Cross-sectional Study

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A cross-sectional, retrospective study analyzing the impact of COVID-19 on surgical mortality in Johannesburg, South Africa

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Background: Various comorbidities are known to exacerbate the risk of surgical mortality with COVID-19 infection. The effect of HIV infection on surgical mortality in the context of COVID-19 has also not been investigated. The aim of our study was to investigate the influence of HIV status on mortality in surgical patients admitted during the COVID-19 pandemic in Johannesburg, South Africa.

Material and methods: We reviewed records of patients who were admitted and underwent surgery during the COVID-19 pandemic and died. Data regarding perioperative COVID-19 infection, risk factors, comorbidities, mortality preventability, and contributing factors were extracted. Logistic regression was used to analyze comorbidities associated with COVID-19 infection among surgical mortalities.

Results: A total of 404 records of mortalities were found and 25% (82/404) tested positive for COVID-19. 40% Of the mortalities were either potentially preventable or preventable. Comorbidities in patients who were COVID-19-positive surgical mortalities compared to their negative counterparts included smoking in 35% versus 4%, chronic obstructive pulmonary disease (COPD) in 20% versus 3%, and diabetes mellitus in 23% versus 13%, respectively. The odds of being COVID-19 positive in surgical mortalities with hypertension, smoking, and COPD were 1.96 times [OR = 1.96, 95% CI (1.06, 3.59)], 7.78 times [OR = 7.78, 95% CI (3.45, 18.35)], and 3.09 times [OR = 3.09, 95% CI (1.08, 8.95)], respectively. 55% of COVID-19-positive patients who died were HIV positive compared to 31% among the COVID-19-negative group. 26% of HIV-positive patients were on anti-retroviral treatment (ART). 22% of HIV-/COVID-19-coinfected surgical mortalities were not on antiretroviral treatment compared to 9% in the HIV-positive and COVID-19-negative groups. The odds of COVID-19 infection in surgical mortalities who were HIV positive and not on ART was 3.10 [95% CI (1.55, 6.11)].

Conclusion: The rate of COVID-19 infection was higher in HIV-positive patients who died, especially if they were not on ART. Smoking, COPD, and hypertension imparted the largest risk on COVID-19 infection in cases of surgical mortality. These comorbidities likely superimpose the pathological effects of COVID-19 infection, worsening surgical prognosis.

Keywords: antiretroviral treatment, COPD, COVID-19, HIV, surgical mortality

Introduction

COVID-19 is the pathological manifestation of SARS-CoV-2, a novel coronavirus strain initially identified in pneumonia-like patients in Wuhan, China[1]. To date, there have been approximately 9 000 000 confirmed COVID-19 cases in Africa with over 170 000 COVID-19-related deaths reported.

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HIGHLIGHTS

- The impact of HIV infection on surgical mortalities in the context of COVID-19 is unknown.
- South Africa, with the highest global HIV prevalence, provides critical insights.
- HIV-positive surgical mortalities were disproportionately affected by COVID-19 infection.
- Surgical mortalities with HIV not on anti-retroviral treatment were significantly more likely to be COVID-19 infected.
- Smoking, chronic obstructive pulmonary disease, and hypertension increased the odds of being COVID-19 positive among surgical mortalities.
- Many surgical mortalities during the pandemic were preventable due to systemic constraints.
- Resource limitations exacerbated by the pandemic decreased HIV service delivery.

The first case of COVID-19 in South Africa was reported on 5 March 2020[2]. Subsequently, there have been approximately 4 000 000 confirmed COVID-19 cases in South Africa with over 100 000 COVID-19-related deaths reported to the World Health Organization[3].

Demographic factors and several comorbidities may increase the risk of COVID-19 infection and mortality[4]. In-hospital COVID-19 mortality has previously been linked to gender, age above 65 years old, cardiovascular disease, diabetes mellitus (DM), and obesity[2,5–7]. South Africa harbors among the largest burden of HIV infection globally[8]. HIV infection increases the risk of COVID-19 infection[9] and the development of severe COVID-19 infection including mortality[9–11]. Preventative responses to COVID-19 spread also reduced functional accessibility to HIV treatment due to disruption of in-person visits and follow-ups and may lead to a reduction of adherence to antiretroviral treatment (ART)[12–14].

