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ORIGINAL SCIENTIFIC REPORT

Acute Appendicitis in the Public and Private Sectors in Cape Town, South Africa

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Abstract

Background South Africa has a low incidence of acute appendicitis, but poor outcomes. However, South African studies on appendicitis focus solely on public hospitals, neglecting those who utilize private facilities. This study aims to compare appendicitis characteristics and outcomes in public and private hospitals in South Africa.

Methods A prospective cohort study was conducted among two public and three private hospitals in the Cape Town metropole, from September 2013 to March 2014. Hospital records, operative notes, and histology results were reviewed for patients undergoing appendectomy for acute appendicitis. Patients were interviewed during their hospitalization and followed up at monthly intervals until normal function was attained.

Results A total of 134 patients were enrolled, with 73 in the public and 61 in the private sector. Education and employment were higher among private sector patients. Public sector patients had a higher rupture rate (30.6 vs 13.2 %, $p = 0.023$). Times to presentation were not statistically different between the two cohorts. Public sector patients had longer hospital stays (5.3 vs 2.9 days, $p = 0.036$) and longer return to work times (23.0 vs 12.1 days, $p < 0.0001$). Although complication rates were similar, complications in public hospitals were more severe.

Conclusions Public sector patients in South Africa with appendicitis have higher rupture rates, worse complications, longer hospital stays, and longer recoveries than private sector patients. Patients with perforation had longer delays in presentation than patients without perforation.

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Introduction

Acute appendicitis is one of the commonest surgical emergencies in the world, but has a relatively lower incidence in Africa [1]. In its disease course, the appendix becomes inflamed and infected by intestinal bacteria, leading to swelling, and eventual wall rupture if left untreated, potentially leading to sepsis and death [2]. Patients with ruptured appendicitis have longer hospital stays, more complications, and higher mortality than patients who do not progress to rupture [3]. Given the consistent progression to perforation and potential health gains with early treatment, rates of rupture have been advocated as a public health measure of access to medical care [4].

In South Africa, audits of appendicitis have consistently demonstrated higher perforation and complication rates compared to those in developed countries [3, 5–7]. These have been attributed to longer delays of presentation to hospitals [8], socioeconomic disadvantage [9], and health system constraints [3] common to South Africa and developing regions. However, South Africa has a two-tiered health system, with approximately 85 % of the population using the public sector hospital services and the remaining 15 % using a well-resourced private health system [10]. The current body of appendicitis literature in South Africa has focused on public sector facilities, thus neglecting the substantial population who utilize private health facilities [11].

Therefore, the aim of this study was to compare patients with acute appendicitis in the public and private sectors in South Africa. The primary outcome measured was perforation rates between public and private sector patients, and secondary outcomes measured were patient characteristics, complications, and postoperative recoveries between the two sectors.

Materials and methods

All adults undergoing appendectomy for presumed acute appendicitis from September 2013 to March 2014 were candidates for inclusion in this study. Patients were enrolled from two public hospitals and three private hospitals in the Cape Town metropole. Of the public hospitals, one was a tertiary hospital and the other a regional hospital, both receiving patients referred from district hospitals in the region. The private sector patients were under the care of a group of surgeons who operated at three different hospitals, as well as other private surgeons in solo practice.

Based on daily inspection of operative schedules and admission logs, patients who underwent appendectomy were enrolled. Enrollment took place while patients were hospitalized for appendectomy and continued until sufficient numbers were obtained to adequately power each arm of the study, ending in January 2014 for public hospitals and March 2014 for private. Informed consent was obtained from each patient, along with ethics approval from the Human Research Ethics Committee at the University of Cape Town and by local authorities from each hospital.

Upon enrolment, patients were individually interviewed and their hospital records were reviewed—including vital signs, laboratory investigations, histology, theater records, and operative notes from the surgeons—in order to document their symptom course and journey from illness onset to the theater. Four weeks after discharge, follow-up interviews were conducted with patients either telephonically or in person, and their in-hospital postoperative course and recovery at home documented. If patients had not returned to work yet or resumed normal function, follow-up interviews were conducted at monthly intervals until normal function was reached. Patients undergoing incidental appendectomy, or those treated conservatively, were excluded from this study.

