International Journal of Community Medicine and Public Health
Adan AA et al. Int J Community Med Public Health. 2024 Nov;11(11):4162-4167
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20243269

Original Research Article

Proportion of secondary bacterial infections among the SARS-COV-2 patients admitted in the selected health facilities in Mombasa and Nairobi counties in Kenya

Ali Abdi Adan[1]*, Joseph Juma[1], Oscar Donde[2], Jared Otieno Ogolla[3]

[1]Department of Community Health, School of Public Health, Thika, Kenya
[2]Department of Environmental Science, Faculty of Environment and Resources Development, Egerton, Kenya
[3]Department of Environmental Health, School of Public Health, Thika, Kenya

Received: 26 February 2024
Revised: 14 July 2024
Accepted: 15 July 2024

***Correspondence:**
Ali Abdi Adan,
E-mail: aliadan2011@yahoo.com

ABSTRACT

Background: There is still scarcity of evidence on proportion of secondary bacterial infections among SARS-COV-2 patients in Kenya. This study therefore sought to determine the proportion of secondary bacterial infections among SARS-COV-2 patients in ICUs in the selected health facilities in Mombasa and Nairobi Counties.
Methods: The retrospective cross-sectional sampled the records of 385 SARS-COV-2 patients admitted and administered antibiotics during treatment in the intensive care units (ICU) in the six health facilities that acted as isolation and treatment centers for SARS-COV-2 patients between 13th March 2020 and 31st December 2021. The research team reviewed the medical records of the SARS-COV-2 positive patients and extracted the patient demographic data, medical history, underlying co-morbidities, clinical symptoms, laboratory findings, management and treatment measures and antimicrobial susceptibility tests.
Results: 47.3% of the patients in the study had secondary bacterial infections. Significant majority of patients of these patients were smokers (n=158, 86.8%, p≤0.05), had very high fever at admission in the ICU (n=139, 76.4%, p=0.033) and were administered iron supplement during the hospital stay (n=125, 68.7%, p=0.027).
Conclusions: SARS-COV-2 patients who smoke, report high fever at admission in the ICU and given iron supplement during their stay in the health facility tend to have a high prevalence of secondary bacterial infections.

Keywords: SARS, SARS-COV-2, Secondary bacterial infections, Severe acute respiratory syndrome

INTRODUCTION

Secondary bacterial infections are a common complication associated with severe-acute respiratory syndrome (SARS).[1] The main bacterial pathogens being *Streptococcus pneumoniae*, *Klebsiella pneumoniae*, and *Acinetobacter baumannii*.[2,3] More often, these species often cause severe disease and increased mortality.[1-3]

Other than the bacterial species, other factors associated with these worst outcomess include age and gender. In SARS coronavirus (SARS-COV-2) patients for example, age increases morbidity and mortality. In fact, those aged ≥50 years have higher odds of dying from SARS-COV-2 than their younger counterparts.[4,5] SARS-COV-2 is also more pronounced among the males and those with co-morbidity.[6]

Notably, SARS-COV-2 patients with immuno-compromised system or those ailing from tuberculosis or influenza are more likely to develop secondary infections.[7] For instance, in 2009, during the H1N1 pandemic, it is estimated that more than 30% of those

who died from the diseases were attributed to secondary bacterial infections.[8]

This is because co-morbidity of viral infection and bacterial infections, more often, result to deaths as was observed during the outbreak of H1NI flu in 2009.[8] A similarly pattern of deaths was also reported with SARS-COV-2.[9] However, these deaths varies from 12.4-50%.[10] In China the figure stood at 34.5%.[11] Interestingly, most of the deaths were reported among patients with secondary bacterial infections.[12,13]

Specifically, the deaths were mainly caused by *Staphylococcus sp*.[14] Nevertheless, there is still scarcity of evidence on proportion of secondary bacterial infections among SARS-COV-2 patients in Kenya.

This study therefore sought to determine the proportion of secondary bacterial infections among SARS-COV-2 patients in ICUs in the selected health facilities in Mombasa and Nairobi Counties.

METHODS

Study area

This study was conducted in Nairobi and Mombasa. Specifically, it targeted Kenyatta National Referral Hospital (KNH), Mbagathi County Hospital, Nairobi Hospital, Aga Khan University Hospital (AKUH), Avenue Hospital and Coast General Teaching and Referral Hospital (CGTRH). These facilities acted as isolation and treatment centers for SARS-COV-2 patients during the study period.

Research design

The retrospective cross-sectional study sampled the records of 385 SARS-COV-2 patients administered antibiotics during treatment in the ICU in the six health facilities between 13th March 2020 and 31st December 2021.