Perioperative COVID-19 infection may increases the risk of mortality following surgery across surgical specialties[15,16]. One multicenter prospective study assessing patients undergoing elective and emergency orthopedic surgery found a significantly higher mortality in COVID-19-positive patients (9.4%) compared to their COVID-19-negative counterparts (0.43%)[17]. Similarly, Inzunza *et al* also found higher mortality rate following general, gastroesophageal, hepatobiliary, and colorectal surgery in COVID-19-positive patients[18]. Inzunza *et al* also illustrated a greater proportion of intraoperative respiratory complications occurred in COVID-19-positive patients. COVID-19-positive patients also exhibit a higher 30-day mortality following invasive management for acute coronary syndrome[19].

Although perioperative COVID-19 infection is associated with an increased risk of surgical mortality, the comorbidities contributing to this risk have not been studied. Additionally, the role of HIV infection in contributing to perioperative mortality in the context of COVID-19 infection is yet to be investigated. Given the proposed impact of preventative measures on health service delivery during the COVID-19 pandemic, this analysis becomes imperative. These measures also instilled procedural constraints with regard to surgery. Analysis of surgical mortality preventability in COVID-19-positive and -negative patients during the time of the pandemic is therefore imperative. These investigations have significant scaffolding value, elucidating pathophysiological roles of HIV and other comorbidities in perioperative surgical mortality in the context of COVID-19 infection, and may justify alternative preventative measures in future pandemics to ensure health service delivery for managing chronic conditions such as HIV.

Materials and methods

Ethical approval for this study (M221055 MED-09-108) was provided on 24 April 2023. The work has been reported in line with the STROCSS criteria[20].

We conducted a retrospective analysis of records patients that were admitted and died from March 2020 to August 2022. The study included all in-hospital mortalities within a 30-day period after surgery. The investigation was performed in the surgical departments of a quaternary hospital. Patients deemed COVID-19 positive were those who tested positive for COVID-19 perioperatively. Perioperative COVID-19 infection was considered a single positive COVID-19 test 7 days before or within 30 days after surgery, consistent with previously published literature[18]. Records of patients who did not receive surgery or died before receiving surgery, those who were referred to other non-surgical departments after surgery and subsequently died, and patients with unknown COVID-19 status were excluded. Patients whose records were incomplete were also excluded.

Data collection tool and collection process

Data was retrieved from records of the weekly departmental morbidity and mortality meetings captured in the Research Electronic Data Capture (REDCap) Database. Data retrieved included age, C-reactive protein (CRP), white cell count (WCC), highest blood glucose, lowest hemoglobin, highest systolic blood pressure (BP), and highest diastolic BP. Additional data included decisions made during weekly departmental morbidity and mortality meetings regarding preventability of the mortality including contributing factors like comorbidities, level of supervision, and shortage of resources. The comorbidities studied included hypertension, high body mass index (BMI) (>25 kg/m^2), coronary artery disease, DM, smoking, malignancy, chronic obstructive pulmonary disease (COPD), and HIV infection and treatment status.

Data analysis

Categorical data were summarized using actual counts and/or percentages. Either the mean with standard deviation or median with interquartile range was used to summarize continuous data. The association between various patient strata of the categorical variables was assessed using a Chi-squared test (α = 0.1%; df = *category specific*). To test for association between patient strata of parametric, continuous data, an unpaired Student's *t*-test (two-sided; α = 0.05) comparing means was employed. To elucidate which variables increase the odds of COVID-19 infection in surgical mortality, three logistic regression models (α = 0.05; power = 80%) were developed utilizing various risk factors and comorbidities as predictors. All statistical tests were performed utilizing RStudio (version 4.2.1). The study received prior ethical clearance (M221055 MED-09-108).

Results

Four hundred and sixty-eight records of mortalities were found and 64 were excluded. Of the remaining 404 mortalities, 25% (82/404) had positive COVID-19 results. 66% (253/404) of the surgical mortalities were male patients (253/404) (Fig. 1).

COVID-19-positive surgical mortalities were significantly older compared to COVID-19-negative mortalities ($P = 4.30 \times 10^{-5}$). Although WCC was significantly higher in the COVID-19-positive mortalities (P = 0.02), CRP showed no significant difference between the two groups (P = 0.20). There was also no significant difference between the highest systolic and diastolic BP on admission between COVID-19-positive and -negative surgical mortalities (P = 0.31 and P = 0.48, respectively) (Table 1).