Sample size

The primary outcome for this study was perforation. South African studies have estimated rates of rupture of the appendix to range from 34–57 %, compared to 16–19 % in the U.S [3, 5, 7, 12–14]. Using averages from these figures, point estimates for rupture rates were estimated to be 47.3 and 21.7 % in South Africa and the USA, respectively. We hypothesized that rupture rates in the public sector in Cape Town would be similar to this South African figure, whereas the rupture rate in the private sector would resemble that of the U.S. Using a level of significance (α) of 0.05, and power of 0.80, a sample size of 59 patients in each cohort was needed to compare rupture rates in the public and private sectors in Cape Town.

Definitions

Symptom onset was defined as when the patient first noted abdominal discomfort. Time to presentation was defined as the time from symptom onset to presentation at the final hospital at which appendectomy was performed. Race was self-reported and categorized according to racial categories employed by the national census (Black African, Colored, Indian or Asian, White, Other) [15]. Patients who declined to report race, identified with multiple racial categories, or identified with a different racial category were classified as "other".

Operative findings from operative notes were classified as one of the following: normal, acutely inflamed appendix without rupture, gangrenous appendicitis, or ruptured appendicitis. Histological perforation was defined as perforation on macroscopic analysis. Return to work was calculated as the number of days from hospital discharge until returning to work, normal daily activities for the unemployed, or a full day of classes for students. Complications were classified according to the Clavien classification scheme [16], with Grade 1 and 2 complications considered minor, and complications grade 3 and above major.

Statistical analysis

Exploratory analyses were conducted on demographic variables, with continuous variables described using mean or median values, and categorical variables as percentages.

Continuous variables were compared using the *t* test for independent samples or Wilcoxon rank-sum test for non-parametric data. Associations between categorical variables were conducted using either Chi square analyses or Fisher's exact test, as appropriate. All analyses were conducted on Stata 12 [17].

Results

Demographics

A total of 134 patients were enrolled in the study: 73 from public hospitals and 61 from private hospitals (Table 1). Average ages in both groups were similar (32.3 and 33.0 years, $p = 0.724$). Each cohort was split equally between men and women.

Racial demography differed significantly between the two cohorts, as private sector patients were predominantly white (49.0 %), and public sector patients mostly colored (52.1 %). Black patients were more likely to receive care in public hospitals than at private facilities (82.8 vs 17.2 %, $p = 0.001$).

Education levels also varied between the two cohorts. Most of the public sector patients did not study past secondary school (76.8 %), whereas most private sector patients studied in tertiary education and beyond (68.8 %). No public sector patients reached postgraduate education, compared to 26.2 % of private sector patients.

Public sector patients were more likely to be unemployed than private sector patients (27.4 vs 8.2 %). Of the unemployed private sector patients, three were housewives with working husbands, one was retired, and the other was on lifelong disability. There were more full-time students in the private sector than the public (12.3 % public, 26.3 % private). Nearly all private sector patients had medical insurance coverage (98.4 %), while the vast majority of public sector patients did not (95.9 %).

Disease onset to hospital presentation

To seek access to medical care, 98.4 % of private sector patients used private transport, compared to 57.5 % of public sector patients ($p < 0.001$). One private patient used public transportation (1.6 %), compared to 21.9 % of public sector patients. Public sector patients were more

Table 1 Demographics

	Public ($n = 73$)	Private ($n = 61$)	p value
Age (mean, SD)	32.3 years (±10.7)	33.0 years (±13.8)	0.724
Male	37 (50.68 %)	31 (50.8 %)	0.988
Female	36 (49.3 %)	30 (49.2 %)	
Race			
Black African	24 (32.9 %)	5 (8.2 %)	<0.001
Colored	38 (52.1 %)	14 (23.0 %)	
Indian or Asian	0 (0 %)	5 (8.2 %)	
White	4 (5.5 %)	30 (49.2 %)	
Other	7 (9.6 %)	7 (11.5 %)	
Education			
Primary	5 (6.9 %)	0 (0 %)	0.001
Secondary	51 (69.9 %)	19 (31.2 %)	
Partial tertiary	2 (2.7 %)	3 (4.9 %)	
Tertiary	15 (20.6 %)	23 (37.7 %)	
Honors	0 (0 %)	8 (13.1 %)	
Masters	0 (0 %)	6 (9.8 %)	
Doctorate	0 (0 %)	2 (3.3 %)	
Employment			
Unemployed	20 (27.4 %)	5 (8.2 %)	0.006
Employed	44 (60.3 %)	40 (65.6 %)	
Full-time student	9 (12.3 %)	16 (26.3 %)	
Medical aid			
Yes	3 (4.1 %)	60 (98.4 %)	<0.001
No	70 (95.9 %)	1 (1.6 %)	