Sampling criteria

The number of patients records sampled in each facility was proportionate to the number of SARS-COV-2 patients admitted in each facility. Once the number was determined, the records were selected from the hospital database randomly.

Inclusion criteria

All patients irrespective of their age or co-morbidity were included. These were SARS-COV-2 patients whose samples were subjected to antimicrobial susceptibility test and the results made available to the research team. Only patients admitted in the ICU and whose records were available and complete with the measurement of outcomes were included in the study.

Exclusion criteria

Patients with history of antimicrobial drug resistance prior to the outbreak of SARS-COV-2 were eliminated from the study.

Data collection procedure

The research team reviewed the medical records of the SARS-COV-2 positive patients and extracted the patient demographic data, medical history, underlying co-morbidities, clinical symptoms, laboratory findings, management and treatment measures and antimicrobial susceptibility tests. In case of deaths, the research team reviewed autopsy reports to determine if the death was caused by secondary bacterial infections.

RESULTS

Characteristics of the study participants

A half of the patients were aged 41-64 (n=193, 50.1%) and close to a third ≥65 years (n=127, 33.0%). Majority of the parents were not obese (n=248, 64.4%). However, most were hypertensive and diabetic (n=259, 67.3%; n=302, 78.4%). A substantial number did not have coronary heart disease (n=294, 76.4%), cancer (n=306, 79.5%) or history of a previous disease (n=373, 96.9%). The length of stay for most of the patients in the ICU was 1-6 days (n=301, 78.2%).

The ratio of male to female was almost equal (49.6% versus 50.4%). Several patients were non-smokers (n=227, 59.0%). C-reactive protein (CRP) in the majority of the patients was moderate (n=210, 54.5%) while the number of leukocytes were high among several patients (n=285, 74.0%). Most of the patients SpO_2 were <90 on admission in the ICU (n=299, 77.7%). Notably, a huge proportion of patients exhibited a high fever at admission in in the ICU (n=273, 70.9%). A high number of patients were also administered with iron supplement during their stay in the hospital (n=242, 62.9%).

The most common isolated bacteria among the studied patients was *A. fumigatus* (n=195, 50.6%), followed by *Enterobaterales* (n=89, 23.1%), *K. pneumonia* (n=68, 17.7%), *P. aeruginosa* (n=22, 5.7%) and *S. aureus* (n=11, 2.9%). Eight types of antibiotics were administered to the patients either before or after admission in the ICU. The drugs were administered either solely or in combinations. Those administered before admission in the ICU included cefoperazone and ampicillin/sulbactam while fluconazole, meropenem + vancomycin or piperacillin/tazobactam + levofloxacin were administered after admission.

Table 1: Characteristics and distribution of secondary bacterial infections.

Characteristics of the patients	Secondary bacterial infections		P value at 95% CI
	Present N (%)	Absent N (%)	
Age (years)			
20-40	29 (15.9)	36 (17.7)	0.858
41-64	91 (50.0)	102 (50.2)	
≥65	62 (34.1)	65 (32.0)	
Obesity			
Yes	65 (35.7)	72 (35.5)	0.960
No	117 (64.3)	131 (64.5)	
Hypertensive patient			
Yes	129 (70.9)	130 (64.0)	0.159
No	53 (29.1)	73 (36.0)	
Diabetic patient			
Yes	144 (79.1)	158 (77.8)	0.805
No	38 (20.9)	45 (22.2)	
CHD			
Yes	43 (23.6)	48 (23.6)	1.000
No	139 (76.4)	155 (76.4)	
Cancer patient			
Yes	37 (20.3)	42 (20.7)	1.000
No	145 (79.7)	161 (79.3)	
No personal history of disease			
Yes	3 (1.6)	9 (4.4)	0.147
No	179 (98.4)	194 (95.6)	
Duration of ICU stay (days)			
1-6	148 (81.3)	153 (75.4)	0.175
≥7	34 (18.7)	50 (24.6)	
Sex			
Male	93 (51.1)	98 (48.3)	0.610
Female	89 (48.9)	105 (51.7)	
Smoker			
Yes	158 (86.8)	0 (0.0)	≤0.05*
No	24 (13.2)	203 (100.0)	
CRP on admission to the ICU			
Moderate	100 (54.9)	110 (54.2)	0.919
High	82 (45.1)	93 (45.8)	
Leukocytes on admission to the ICU			
Moderate	50 (27.5)	50 (24.6)	0.561
High	132 (72.5)	153 (75.4)	
SpO_2 on admission to the ICU			
<90	137 (75.3)	162 (79.8)	0.327
>90	45 (24.7)	41 (20.2)	
Fever at admission in the ICU			
High	43 (23.6)	69 (34.0)	0.033*
Very high	139 (76.4)	134 (66.0)	
Type of infecting bacterial organism			
A. fumigatus	94 (51.6)	101 (49.8)	0.134
Enterobacterales	45 (24.7)	44 (21.7)	
K. pneumonia	31 (17.0)	37 (18.2)	
P. aeruginosa	11 (6.0)	11 (5.4)	
S. aureus	1 (0.5)	10 (4.9)	
Antibiotic administered before ICU admission			
Ampicillin/Sulbactam	46 (25.3)	65 (32.0)	0.176
Cefoperazone	136 (74.7)	138 (68.0)	

Continued.