HIV infection and treatment status

The HIV status of 91% (366/404) of the mortalities was known, comprising 93% (76/82) of COVID-19-positive surgical mortalities and 90% (290/366) of COVID-19-negative surgical mortalities. Of the surgical mortality cases whose HIV status was known, 36% (134/366) were HIV positive and 26% (35/134) of HIV-positive patients were on ART (Table 2).

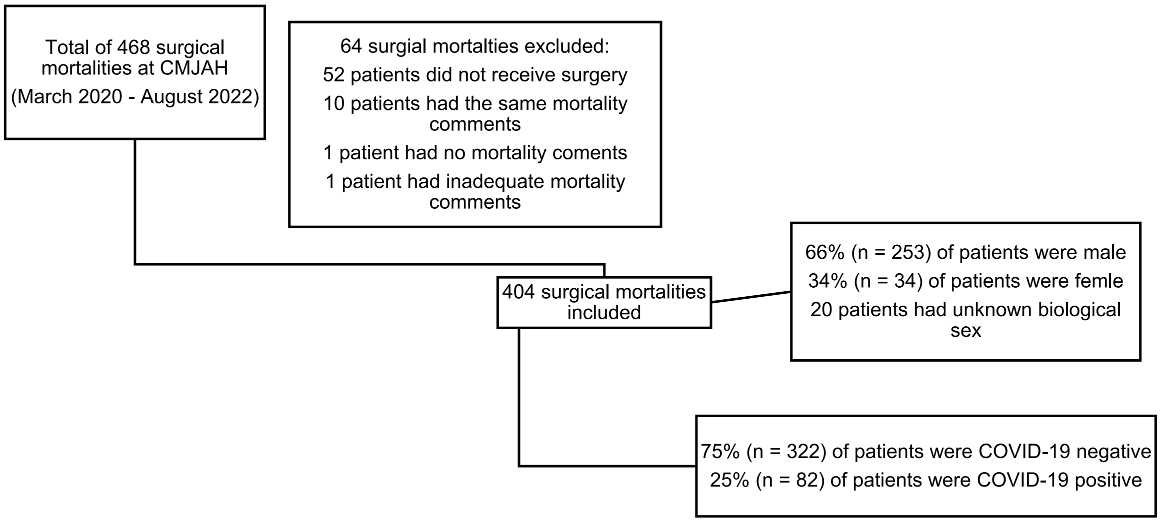

Figure 1. Flow map of the surgical mortalities at Charlotte Maxeke Johanneburg Academic Hospital (CMJAH) from March 2020 to August 2022. The figure shows why 64 surgical mortalities were excluded, as well as the total COVID-19 status and biological sex of the surgical mortalities included.

Data on HIV status and treatment were significantly different for COVID-19-negative and -positive surgical mortality cases ($P = 3.18 \times 10^{-4}$; df = 3) (Table 2). 55% (42/76) of COVID-19-positive surgical mortalities were HIV positive compared to 31% (89/290) of the COVID-19-negative group. HIV-positive and COVID-19-positive surgical mortalities were almost twice as likely not to be on antiretroviral treatment as compared to HIV-positive and COVID-19-negative surgical mortalities [40% (17/42) versus 28% (25/89), respectively] (Table 2).

Other comorbidities and risk factors

The most prevalent risk factor among surgical mortality cases was hypertension (32%; 129/404), while 25% (100/404) had cancer. The distribution of risk factors between COVID-19-negative and -positive surgical mortalities was significantly different ($P = 1.89 \times 10^{-9}$; df = 7) (Table 3). Among the prevalent comorbidities within the COVID-19-positive surgical mortality group were hypertension at 51% (42/82), smoking at 35% (29/82), type 2 DM at 23% (19/82), and COPD at 20% (16/82). The prevalent comorbid conditions in the COVID-19-negative surgical mortality group were hypertension at 27% (87/322) and malignancy at 25% (80/322) (Table 3).

Preventability of surgical mortality

The preventability status of 99% of mortalities (401/404) was discussed and recorded. 58% (233/401) of surgical mortalities were deemed not preventable. There was no significant difference in mortality preventability between COVID-19-positive and -negative surgical mortalities ($P = 0.61$; df = 3) (Table 4).

Factors contributing to surgical mortality

Contributing factors to the mortalities were provided for 66% (213/322) of COVID-19-negative mortalities and 42% (34/82) of COVID-19-positive mortalities in which mortality preventability classification was known. Mortality contributing factors were

Table 1

Quantitative variables in COVID-19-negative and -positive surgical mortalities.