Table 2 Disease presentation

	Public ($n = 73$)	Private ($n = 61$)	p value
Transport			
Private	42 (57.5 %)	60 (98.4 %)	<0.001
Public	16 (21.9 %)	1 (1.6 %)	<0.001
Ambulance	38 (52.1 %)	3 (4.9 %)	<0.001
Time to presentation (h)	56.2 (±70.4)	49.2 (±59.3)	0.360
Laboratory investigations			
Temp	36.8 (±1.0)	36.8 (±0.7)	0.861
Heart rate	99.6 (±26.4)	85.5 (±24.0)	0.002
Systolic BP	126.0 (±21.3)	128.6 (±21.5)	0.789
Diastolic BP	76.6 (±13.7)	72.8 (±16.0)	0.030
Respiratory rate	18.4 (±3.9)	18.3 (±2.2)	0.807
WBC	15.8 (±6.8)	13.4 (±4.7)	0.071
HGB	13.7 (±2.1)	13.7 (±1.5)	0.829
PLT	310.8 (±102.1)	234.9 (±61.3)	0.002
CRP	202.2 (±136.7)	72.8 (±88.7)	<0.001

likely to use the ambulance services than private sector patients (52.1 vs 4.9 %). There was not a significant difference in overall times to presentation (56.2 vs 49.2 h, $p = 0.360$). Public sector patients had higher heart rates, C-reactive protein levels, and platelets than public sector patients (Table 2), whereas other laboratory investigations and presenting vital signs were similar.

Operative data

Comparative operative data are shown in Table 3. Recorded anesthetic times were greater for public hospitals than private (1.7 vs 1.1 h, $p < 0.001$). Laparoscopic appendectomies took longer than an open, local approach (1.5 vs 1.1 h, $p < 0.001$). In the private sector, nearly all appendectomies were performed laparoscopically or via local incision (47.5 and 50.8 %, respectively). The only private sector patient who underwent laparotomy was found to have a ruptured appendix with several intraabdominal abscesses on preoperative CT imaging.

In the public sector, laparoscopic approaches were used about half as often as open (24.7 vs 47.5 %, $p = 0.006$). Nine operations were started laparoscopically but were converted to open procedures (12.3 %), as a result of finding purulent peritonitis or experiencing technical difficulty with proceeding laparoscopically. Of the 53 open procedures performed in the public sector, 45.3 % were done through a local incision, 39.6 % via laparotomy, 13.2 % via lower midline incision, and one via Pfannestiel incision.

Table 3 Operative data

	Public ($n = 73$)	Private ($n = 61$)	p value
Anesthetic times (h, SD)	1.7 (±1.0)	1.1 (±0.4)	<0.001
Open			
Lanz	24 (33.8 %)	31 (50.8 %)	<0.001
Lower midline	7 (9.9 %)	0 (0 %)	
Laparotomy	21 (29.6 %)	1 (1.6 %)	
Pfannestiel	1 (1.4 %)	0 (0 %)	
Laparoscopic	18 (24.7 %)	29 (47.5 %)	0.006
Conversions	9 (12.3 %)	0 (0 %)	0.003
Operative findings			
Normal appendix	5 (6.9 %)	6 (9.8 %)	0.079
Acutely inflamed	29 (39.7 %)	36 (59.0 %)	
Gangrenous	9 (12.3 %)	5 (8.2 %)	
Perforated	30 (41.1 %)	14 (23.0 %)	

Surgeons reported more perforations in the public cohort than the private (41.1 vs 23.0 %, $p = 0.026$). Normal appendices were uncommon in each group—6.9 % of public sector patients, 9.8 % of private. Of these 11 patients, four had bloody or purulent peritonitis without obvious source, one with mesenteric adenitis, one ruptured ovarian cyst, and five without any intraabdominal pathology. All patients received preoperative antibiotics.

