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Research Article

Clinical Characteristics of the First 100 COVID-19 Patients Admitted to a Tertiary Hospital in Johannesburg, South Africa

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ABSTRACT

Background: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the disease it causes, coronavirus disease 2019 (COVID-19), has spread rapidly across the globe resulting in more than 7,000,000 cases and 400,000 deaths worldwide, of which 52,991 cases and 1162 deaths have occurred in South Africa.

Objective: To describe the clinical characteristics of the first 100 patients with COVID-19 admitted to a tertiary hospital in Johannesburg, South Africa.

Methods: We conducted a single-centre retrospective review of the first 100 patients with reverse transcriptase polymerase chain reaction-confirmed COVID-19 infection admitted to a tertiary academic hospital in Johannesburg, South Africa.

Results: The 100 patients were predominantly male (53%), of black ethnicity (79%) and had a median age of 42 years. The most common comorbidities were hypertension (31%), diabetes mellitus (18%) and 47% of the patients had an endomorphic phenotype. Eleven per cent (11%) of our patients were HIV positive. During hospitalisation, 14 patients (14%) required admission to the intensive care unit (ICU). For those patients with an outcome available, the overall mortality rate was 10% ($n = 6$), and 57% ($n = 4/7$) for those admitted to the ICU. Mean length of stay for those who had died or had been discharged was 6.8 days.

Conclusion: This case series describes clinical characteristics in the first 100 patients with confirmed COVID-19 admitted to a large centre in Johannesburg, South Africa. Our findings are concordant with universally reported data; however, more data is needed on COVID-19 in the South African setting, specifically related to tuberculosis and HIV.

Keywords: COVID-19, South Africa, HIV, Hospital outcomes

INTRODUCTION

On 7 January 2020, a novel coronavirus, initially named 2019-nCoV, was identified in bronchoalveolar lavage specimens of five patients who presented with pneumonia of unknown cause to a hospital in Wuhan, China.(1) The initial case report of patients affected by 2019-nCoV, later renamed SARS-CoV-2 (COVID-19), included 41 patients, of which 27 had been exposed to the Huanan seafood market.(2) Since this first report, the virus has spread rapidly across the globe resulting in more than 7.4 million cases and over 418,000 deaths as on 12 June 2020.(3) The majority of affected patients, 81%, in a large cohort in Wuhan presented with mild respiratory disease after an incubation period of 2.1 to 11.1 days, although non-respiratory symptoms such as anosmia, nausea and vomiting and diarrhoea have also been reported in later cohorts.(4,5)

In the original Wuhan cohort, 14% of patients had severe disease requiring oxygen therapy, whilst 5% had critical disease and required either ventilation, inotropic support or renal replacement therapy. The overall case fatality rate (CFR) was 2.3% although this was significantly higher in elderly patients (14.8% in those 80 years and older) and those with hypertension (6%) and diabetes (7.3%).(4)

In South Africa, the first case of COVID-19 was diagnosed in Pietermaritzburg, Kwa-Zulu Natal, on 5 March 2020, in a traveller who had recently returned from Italy.(6) The second case in the country and the first in the Gauteng province, a 38-year-old female who had travelled with the index patient, was diagnosed a day later and admitted to the Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) for further management. Following the index case, as on 9 June 2020, a total of 52,991 patients have been diagnosed with COVID-19 and 1162 patients have died as a result of the disease in South Africa. Gauteng province accounts for 6546 of the country's infected patients, the third-most affected province in the country, with 57 deaths.(7)

South Africa has many differences from the rest of the world with a high prevalence of hypertension and diabetes, 26.9% and 11.3%, respectively, and an estimated 14% of the population living with HIV, of which only 55% are virally suppressed.(8–10) The original Wuhan cohort showed that the CFR was significantly higher in patients with hypertension and diabetes but very little has been published on people living with HIV (PLWH), especially those who are not virally suppressed.(4) A study from China reported similar rates of COVID-19 disease in HIV-positive and HIV-negative patients.(11)

A PubMed search on 10 June 2020 for 'COVID-19' or 'SARS-CoV-2' resulted in over 20,000 articles that have been published on the topic, of which more than 500 are case reports. To our knowledge, no South African case series has been published on patients with COVID-19 to date.