		COVID-19 negative (total $n = 322$)	COVID-19 positive (total $n = 82$)	P-value
Age (years)	Mean (standard deviation)	50.56 (17.35)	58.31 (14.29)	*4.30×10^{-5}
	Number of patients (% coverage)	297 (92%)	78 (95%)	
C-reactive protein (highest) (mg/l)	Mean (standard deviation)	235.17 (107.55)	220.62 (106.71)	0.20
	Number of patients (% coverage)	149 (46%)	52 (63%)	
White cell count (highest) ($\times 10^9$/l)	Mean (standard deviation)	16.09 (8.96)	19.06 (10.13)	*0.02
	Number of patients (% coverage)	185 (57%)	57 (69%)	
Blood glucose (highest) (mmol/l)	Mean (standard deviation)	9.66 (6.21)	12.56 (11.79)	0.14
	Number of patients (% coverage)	73 (22%)	23 (28%)	
Hemoglobin (lowest) (g/dl)	Mean (standard deviation)	9.41 (3.13)	9.64 (2.84)	0.30
	Number of patients (% coverage)	244 (76%)	57 (69%)	
Systolic blood pressure (highest) (mmHg)	Mean (standard deviation)	122.75 (25.91)	124.52 (23.22)	0.31
	Number of patients (% coverage)	250 (78%)	57 (69%)	
Diastolic blood pressure (highest) (mmHg)	Mean (standard deviation)	74.34 (18.67)	74.21 (16.17)	0.48
	Number of patients (% coverage)	250 (78%)	57 (69%)	

*Indicates a significant statistical result.

Table 2

HIV infection and treatment status of COVID-19-negative and -positive surgical mortalities.

	COVID-19-negative mortalities (total $n = 290$)	COVID-19-positive mortalities (total $n = 76$)	Total
HIV negative	201 (69%)	34 (45%)	235
HIV positive on treatment	26 (9%)	9 (12%)	35
HIV positive not on treatment	25 (9%)	17 (22%)	42
HIV positive with unknown treatment status	38 (13%)	16 (21%)	54
Total			366

significantly different between COVID-19-negative and -positive surgical mortalities ($P = 2.15 \times 10^{-4}$; df = 7). Communication between staff as a contributing factor for mortality was considerably higher among COVID-19-positive mortalities as compared to COVID-19-negative mortalities [29% (10/34) versus 13% (28/213)]. Supervision as a contributing factor to preventable mortality was higher in COVID-19-positive surgical mortalities than COVID-19-negative surgical mortalities [15% (5/34) compared to 10% (21/213)] (Table 5).

Perioperative constraints

Perioperative constraints assessed included delayed presentation to the hospital or theater and immunosuppressive states other than HIV infection and sepsis at any stage. There was no significant difference in the surgical constraint data between COVID-19-positive and -negative surgical mortalities ($P = 0.18$; df = 3). The prevalence of sepsis was identical between COVID-19-negative and -positive patients who died at 40%, 108/270 and 39/97, respectively. Delay to theater was the second most prevalent surgical constraint in both COVID-19-positive and -negative patients at 37% (36/97) and 31% (84/270), respectively (Table 6).

Likelihood of COVID-19 infection

The odds of COVID-19 infection was significantly higher in older patients [OR = 1.03, 95% CI (1.02, 1.05)], untreated HIV disease [OR = 3.10, 95% CI (1.55, 6.11)], COPD [OR = 3.09, 95% CI (1.08, 8.95)], and hypertension [OR = 1.96, 95% CI (1.06, 3.59)] (Table 7).

Table 3

Risk factors present in COVID-19-negative and -positive surgical mortalities.

	COVID-19-negative mortalities[a]	COVID-19-positive mortalities[a]	Total[b]
Hypertension	87 (27%)	42 (51%)	129 (32%)
High BMI (>25 kg/m^2)	42 (13%)	12 (15%)	54 (13%)
Cardiovascular disease	23 (7%)	5 (6%)	28 (7%)
Diabetes mellitus type 1	20 (6%)	4 (5%)	24 (6%)
Diabetes mellitus type 2	43 (13%)	19 (23%)	62 (15%)
Smoking	12 (4%)	29 (35%)	41 (10%)
Malignancy	80 (25%)	20 (24%)	100 (25%)
Chronic obstructive pulmonary disease	9 (3%)	16 (20%)	25 (6%)

[a]Percentages calculated out of a total number of COVID-19-negative (n = 322) and COVID-19-positive (n = 82) surgical mortalities.
[b]Percentages calculated out of the total number of surgical mortalities included in the study (n = 404).