Hospital course

Patients in public hospitals had longer hospital stays than patients in private hospitals (5.3 vs 2.9 days, $p = 0.034$), a difference which held true when comparing public and private sector patients with similar histological findings (-data not shown).

Intensive care was required for 9.6 % of public sector patients, compared to 3.3 % of private sector patients ($p = 0.134$). Overall complication rates were similar between the two sectors, with 30.1 % for the public sector and 26.2 % for the private ($p = 0.617$), and were similar when comparing readmission rates and specific types of complication (Table 4). There were no differences in major complications between the public and private cohorts (12.3 vs 6.6 %, $p = 0.261$), nor in minor complications (20.6 vs 21.3 %, $p = 0.914$).

There were two deaths observed, both in the public sector. The first patient had perforated appendicitis with generalized peritonitis, developed a large wound dehiscence and enterocutaneous fistula, and died 30 days after his operation. The second patient had purulent peritonitis and a neuroendocrine tumor, developed an enterocutaneous fistula and died 30 days after her operation.

Histology

Histology results are shown in Table 5. Public sector patients had a normal appendix on pathologic review at a similar rate as private patients (13.9 vs 5.7 %, $p = 0.076$). The perforation rate on histology for public sector patients was significantly higher than that for private patients (30.6 vs 13.2 %, $p = 0.023$), with an overall perforation rate for both cohorts of 24.0 %.

There were 14 patients with abnormal histology, but not appendicitis. Four were diagnosed with acute peritonitis, three with acute serositis, three with fibrous obliteration, two with early focal appendicitis, one with submucosal fibrosis, and one with a large neuroendocrine tumor.

Discharge & home recovery

As a whole, public sector patients took significantly longer to return to work than private sector patients, averaging 23.0 versus 12.1 days ($p < 0.0001$). This difference held true when performing subgroup analyses of patients within the same pathologic grade of appendicitis, those who underwent laparoscopic versus open procedures, and employment status (Table 6).

Table 4 Hospital course and complications

	Public ($n = 73$)	Private ($n = 61$)	p value
Length of stay (SD)	5.3 (±7.1)	2.9 (±1.7)	0.036
ICU	7 (9.6 %)	2 (3.3 %)	0.134
Complications			
Wound sepsis	14 (19.2 %)	12 (19.7 %)	0.943
Pneumonia	1 (1.4 %)	1 (1.6 %)	0.705
Fistulae	3 (4.1 %)	0 (0 %)	0.159
Ileus	5 (6.9 %)	0 (0 %)	0.045
Reoperation	1 (1.4 %)	3 (4.9 %)	0.245
Readmission	6 (8.2 %)	3 (4.9 %)	0.344
Death	2 (2.7 %)	0 (0 %)	0.295
Other	3 (4.1 %)	2 (3.3 %)	0.620
Clavien Dindo Class			
1	5 (6.9 %)	4 (6.5 %)	1.000
2	17 (23.3 %)	11 (18.0 %)	0.456
3	2 (2.7 %)	3 (4.9 %)	0.659
4	8 (11.0 %)	2 (3.3 %)	0.110
5	2 (2.7 %)	0 (0 %)	0.500

Discussion

The presentation and outcomes of acute appendicitis differ between African and Western nations. Incidence rates of appendicitis among Africans have been estimated to be much lower than among Westerners [18], but with higher rupture and complication rates [3, 13]. In the South African literature, poorer outcomes have been attributed to socioeconomic disadvantage [7], health system weaknesses [3], poor access to care [8], and delayed presentation to the hospital [5]. While these trends have been studied in other contexts [19], the lack of research among well-resourced South Africans has limited generalizability to the South African context. The majority of South Africans utilize public hospital services, but a relatively wealthy minority utilizes private facilities [10]. Appendicitis in the public sector has been widely studied, whereas outcomes in the private sector have yet to be explored.