METHODS

Data collection

We performed a single-centre case series on the first 100 adult patients with reverse-transcriptase polymerase chain reaction (RT-PCR)-confirmed COVID-19 admitted to CMJAH. CMJAH is a 1088-bedded central hospital, located in Parktown, Johannesburg, providing specialist care to patients from surrounding areas as well as multiple tertiary and district hospitals in Gauteng and other provinces. In the early stages of the pandemic, CMJAH was designated as one of the three hospitals in the Gauteng province to treat patients with COVID-19.(12) The hospital also served as a quarantine facility for asymptomatic patients and those with mild illness that were unable to safely self-isolate at home.

Patient data, including demographic details, past medical history, symptoms and signs on admission, radiological and laboratory findings, treatment given during admission and patient outcome, were recorded by treating physicians at the time of admission, during the patient's hospital stay and at discharge using dedicated data collection sheets which were subsequently transferred onto a password-protected database. Data was supplemented with laboratory information from the National Health Laboratory Service (NHLS) lab system (TrakCare, Intersystems, Cambridge, MA, USA).

Patients were divided into two groups, asymptomatic and symptomatic, for purposes of comparison. Symptomatic was defined as any of the following, cough, diarrhoea, dyspnoea, fatigue, fever (self-reported), headache, malaise, myalgia, rhinitis, sore throat and vomiting. Severity of illness was defined as a respiratory rate greater than or equal to 22 breaths/min and systolic blood pressure <100 mmHg (as per the quick sepsis-related organ failure assessment (qSOFA),(13) peripheral oxygen saturation less than 90%, pulse rate >100 beats/min, temperature $>37.8^{\circ}$C or admission to the intensive care unit (ICU).

Statistical analysis

Data was exported to Microsoft Excel 16.3 (Microsoft Corporation, Redmond, USA) and analysed in Microsoft Excel and Prism 8.4 (GraphPad Software Inc., La Jolla, California). The Shapiro–Wilk normality test indicated that the data reported was not normally distributed; hence, non-parametric statistical tests were used for all the analyses performed. The results were reported in both a table format, as well as graphically using a box-and-whisker plot where applicable. The results included in the tables were reported as medians with interquartile ranges (IQRs) and with 95% confidence intervals (CI) where appropriate. The box-and-whisker plot displayed the data using the standard five-number summary: top and bottom boundary of the box indicating the 75th and 25th percentiles, the line within the box depicted the median and the whiskers represented the minimum and maximum values measured. All the laboratory investigations, measured as continuous variables, were compared in asymptomatic and symptomatic patients. For the patients categorised into asymptomatic versus symptomatic, the data were analysed using a Mann–Whitney test and analysis of the association between comorbidities and symptoms was performed using the Pearson's chi-square test and if the frequency was ≤ 5, a Fisher's exact (two-tailed) test was used. A p-value < 0.05 was considered statistically significant.

Ethics approval

Ethical approval for the study was obtained from the University of the Witwatersrand Human Research Ethics Committee Medical and hospital management at CMJAH;

patients admitted prior to this date had their data captured retrospectively, and those admitted subsequently provided informed consent to have their information prospectively included in the database.

RESULTS

Demographics

We analysed the data on the first 100 patients with RT-PCR confirmed COVID-19 admitted to CMJAH. The majority of the patients were male ($n = 53$, 53%) and of black ethnicity ($n = 79$, 79%). Median age was 42 (IQR 35–53, SD ±13.9). Fifty-two patients (52%) had at least one comorbidity; the most common comorbidities were hypertension ($n = 31$, 31%) and diabetes mellitus ($n = 18$, 18%). Eleven per cent of patients were HIV positive. Of the study cohort, 47% were of an endomorphic phenotype. Further demographic data is presented in Table 1.

Symptoms and admission vital statistics

Twenty-two patients (22%) were asymptomatic (reported no symptoms) and were admitted for purposes of self-isolation. The prevalence of reported symptoms in the symptomatic cohort is presented in Table 2. Twenty patients (20%) had a recorded temperature on admission >37.8°C, 22 patients were tachypnoeic (22%), 37 were tachycardic (37%), 50 were hypoxaemic (50%) and 7 (7%) had systolic blood pressure readings ≤100mmHg on admission.

Laboratory data

Laboratory tests were not requested for all patients admitted with asymptomatic disease; as a result, we do not have complete laboratory data for the whole cohort. Available admission laboratory data is presented in Table 3.