Table 4

Preventability of COVID-19-negative and -positive surgical mortalities.

	COVID-19-negative mortalities (Total $n = 321$)	COVID-19-positive mortalities (Total $n = 80$)	Total
Not preventable	185 (58%)	48 (60%)	233 (58%)
Potentially preventable	109 (34%)	28 (35%)	137 (34%)
Preventable	21 (6%)	4 (5%)	25 (6%)
Not known	6 (2%)	0 (0%)	6 (1%)
Total			401

Discussion

The effect of HIV on surgical mortality in the context of COVID-19 infection is yet to be investigated. In this study, we aimed to elucidate this association along with other comorbidities by assessing surgical mortalities. The importance of such an inquiry is rooted in the unparalleled HIV prevalence in South Africa. Additionally, the COVID-19 pandemic had a significant impact on the functioning of healthcare systems and the delivery of services across the world. Here, we analyzed the effect of the COVID-19 pandemic on the rate and factors that contributed to mortalities in surgical patients, including HIV status.

Our study revealed that considerably more COVID-19-positive surgical mortalities were HIV positive than compared to COVID-19-negative surgical mortalities. Additionally, COVID-19- and HIV-positive surgical mortalities were almost twice as likely not to be on ARV treatment. In the context of surgical mortality, being HIV positive and not on treatment increase the odds of COVID-19 infection 3.1 times. Thus, our data suggest untreated HIV infection increases the risk of COVID-19 infection and further suggest that untreated HIV infection may increase the risk of perioperative mortality in the context of COVID-19 infection.

Current postulations for this finding are rooted in a chronic inflammatory state with HIV infection, which, when combined with the cytokine storm often observed in COVID-19-infected patients, worsens outcomes leading to mortality[21,22]. The increased risk of COVID-19 infection with HIV infection as reported in literature is likely linked to chronic immunosuppression[9,11]. The functional impedance increasing the risk of COVID-19 infection among HIV-positive patients may be rooted in delayed immunoglobulin production, specifically in poorly controlled HIV[23–26]. Our data illustrate this notion for the first time in surgical mortalities, particularly HIV-positive mortalities not on ART.

Our investigation not only demonstrated a link between HIV/COVID coinfection and surgical mortality but also highlighted the importance of adherence to HIV treatment. Of the total surgical mortality cases whose HIV status was known, 36% were HIV positive, and of these HIV-positive patients, only 26% were on treatment. This lies in contrast to the pre-pandemic South African populational statistics where HIV prevalence is estimated to be at 17%, and patients on ART at

Table 5

Contributing factors of COVID-19-negative and -positive surgical mortalities.

	COVID-19-negative mortalities (total $n = 213$)	COVID-19-positive mortalities (total $n = 34$)	Total
None of these factors contributed	115 (54%)	11 (32%)	126 (51%)
Training	12 (6%)	2 (6%)	14 (6%)
Supervision	21 (10%)	5 (15%)	26 (11%)
Lack of resources	4 (2%)	1 (3%)	5 (2%)
Equipment	7 (2%)	2 (6%)	9 (4%)
Infrastructure	20 (10%)	1 (3%)	21 (8%)
Communication between staff	28 (13%)	10 (29%)	38 (15%)
Unknown	4 (2%)	1 (3%)	5 (2%)
Other	2 (1%)	1 (3%)	3 (1%)
Total			247 (100%)

Table 6

Peri-surgical constraints in COVID-19-negative and -positive mortalities.

	COVID-19-negative mortalities (total $n = 270$)	COVID-19-positive mortalities (total $n = 97$)	Total
Delayed presentation	56 (21%)	20 (21%)	76 (21%)
Delayed to theater	84 (31%)	36 (37%)	120 (33%)
Immunosuppression	22 (8%)	2 (2%)	24 (6%)
Sepsis	108 (40%)	39 (40%)	147 (40%)
Total			367

62.3%[27]. This discrepancy may microcosm the impact of the COVID-19 pandemic on HIV health service delivery in South Africa. In sub-Saharan Africa, the COVID-19 pandemic exacerbated barriers to the accessibility, availability, and affordability of HIV healthcare and services[28]. Overall decreases in HIV testing, ART initiation, and pre-exposure prophylaxis (PrEP) usage were noted in South Africa during the pandemic[29,30]. Internationally, measures employed to maintain HIV service delivery included telehealth and ART delivery, which instilled notable service delivery resilience in developed countries[31]. In South Africa, no disruption to HIV services was noted in private primary healthcare centers, illustrating the importance of funds in providing the measures required for maintained service delivery[30].