Age trends in this study were consistent with the general literature, with the peak incidence in patients in the second and third decade of life [13, 18, 20]. While several audits have found a male skew in appendectomy operations [5–8, 21, 22], our study had an even gender split in both public and private cohorts. Negative appendectomies have been reported to be more common among women, due to gynecologic conditions which mimic appendicitis [23]. In our study, women trended toward higher rates of negative appendectomies than men, although this was not statistically significant (36.4 vs 25.0 %, $p = 0.154$).

Not surprisingly, public and private sector patients in our study differed greatly in the racial demography, education level, employment status, and access to medical insurance. These differences emphasize social and economic inequalities persistent in healthcare, such that wealthier patients are more likely to afford and access private health services [24].

Table 5 Histology results

	Public ($n = 72$) (%)	Private ($n = 53$) (%)	Total ($n = 125$) (%)	p-value
Normal	10 (13.9)	3 (5.7)	13 (10.4)	0.076
Acute	23 (31.9)	32 (60.4)	55 (44.0)	0.014
Gangrenous	7 (9.7)	7 (13.2)	14 (11.2)	0.722
Perforated	22 (30.6)	7 (13.2)	29 (23.2)	0.009
Abnormal, not appendicitis	10 (13.9)	4 (7.6)	14 (11.2)	0.178

Table 6 Days to return to work from discharge

	Public ($n = 63$)	Private ($n = 54$)	Total ($n = 117$)	p value
Overall (days)	23.0 (±23.2)	12.1 (±7.6)	17.9 (±18.0)	<0.001
Histologic diagnosis				
Acute (SD)	22.1 (±16.5)	12.6 (±8.3)	16.6 (±13.2)	0.004
Gangrenous (SD)	15.4 (±10.6)	10.9 (±5.8)	13.6 (±8.6)	0.335
Perforated (SD)	31.1 (±36.7)	11.0 (±8.4)	25.5 (±32.5)	0.008
Surgical approach				
Open (SD)	24.5 (±25.0)	12.5 (±7.4)	20.0 (±21.0)	0.001
Lap (SD)	19.0 (±17.7)	11.6 (±8.0)	14.5 (±13.1)	0.048
Employment				
Employed (SD)	23.0 (±15.9)	12.8 (±7.3)	26.9 (±35.1)	<0.001
Student (SD)	13.3 (±3.5)	7.9 (±3.6)	10.0 (±4.4)	0.004
Unemployed (SD)	28.6 (±38.8)	20 (±13.4)	18.0 (±13.4)	0.632

The public sector histological perforation rate of 31 % was significantly higher than the 15 % perforation rate in the private sector. This perforation rate in the public sector cohort falls in the 17–57 % range estimated from past appendicitis audits in South African public hospitals [3, 5–9, 21, 22]. The highest of these estimates came from studies which used operative findings as the basis for appendicitis classification [3, 7], rather than histological findings, which were used in this study to define perforation. There was a tendency for surgeons to overdiagnose perforation in the operating theater compared to histological diagnoses in this study, a trend consistent with a previous study in Durban [5].

The private sector perforation rate compares favorably with estimates in developed countries [12, 13]. This finding supports the presumption that private sector patients do not share the same factors that put disadvantaged South Africans at risk for perforation. The bulk of literature on appendicitis in South Africa has been limited to black patients in public hospitals [3, 6, 8, 9, 21, 22], a racial demographic which has been socially and economically disadvantaged throughout the country's history [25]. This study provides valuable insight into a racially diverse cohort of patients, showing that while economic advantage remains largely adherent to racial divisions, these divisions are becoming increasingly blurred. The starkly different perforation rates between the two sectors reinforce the notion that perforation risks are not inherently racial in nature, as has been suggested in the past [6, 26], but instead related to social and economic factors.

Delays in presentation to the hospital are associated with increased perforation risk [27–29]. In this study, public sector patients on average had longer presentation times than private patients, although this was not statistically significant. Within each histological class of appendicitis, there were no differences in presentation delays between public and private sector patients. Across both cohorts, patients with perforated appendicitis had longer delays in presentation compared to patients without perforation (86.8 vs 43.3 h, $p < 0.001$).