Characteristics of the patients	Secondary bacterial infections		P value at 95% CI
	Present N (%)	Absent N (%)	
Antibiotic administered during ICU admission			
Fluconazole	51 (28.0)	41 (20.2)	0.058
Meropenem+vancomycin	80 (44.0)	84 (41.4)	
Piperacillin/tazobactam+levofloxacin	51 (28.0)	78 (38.4)	
Administered iron supplement during the hospital stay			
Yes	125 (68.7)	117 (57.6)	0.027*
No	57 (31.3)	86 (42.4)	
Took fluconazole as part of their therapy regimen			
None	131 (72.0)	162 (79.8)	0.074
Took fluconazole	51 (28.0)	41 (20.2)	

*Statistically significant

Table 2: Regression coefficients for regression analysis between secondary bacterial infection and characteristics of the patients.

	Unstandardized coefficients		Standardized coefficients	t	Sig.	95% CI for B	
	B	Std. error	Beta			Lower bound	Upper bound
(Constant)	0.05	0.07	0.00	0.75	0.452	-0.09	0.20
Smoking	0.89	0.02	0.88	35.95	0.000	0.84	0.94
Iron	0.04	0.03	0.04	1.67	0.096	-0.01	0.09
Fever	0.00	0.03	0.00	-0.02	0.986	-0.05	0.05

R=0.88, Adjusted R^2=0.78

Cefoperazone was the most common antibiotics administered before ICU admission (n=274, 71.2%) and combination of meropenem + vancomycin after admission (n=164, 42.6%). This was closely followed by a combination of piperacillin/tazobactam + levofloxacin (n=129, 35.5%). A pantry 23.9% (n=92) had taken fluconazole as part of their therapy regimen. Table 1 summarizes the characteristics of the patients who were sampled in this study.

Proportion of secondary bacterial infections among the SARS-COV-2 patients admitted and treated in the six health facilities in Mombasa and Nairobi Counties

Of the 385 patients studied, 182 (47.3%) had developed secondary bacterial infections. The KNH and Mbagathi hospital had almost equal number of patients with secondary bacterial infections (n=54, 29.7% versus n=52, 28.6%). This was followed by those admitted at Avenue hospital (n=32, 17.6%), CGTRH (n=20, 11.0%), AKUH (n=13, 7.1%) and then Nairobi hospital (n=11, 6.0%). (Figure 1).

A half of the patients with secondary bacterial infections were 41-64 years (n=91, 50.0%). Most of the patients who were not obese had a high number of secondary infections compared to their counterparts who were obese (n=117, 64.3% versus n=65, 35.7%). There were also a remarkably high number of secondary infections among the hypertensive patients (n=259, 67.3%) and diabetic patients (n=144, 79.1%).

The high number of patients with secondary infections was also reported among patients with no CHD (n=294, 76.4%), non-cancer patients (n=145, 79.7%), no personal history of disease (n=179, 98.4%) and among those who had stayed in the ICU for 1-6 days (n=148, 81.3%). The proportion of secondary bacterial infections was slightly more than half in male patients. (n=93, 51.1%). It was also higher among patients who reported that they were smokers (n=158, 86.8%). Those who had moderate CPR at admission in the ICU (n=100, 54.9%), had a SpO_2<90 at admission (n=137, 75.3%) and high leukocytes levels (n=132, 72.5%).

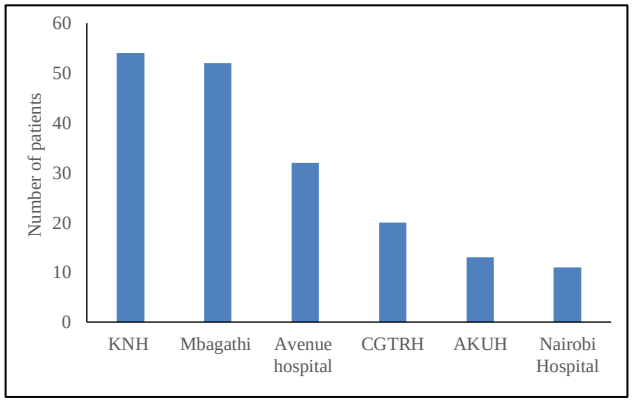

Figure 1: Number of patients that developed secondary bacterial infections per health facility.