Other comorbidities and risk factors investigated in the context of surgical mortality were age, hypertension, DM types 1 and 2, smoking, and COPD. The age of COVID-19-positive mortalities was significantly higher than COVID-19-negative mortalities, congruent with the current consensus that older people are at a greater risk for mortality when suffering from COVID-19, especially in the context of surgery[32].

Hypertension, DM type 2, smoking, and COPD were more prevalent in COVID-19-positive surgical mortalities than COVID-19-negative surgical mortalities, consistent with previous reports regarding COVID-19 infection and surgical mortality[33–35]. COPD and DM type 2 have also previously been identified as independent risk factors for mortality in patients with COVID-19[17,36].

Data collected for COVID-19-positive and -negative surgical mortalities also included mortality preventability, contributing factors, and surgical constraints.

Moeng and Luvhengo[37] determined that 46.1% of the surgical mortalities at the same hospital were either preventable or potentially preventable, compared to 40.4% of surgical mortalities during the pandemic as presented in this study (Table 4). This may be due to the fact 40.8% of all mortalities occurred in the trauma department in the study performed by Moeng and Luvhengo[37], where it was illustrated that head injuries, penetrating trauma, and blunt trauma were all notable contributors to preventable and potentially preventable mortalities. Notably,

Table 7

Logistic regression results showing the odds of COVID-19 infection among surgical mortalities.

	Coefficient	*P*-value	Odds ratio (95% CI)
Age and gender			
Age	0.031	$^*P = 13.1 \times 10^{-5}$	1.03 (1.02, 1.05)
Male	0.431	$P = 0.50$	1.54 (0.49, 6.77)
Female	0.106	$P = 0.87$	1.11 (0.34, 5.07)
Immunosuppression and HIV infection status and treatment			
Immunosuppression	–0.932	$P = 0.22$	0.39 (0.06, 1.40)
HIV positive, on treatment	0.565	$P = 0.18$	1.76 (0.74, 3.88)
HIV positive, not on treatment	1.131	$^*P = 11.5 \times 10^{-4}$	3.10 (1.55, 6.11)
HIV positive, treatment status unknown	0.552	$P = 0.10$	1.74 (0.88, 3.32)
Comorbidities and risk factors			
DM type 1	0.104	$P = 0.86$	1.14 (0.29, 3.28)
DM type 2	0.375	$P = 0.33$	1.46 (0.67, 3.07)
Hypertension	0.675	$^*P = 0.02$	1.96 (1.06, 3.59)
High BMI	–0.036	$P = 0.93$	0.96 (0.41, 2.11)
Cardiovascular disease	–0.755	$P = 0.23$	0.47 (0.12, 1.49)
Smoking	2.051	$^*P = 1.27 \times 10^{-6}$	7.78 (3.45, 18.35)
Malignancy	0.151	$P = 0.64$	1.16 (0.61, 2.16)
COPD	1.128	$^*P = 0.03$	3.09 (1.08, 8.95)

BMI, body mass index; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus.

*Indicates a significant statistical result.

these conditions exhibit a propensity to result in potentially preventable mortalities due to their dependence on surgical training and senior supervision for success.

The factors contributing to surgical mortality were significantly different between COVID-19-positive and -negative patients (Table 5). There was a considerable difference in communication between staff as a contributing factor to mortality between COVID-19-positive and -negative surgical mortalities. This exists in contrast to data published by Moeng and Luvhengo[37], which attributed error of judgment, training, and supervision as the most impactful contributing factors to preventable mortalities. Equipment as a contributing factor for mortality is three times higher among COVID-19-positive surgical mortalities as compared to COVID-19-negative surgical mortalities. Poorer communication and equipment as contributing factors may be attributable to the functional constraints of COVID-19 protocols in theater or in supporting facilities. These included social distancing and reduced staff numbers, which may functionally impede equipment partitioning. Infrastructure was a notable contributing factor to deaths of COVID-19-negative patients and can be attributed to the fact that areas and wards at the study site were restricted to only COVID-19-positive patients, reducing the available infrastructure for treating COVID-19-negative patients.