Taken at face value, the comparable complication rates between the two sectors in spite of different perforation rates may suggest similar severity of disease between the two groups. However, while the complications rates may themselves be similar, the complications in the public sector were arguably more severe in nature. For example, wound sepsis occurred in 19 % of patients in both sectors, requiring antibiotics and in many cases, opening the surgical wound and allowing closure by secondary intent. But while nearly all private patients with wound sepsis had small Lanz or laparoscopic incisions (91.6 %), over half of the public patients with wound sepsis had to manage open laparotomy incisions (57.1 %). Most of these public patients lacked resources or assistance to dress their wounds at home, necessitating multiple time-consuming visits to day hospitals.

Need for intensive care was not statistically different between the two cohorts, but there were notable differences between the public and private sector patients who required ICU admission. All of the public sector patients requiring intensive care were admitted to the ICU because of overwhelming sepsis resulting from their primary disease process. The two private sector patients admitted to the ICU required close monitoring for conditions unrelated to appendicitis—one developed hallucinations and severe anxiety from medications, and the other required tight glycemic control for Type I diabetes. Thus, while ICU admissions did not vary significantly between the two cohorts, the underlying reasons for admission suggested a greater severity of disease in the public sector.

Patients in the public sector had higher heart rates and diastolic blood pressures than private sector patients. When

taking their higher white blood cell counts, platelets, and C-reactive protein into account, public patients were observed to be in more acute distress than private patients. Operative times were also longer in public hospitals than private hospitals, which is attributable to the greater frequency of laparotomies performed and procedures converted from laparoscopy to open in public hospitals.

Public sector patients had longer hospital stays than private patients, even when controlling for histological and operative diagnosis. In addition to greater severity of disease in the public sector, differences in hospital systems and financial repercussions also affected length of hospital stay. Many private patients felt the need to recover quickly and minimize hospital stays, to avoid large hospital fees and charges. Unlike those in the private sector, patients in the public sector rarely cited this financial pressure as a motivation for recovery.

Public sector patients also took longer to return to work or normal activity than private sector patients, even when controlling for severity of disease, operative approach, and employment status. The reasons underpinning this difference are unclear from this study, but conceivably relate to a patient's home environment, support structures, type of employment, and motivation for recovery.

Surgical approaches have been discussed in recent studies, with very low rates of laparoscopy being utilized in public sector hospitals for appendectomy [7]. In this study, appendectomies were performed laparoscopically in a quarter of public hospital patients, and almost half of private patients. The decision to proceed with laparoscopy versus an open approach is influenced by a number of factors, including surgeon comfort, availability of equipment and support staff, patient characteristics, and issues pertaining to medical aid reimbursement. A number of private sector patients elected an open operation due to the potential that laparoscopy would not be adequately reimbursed by their medical aid.

The findings of this study reinforce the existing literature on appendicitis in South Africa overall, while raising some important questions. Appendicitis outcomes in South Africa have often been compared to those in Western countries in an effort to highlight the unique health system challenges which are faced here. However, there has been little information available on private sector patients with appendicitis. This study confirms the hypothesis that private sector patients with appendicitis have similar outcomes and disease presentation as patients in developed nations.

Therefore, it can confidently be stated that significant healthcare disparities in treating appendicitis exist not only between South Africa and Western nations, but also within the country itself. Furthermore, the disparities found in this study more or less follow socioeconomic divisions rather than racial lines, effectively arguing that high perforation rates in South Africa may largely be attributable to economic and system factors rather than purely ethnic factors.

This study raises important questions about public health facilities, patients who access them, and the interface between the two. Understanding the decision-making process for public patients seeking urgent surgical care, as well as their experiences as patients in the health system, will enable health managers and policymakers to identify opportunities for system strengthening and ultimately improve patient outcomes. It also encourages further analysis of the private sector which may shed light onto how outcomes may be improved in public hospitals.

Conclusions

South African patients undergoing appendectomy for acute appendicitis in the public sector have higher perforation rates, worse complications, and more severe disease than patients in the private sector. This disparity likely stems from a combination of social and economic differences that characterize the patient populations that are served in each sector. Hospital stays and recovery at home are longer for public sector patients, even when controlling for disease severity and surgical approach. As a whole, patients with perforation had delayed coming to hospital longer than patients with non-perforated appendicitis, although the reasons underlying these delays are unclear.

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Conflict of interest None.

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