims [39].

In a similar report in Benin City, Nigeria, Agbonrofo and colleagues observed a two-pronged seasonal event of PPU coinciding with months of February to May for the first phase and August to December for the second phase [37]. First, the period February to May overlapped with the time of religious fasting by Christians, which formed the predominant religious group in the area [37]. Remarkably, the seasonal religious rites coincided with the high pre-planting and planting seasonal perforation incidence observed in their study [37]. Second, the authors found that the August-December peak applied to both the young and elderly patients [37]. This peak, in the younger patient was attributable to increased peasant manual labor, loading/haulage of farm produce and for the elderly peasant farmers, the cold, humid rainy season worsened their arthritic pains [37]. Both circumstances raised their need for NSAIDS consumption hence the increased perforation during this phase of the seasonal changes [37].

The order of occurrence of the causative factors of generalized peritonitis in the elderly reported in high-resource settings [1,2,9,10] literature varied from the tropical [28,39,40] series. In unselected adult cohorts with peritonitis in Ile-Ife [38], Nigeria, the order of frequency was ruptured appendix (32.4%), typhoid perforation (18.9%) and perforated peptic ulcer (16.3%) akin to findings from previous studies [24,28,19]. Though appendicitis and its complications are not uncommon in elderly patients, studies have shown that appendiceal lumen is almost obliterated in the aged giving less room for appendicitis [28,40]. Curiously, Njeze in Enugu, Nigeria, reported an unusual situation where no cases of appendicitis were found among 119 elderly patients with major abdominal conditions recruited over a 16-year period [41]. The wide gap in the etiological spectrum of generalized peritonitis between this study and Njeze series [41] may be due to differences in study design and setting. Njeze [41] did a single-center retrospective review at a municipal, private hospital while ours was a prospective, multicentre analysis comprising both central and district hospitals, including a tertiary health facility.

Prognostic factors of mortality and morbidity

Curiously, we made paradoxical observations with respect to the mortality for the different causative factors. We found that typhoid perforation was the deadliest in terms of mortality despite occupying a distant third as an etiologic cause of generalized peritonitis in the elderly (Tables 1 and 4). Put differently, the mortality rate of typhoid perforation was 1.5 and 1.7 times higher than PPU and complicated appendix respectively, but lagged behind complicated appendix and PPU in the ratio of 1:1.3:2 (typhoid perforation: complicated appendix: PPU). In an excellent report involving 305 cases of generalized peritonitis, Chimchom-Mefire and colleagues working in Cameroon found a more disturbing situation where typhoid perforation had a morbidity rate of 58.1% and was the highest contributor to death toll, accounting for 34.7% of all deaths, but in terms of frequency, occupied a distant fourth coming after PPU, complicated appendix and postoperative peritonitis in that order [11]. A mortality rate of 37.2% was quoted for typhoid perforation, coming second after sigmoid colon perforation (44.4%); others were postoperative peritonitis 20.5%, PPU 10.1% and complicated appendix 7.6% [11]. Published data from Nigeria [19,40] and Tanzania [24] conform with the above findings.

There was significant statistical difference in morbidity and mortality rates in the various age ladders that make up elderly population with the poorest results recorded in those aged > 84years and best outcomes in those aged 65–74 years (Table 3a). It has been shown that death and

Table 3

a: Postoperative outcomes.

Outcomes	Age Range (years)			
	65–74 (N=150)	75–84 (N=76)	>84 (N=10)	χ^2 (P-value)
Complications	N (%)	N(%)	N(%)	
Wound infection	78(52.0)	54(71.1)	8(80.0)	22.48 (0.031)
Intra-abdominal abscess	14(9.3)	8(10.5)	2(20.0)	
Burst Abdomen	6(4.0)	3(3.9)	1(10.0)	
Enterocutaneous fistula	11(7.3)	9(11.8)	2(20.0)	
Atelectasis	8(5.3)	7(9.2)	2(20.0)	
Incisional hernia	12(8.0)	7(9.2)	1(10.0)	
Stoma prolapse	2(1.3)	0(0.0)	0(0.0)	
Sepsis	20(13.3)	14(18.4)	3(30.0)	
Adhesive bowel obstruction	13(8.7)	7(9.2)	1(10.0)	
Secondary depression	48(32.0)	28(36.8)	4(40.0)	
LOHS (days)				
1–7	12 (8.0)	2(2.6)	0(0.0)	* 4.83 (0.412)
8–14	57(38.0)	24(31.6)	3(30.0)	
>14	81(54.0)	50(65.8)	7(70.0)	
Mortality	37(24.7)	27(35.5)	4(40.0)	8.37 (0.07)

b: Characteristics of Clavein-Dindo[31] classification of postoperative complications.