There was no significant difference in the proportion of secondary bacterial infections among patients who had

the infections and those without with regards to age (p=0.858), obesity status (p=0.960), hypertension (p=0.159), diabetic status (p=0.805), CHD (p=1.000), cancer status (p=1.000), no personal history of disease (p=0.147), length of stay in the ICU (p=0.175), sex of the patient (p=0.610), leukocytes levels (p=0.561), SpO_2 (p=0.327), antibiotics administered before admission in the ICU (p=0.176), during admission in the ICU (p 0=0.058), type of infecting bacteria (p=0.134) and level of CRP at the time of admission in the ICU (p=0.919). However, the proportions differed significantly with smoking ($p \leq 0.05$), fever (p=0.033) and administration of iron supplement during admission in the ICU (p=0.027). (Table 1).

Multiple regression analysis was used to analyze the three variables (smoking, fever at admission in the ICU and took fluconazole as part of their therapy regimen) further. Only the difference in proportion of secondary bacterial infections among the smokers and non-smokers remained significant ($p \leq 0.05$). The difference in the proportions in the other two variables was insignificant. The model accounted for 78% of the observed difference in the proportions in the three variables (R^2=0.78) (Table 2).

DISCUSSION

Several population characteristics can influence the spread and impact of SARS-COV-2.[15-17] These characteristics include age distribution, underlying health conditions, socioeconomic status, population density, and access to healthcare, among others. This study observed that most of the patients who had secondary bacterial infections were aged 41-61 years. A plausible explanation for this is that the patients in this age group had underlying health conditions such as diabetes, heart disease, or lung disease that increased their risk for secondary bacterial infections. These conditions can weaken the immune system and make it harder for the body to fight off infections.

The finding disagrees with most of the studies that indicate that the most affected group with SARS-Cov-2 were those above the ages of 61.[18,19] However, is in tandem with one study that indicated that the most affected are those below the ages of 61.[20] Sixty-seven percent (67%) of the patients admitted in the ICU with SARS-COV-2 were 20-64 years. This finding is closer to that of Eva et al which observed that 52% of the young people aged 18-65 comprised all the patients admitted in the health facilities in Spain. However, unlike the study conducted in Spain, this study did not capture any patient below 20 years and those above 64 years.[20]

Close to half of the patients in this study had secondary bacterial infection. This number is higher than that reported by Mylene and Peter.[21] However, this study found that the prevalence of secondary pulmonary bacterial infection in SARS-COV-2 patients was higher than that in the previous Spanish flu and H1N1 pandemic.[22-24]

The prevalence of secondary pulmonary bacterial infection in SARS-COV-2 patients in this study was 47.3%, which is not in concordance with the findings of previous studies that reported a prevalence of secondary infections ranging from 6% to 14% in SARS-COV-2 patients.[25-27] Majority of the patients who had secondary bacterial infections were smokers. Tobacco smoke as a risk factor for multiple and varied bacterial infections is well documented.[28] And thus, it could have compounded the patients conditions.

The study's sample size of 385 might not fully represent the diversity of SARS-CoV-2 patients in Kenya. Additionally, the selection of participants from only six health facilities might have introduced selection bias. The study also only included patients with complete and available medical records, potentially excluding cases with incomplete documentation, which could affect the generalizability of the findings. The study duration was 21 months and this might not have captured long-term trends in bacterial infections and AMR among SARS-CoV-2 patients. Lastly, the accuracy of the collected data relied heavily on the completeness and accuracy of medical records, which varied among healthcare facilities

CONCLUSION

In conclusion, SARS-COV-2 patients who smoke, report high fever at admission in the ICU and given iron supplement during their stay in the health facility tend to have a high prevalence of secondary bacterial infections. It is, therefore, important for facilities to invest in laboratory capacity to improve the diagnosis and management of bacterial infections. Rapid and accurate diagnosis of bacterial infections can help clinicians choose the appropriate antimicrobial therapy.

ACKNOWLEDGEMENTS

Our sincere gratitude goes to the health records department of the six health facilities which participated in this study. Their contributions have been instrumental in shaping the outcome of this study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee Mount Kenya University

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Cite this article as: Adan AA, Juma J, Donde O, Ogolla JO. Proportion of secondary bacterial infections among the SARS-COV-2 patients admitted in the selected health facilities in Mombasa and Nairobi counties in Kenya. Int J Community Med Public Health 2024;11:4162-7.