Various surgical constraints may explain the persistence of a considerable proportion of preventable surgical mortalities during the pandemic (Table 6), considering that trauma-related mortalities have almost halved as compared to prior to the pandemic[37]. Sepsis was the most prevalent surgical constraint in our patient sample: a validated risk factor for surgical mortality among COVID-19-positive patients[38]. Interestingly, the prevalence of sepsis in our study was similar between COVID-19-negative and -positive surgical mortalities. Delay to theater was the second most common surgical constraint in our study. Functionally, this may have been due to the waiting time for preoperative swab results, shortage of staff due to pandemic-mediated limited theater quotas, and the reduced availability of theater spaces due to repurposing for ICU spaces. One study has illustrated a 3-h increase in waiting time for surgery during the pandemic as compared to prior, without significant changes in surgical mortality[39]. This limits the plausible contribution of delay to theater to the preventable surgical mortalities assessed during the pandemic.

Limitations regarded the nature of our data and the setting from which the data were obtained. The mechanism of COVID testing at the study site existed as a limitation. The clinical sensitivity of the COVID-19 reverse transcriptase polymerase chain reaction (RT-PCR) test is moderate at best[40]. Thus, the potential for false positives overestimating the effect of COVID-19 infection on surgical mortality arises. A second limitation involves the postponement of all elective surgeries during the initial period of COVID-19. This may exist as a confounding factor as mortality may have been attributable to the severity of ailment requiring emergency surgery in addition to COVID-19 infection.

Conclusion

Here, we illustrated for the first time an association between HIV and COVID-19 coinfection and surgical mortality. Our data also illustrated a significantly increased risk of COVID-19 infection among surgical mortalities who were not on ART. In addition, our data suggested a reduction in HIV service delivery during the pandemic. Protocols implemented during the COVID-19 pandemic plausibly also affected surgical service delivery. Although the proportion of preventable surgical mortalities decreased during the pandemic, COVID-19 protocols directly resulted in contributors to mortality in both COVID-19-positive and -negative patients such as (1) poor communication (due to social distancing, reduced staff numbers, and staff repurposing), (2) equipment (due to decreased staff numbers and equipment sequestration for COVID-19 treatment), (3) infrastructure (as ICU and theater space were repurposed), and (4) delay to theater (due to awaiting COVID-19 RT-PCR results, reduced theater capacity, and porter shortage). Our study rudimentarily suggests a need for interventions ensuring robust HIV service delivery, which is resilient to the constraints posed by future pandemic protocols. These interventions should be affordable, ensuring accessibility among individuals reliant on public healthcare. Our investigation also provides an elementary scaffold on which aspects of surgical workflow should be maintained to ensure optimal surgical service delivery and reduce preventable surgical mortalities in future pandemics.

Ethical approval

Ethical approval for the study was received from the Human Research Ethics Committee of the University of the Witwatersrand, Johannesburg, Republic of South Africa on 24 April 2023. The reference number is M221055 MED-09-108.

Consent

This category is not applicable to the study. All available mortality data had been de-identified (no patient names or hospital numbers) before data analysis.

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Author's contribution

S.E., C.M., and T.L. contributed to the study concept and design. S.E., C.M., J.V.R., and K.M. contributed to the data collection sheet design. All authors contributed to the data collection. S.E. contributed to the data analysis. S.E., C.M., J.V.R., and F.T. contributed to the data interpretation. All authors contributed to writing the paper. S.E., C.M., and T.L. contributed to the review.

Conflicts of interest disclosure

The authors declare no conflicts of interest.

Guarantor

Thifhelimbilu Luvhengo, Sean Engelhardt, and Ciara Morley

Research registration unique identifying number (UIN)

The study was registered through ISRCTN, available through www.ISRCTN.com. The unique identifying number for the study is ISRCTN97118839. The study registration is available at www.ISRCTN.com/ISRCTN97118839.

Provenance and peer review

This paper was not invited.

Data availability statement

All data analyzed for the completion of the study is stored on REDCap, an electronic database used to record all surgical data at the study site: Charlotte Maxeke Johannesburg Academic Hospital, Johannesburg, South Africa. Data are accessible upon receiving ethical clearance.

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Presentations

None declared.

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