Complications	Total	Grade I	Grade II	Grade IIIa	Grade IIIb	Grade IVa	Grade IVb	Grade V	p-value
Variables	N	N	N	N	N	N	N	N	
Surgical Site Infection (SSI)	140	0	29	56	17	14	8	16	0.038
Sepsis	37	0	2	1	1	3	8	22	0.031
Intra-abdominal abscess	24	0	0	2	4	6	5	7	0.004*
Entero-cutaneous fistula	22	0	2	0	2	4	4	10	0.046
Adhesive bowel obstruction	21	0	3	0	4	5	4	5	0.000
Incisional hernia	20	0	0	13	6	1	0	0	0.002
Atelectasis	17	0	2	0	0	5	4	6	0.008
Burst abdomen	10	0	0	0	3	4	2	1	0.002*
Stoma prolapse	2	0	0	0	2	0	0	0	
Secondary depression	80	27	52	0	0	0	0	1	0.000
Total	473	27	93	72	39	42	35	68	

†LOHS= length of hospital stay *Fisher's exact test used; *N*=number of patients.
N= number of outcomes; SSI= surgical site infection; * Fisher's exact test used.

morbidity rates accompanying all forms of surgical illnesses, including generalized peritonitis, increase consistently with advancing age [2,3,6]. Mannheim Peritonitis Index (MPI), a key surgical risk calculator predicting mortality in surgical patients with peritonitis globally, utilizes "age" as a major component [3,17]. We observed that aside advanced age >74years, other main clinical variables associated with increased mortality were etiology of peritonitis ($P = 0.036$), comorbidity ($P = 0001$), delay beyond 24 h ($P = 0.000$), ASA score of >III (p-=0.007) and rural residence of the patients ($P = 0.035$). The above findings conform with data from previous published studies on generalized peritonitis in America [2,6,8,10,17,18,42], Europe [3,5,15,16,43], SSA [19,40,41] and India [38].

Comparison of our findings with previous reports

In patients with generalized peritonitis, peritoneal sepsis serves as the first pathologic insult while the resulting acute increase in intra-abdominal pressure (IAP) and subsequent development of intra-abdominal hypertension (IAH) and further, abdominal compartment syndrome (ACS) constitute the major pathway to septic shock and multi-organ failure [22,44]. Indeed, studies have shown that IAH and ACS are associated with 11-fold rise in mortality and this may explain the high mortality observed in this study and other studies on peritonitis in the elderly [2,3,5,6,15,16,38]. The delicate internal milieu, diminished physiological response to rigorous fluid therapy especially damage control resuscitation, increased tendency to septic complications and presence of multiple comorbid diseases were thought to be responsible for early and increased rates of ACS and mortality in elderly patients with acute generalized peritonitis (AGP) [3,16,18,22,44].

In a referral hospital in Italy, Neri et al. reported on a series of 143 patients that comprised predominantly people older than 50years (80.4%) who were reviewed over six years period [3]. It was found that colonic diverticulosis (21.0%) was the commonest cause of perforation peritonitis followed by cancer (18.2%), peptic ulcer (17.8%), iatrogenic lesions (15.4%) and ischaemic perforation (12.6%) [3]. In our study however, malignant perforation accounted for a negligible 1.7%, being far below the high-resource setting [2,5,6] figures of 15–20%. Truly, the above observations showed that malignancy is not a common cause of perforation peritonitis in our environment, consistent with reports from India [38], Nigeria [19,40] and Cameroon [11]. In Europe and US, diverticular disease is a common cause of perforation peritonitis in the elderly, but was an insignificant cause of perforation peritonitis (2.9%) in this study. Indeed, in US, Yale et al. observed that colonic diverticulitis tied up with perforated appendix as the most frequent cause of peritonitis in the elderly aged >65 years. [2] In a California study comparing intra-abdominal sepsis in >65 years and <65 years, appendicitis was the prime cause in both age groups [2]. However, in those aged >65 years, diverticular disease was as frequent as appendicitis, but in those ≤ 65 years, intra-abdominal abscess came after appendicitis [2]. The above observations suggest that though, appendicitis and PPU remained important etiologic factors of peritonitis in the elderly in both high-resource and tropical countries, typhoid perforation and diverticular disease have predilection for tropical and Western variants of peritonitis respectively.

Our finding that appendiceal disease is a frequent cause of peritonitis in this study is worrisome and evaluation of factors that led to the high occurrence of complicated appendix in our cohorts is warranted and need to be addressed. First, delayed presentation was very prominent in the elderly with appendicitis and together with atypical clinical presentation, may offer explanation for many of the appendiceal cases presenting with rupture and generalized peritonitis rather than at simple non-complicated stage. In a USA series, Watters et al. found that patients

Table 4
Clinal determinants of mortality.

Clinical parameter	No of cases	No of mortality(%)	χ^2 (P-value)	OR (95% CI of OR)
Etiologic type				
Perforated PUD	89	23(25.8)	5.33	4.54
Ruptured/ gangrenous Append	59	14(23.7)	(0.036)	(7.79–28.41)
Typhoid perforation	44	18(40.9) (ref)		
Postoperative	12	4 (33.3)		
Others	32	9(28.1)		
Comorbidity				
Present	214	64(30.0) (ref)	12.42 (0.001)	12.05 (2.14–28.42)
None	22	4(18.2)		
Age range(years)				
65–74	150	37(24.7)	4.36	6.37
≥75	86	31(36.0) (ref)	(0.044)	(11.07–39.16)
Degree of delay(days)				
0–24	9	1(11.1)	2.58	3.55
25–48	44	8(18.2)	(0.000)	(18.67–69.53)
>48	183	59(32.2) (ref)		
ASA score				
III	64	10(15.6)	28.33	7.43
IV	122	34(27.9)	(0.007)	(7.72–38.44)
V	50	24(48.0) (ref)		
Level of Hospital				
Tertiary (Central location)	84	22(26.2)	16.34 (0.035)	1.42 (2.82–13.48)
District (Rural location)	152	46(30.3) (ref)		

No= number; PUD= peptic ulcer disease; Append= appendix; OR= odd ratio; CI= confidence interval;.
*Fisher's exact test used; ASA= American Society of Anaesthesiologists.

Table 5
Impact of operative techniques on morbidities and mortalities.

Operative Technique	Frequency	Morbidity(%)	Mortality(%)
Simple closure + drain	112	81(72.3)	42(36.8)
Resection +/- stoma	9	6(66.7)	4(44.4)
Evacuation + Drain + Biopsy	10	4(40.0)	1(10.0)
Splenectomy/ splenorrhaphy	8	5(62.5)	1(12.5)
Simple closure + stoma	31	19(61.3)	6(18.8)
Appendectomy + drain	52	34(65.4)	11(21.2)
Others	14	8(57.1)	3(21.4)
Total	236	157(65.7)	68(28.5)
χ^2 (P-value)		2.42 (0.220)	21.14 (0.036)
OR (95% CI of OR)		7.42 (3.63–23.42)	2.53 (6.84–37.64)

OR= odd ratio; CI= confidence interval.

aged 65 years or older presented with a longer history and were much more likely to have a gangrenous or perforated appendix than were younger patients (odd ratio: 3.1; 95% CI: 1.1–8.4, P <0.05) [6]. The authors found that elderly patients with appendicitis may experience delay in presenting to hospital due to difficulties in leaving home, fear of hospitalization, alterations in usual symptoms and diminished perception of them, or diminished ability to express their symptoms effectively [6]. It has been cited that absence of the expected localization of pain to the right lower quadrant was noted in 50.0% of older patients with appendicitis and that variability in the main manifestations of appendicitis is a well-known phenomenon in the elderly and a key player in prolonged delay before presentation [2,6]. Second, it has been reported that changes occur in the appendix with advancing age including, but not limited to atherosclerosis [2]. These events diminish blood supply to the appendix causing muscularis to become fibrotic and laden with fat; thus, small changes in intra-luminal pressure can produce rapid ischemia, gangrene and perforation [2]. Third, published studies have shown that a subset of appendicitis may start in the perforated form right from outset [28,45]. On this background, we have not dismissed the possibility of increased frequency of this variant in our patient population and its relative contribution to appendix-related peritonitis.

Surgical treatment

The operative techniques employed in this study were determined by the type of pathologic process, extent of the disease, clinical state of the patients and availability of intensive or postoperative care unit. Analysis of the impact of operative procedure on outcome showed that the highest rates of morbidity were found on those that received simple closure of perforated bowel (typhoid perforation, PPU, trauma) while mortality rate was greatest among those that had intestinal resection from whatever cause (Table 5). Indeed, the need for bowel resection in patients with acute generalized peritonitis (AGP) is a reflection of the degree of advancement and progression of the primary pathologic process. In turn, the degree of disease advancement reflects prolonged delay, extensive pathologic process or conditions arising from very virulent organisms with severe local and systemic forms of acute inflammatory response. Rajandeep and colleagues from India shared similar experience in their review of 400 patients with peritonitis [38]. Similar to the choice of operative methods used in this study, the authors used simple repair to manage half (50.5%) of the entire cases followed by stoma formation (22.5%) and appendectomy (17.0%) [38]. The morbidity and mortality rates were highest in patients with typhoid perforation compared with other forms of perforation peritonitis [38]. Published data from studies done in other LMICs [11,40,41] support the Indian results and ours, but contrast with data derived from high-resource settings [2,3,5,6].

Implications of COVID-19 pandemic on peritonitis in elderly

The recent outbreak of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-COV2) from Wuhan, China in December 2019 (otherwise known as COVID-19) added complexity to the management of elderly patients with generalized peritonitis [45]. First, symptoms and signs of COVID-19 like fever, cough, dyspnea, fatigue and vomiting may be apparently overlooked and therefore contribute to missed diagnosis in elderly patients with generalized peritonitis due to overlapping of clinical features [45]. This is particularly applicable in the elderly who often display atypical manifestations of acute abdomen and sepsis [6,15]. Moreover, elderly patients often have comorbid illnesses which can lead to cough, dyspnea, abdominal swelling (from ascites), fatigue, fever and vomiting [6,25,15]. Acute exacerbations of these symptoms may mimic both SARS-COV2 and peritonitis and therefore may lead to unnecessary delay in making an informed decision [45,46]. Second, management of elderly patients with generalized peritonitis requires facilitated consultation by dedicated multidisciplinary team led by general surgical team who often recommend ICU admissions postoperatively [45,46]. In sub-Saharan Africa with low therapeutic and financial resources and in most cases, inadequately equipped ICU, elderly patients with peritonitis requiring mechanical ventilation will definitely reduce the number of available ventilators that will be reserved for severe forms of COVID-19. In addition, they may be competing with COVID-19 patients for monitors, oxygen, attention of health personnel, bed spaces or even personal protective equipment (PPE) and other consumables [45,46]. This way, repeated crisis or service failure for both COVID-19 and peritonitis becomes a real problem in the ICU settings of resource-constrained nations like ours. Third, COVID-19 and other nosocomial infections constitute real danger for elderly patients with peritonitis who are admitted in the ICU setting [45,46].

Limitations

First, the relatively short follow up period and poor adherence to follow up visits reduced the accuracy of the dataset. We noted in the methods section that patients were followed up for a variable period of 3–48months, suggesting a very short follow up (few months) for some patients. Second, surgical risk scores like Mannheim Peritonitis Index (MPI) and Boey's score were not done to truly assess the prognostic role of advanced age in patients with generalized peritonitis. Third, the exclusion of the elderly who were managed conservatively, died before operative treatment and those that declined surgical operation gave room for 'missing data' and therefore incomplete representation of the true picture especially data on etiologic spectrum and outcome. Therefore, this study is applicable only to peritonitis in the elderly patients treated surgically and not all cases of peritonitis in the elderly.

Recommendations

Improvement in sanitation and waste disposal, provision of pipe born water and enforcement of relevant laws on indiscriminate dispensary of NSAIDS and steroids are important steps to reduce incidence of typhoid perforation and PPU. Health education, enlightenment campaigns, private-public partnership on sustainable health delivery, incentives to drive urban-rural shift of health workers especially specialist surgeons and anesthetists and wider coverage of National Health Insurance Scheme (NHIS) are salutary. Upward review of national health budget is a key strategy.

Conclusion

In the elderly patients with peritonitis, PPU is the most frequent cause in our environment, but mortality rate is highest in those with typhoid perforation followed by postoperative peritonitis. Complicated appendicitis (though the second most frequent cause after PPU) recorded the least mortality rate of all the four major causes of generalized peritonitis in this study. Wound infection was the commonest postoperative morbidity and the rates and severity of these morbidities increased with age. In addition to etiologic factors, other factors associated with increased mortality were age > 84years, comorbidity, district location of hospital, delay >24 h, bowel resection and ASA scores IV-V.

Dissemination of results

The results from this study was shared with staff members at the data collection site through an informal presentation in the surgery grand rounds.

CRediT authorship contribution statement

Aloysius Ugwu-Olisa Ogbuanya: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Nonyelum Benedett Ugwu:** Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Vincent C Enemuo:** Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Ugochukwu U Nnadozie:** Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Uche Emmanuel Eni:** Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Richard L Ewah:** Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Uzoamaka E Ajuluchuku:** Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Daniel A Umezurike:** Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Livinus N Onah:** Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declared no conflicts of interests

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