Treatment

As the pandemic evolved, treatment protocols were continuously revised, and no single treatment protocol was continued throughout the entire 3 months for this series of patients. Table 4 is a summary of different therapies prescribed. Anticoagulation with low-molecular-weight heparin (LMWH) was given as standard of care to all patients. The dose of LMWH was dependant on disease severity,

Table 1: Demographic data of the first 100 COVID positive patients

Age group	All	<20	21–30	31–40	41–50	51–60	61–70	71–80	80+
N (%)	100	1 (1%)	14 (14%)	32 (32%)	23 (23%)	18 (18%)	7 (7%)	3 (3%)	1 (1%)
Median age (IQR)	42 (35 –53)	18	27 (24–30)	37 (32–38)	45 (43–47)	55 (53–59)	63 (63–67)	71 (72–76)	86
Gender									
Male, *n* (%)	53 (53%)	1 (100%)	6 (43%)	11 (34%)	17 (74%)	8 (42%)	6 (86%)	3 (100%)	1 (100%)
Female, *n* (%)	47 (47%)	0	8 (57%)	21 (66%)	6 (26%)	11 (58%)	1 (14%)	0	0
Race									
Black, *n* (%)	79 (79%)	1(100%)	14 (100%)	27 (84%)	17 (74%)	13 (68%)	5 (71%)	1 (33%)	1 (33%)
White, *n* (%)	6 (6%)	0	0	2 (6%)	1 (4%)	1 (5%)	2 (29%)	0	0
Indian, *n* (%)	10 (10%)	0	0	3 (9%)	4 (17%)	2 (11%)	0	1 (33%)	0
Coloured, *n* (%)	5 (5%)	0	0	0	1 (4%)	3 (16%)	0	1 (33%)	0
Travel history, *n* (%)	9 (9%)	0	1 (7%)	2 (6%)	1 (4%)	0	5 (71%)	0	0
Positive contact, *n* (%)	34 (34%)	1(100%)	5 (36%)	7 (22%)	11 (48%)	5 (28%)	3 (43%)	2 (67%)	0
Comorbidities	51 (51%)	0	4 (29%)	13 (41%)	16 (70%)	14 (78%)	3 (43%)	1 (33%)	0
Hypertension	31 (31%)	0	0	5 (16%)	12 (52%)	9 (50%)	3 (43%)	1 (33%)	0
Diabetes	18 (18%)	0	1 (7%)	3 (9%)	5 (22%)	7 (39%)	1 (14%)	1 (33%)	0
HIV	11 (11%)	0	0	6 (19%)	1 (4%)	3 (17%)	1 (14%)	0	0
Malignancy	2 (2%)	0	0	0	0	1 (6%)	1 (14%)	0	0
CKD	7 (7%)	0	0	2 (6%)	3 (13%)	2 (11%)	0	0	0

HIV, Human immunodeficiency virus; CKD, chronic kidney disease; *N*, number.

Table 2: Reported symptoms on admission in the symptomatic group

Symptom	*N* (%)
Cough	49 (62.8%)
Diarrhoea	3 (3.8%)
Dyspnoea	35 (44.8%)
Fatigue	13 (16.6%)
Fever	42 (53.8%)
Headache	9 (11.5%)
Malaise	14 (17.9%)
Myalgia	12 (15.3%)
Rhinitis	3 (3.8%)
Sore throat	23 (29.5%)
Vomiting	11 (14.1%)

and the treatment protocol at the time, and is not included in the table.

Outcomes

At the time of this report 42% ($n = 42$) were still in hospital. For those patients with an available outcome (i.e. discharged or died), the mean length of hospital stay was 6.8 days; the overall mortality rate was 10% ($n = 6$), and 57% ($n = 4/7$) for those admitted to the ICU. No patients in the asymptomatic group died. Three of the patients who died had a sudden cardiac arrest. There were no recorded cardiac dysrhythmias documented in these patients, so we assume the probable aetiology to be pulmonary thromboembolic disease. The remaining three had progressive refractory hypoxia on maximal ventilation.

Comparative analysis

We compared comorbidities and laboratory data between the two groups described above (asymptomatic and

Table 3: Laboratory data

	Number of patients with available results	Median (IQR)	Standard deviation	95% CI
White cell count ($\times 10^9$/l)	86	6.935 (4.8–9.5)	5.873	6.462–8.15
Haemoglobin (g/dl)	86	13.65 (12.2–14.9)	2.595	12.64–13.82
Platelets ($\times 10^9$/l)	84	230 (179.8–301.5)	97.34	209–249.5
Neutrophil count ($\times 10^9$/l)	54	5.355 (3.1–7.5)	6.478	4.293–6.454
Lymphocyte count ($\times 10^9$/l)	54	1.33 (0.9–2.1)	1.891	1.103–1.621
C-reactive protein (mg/l)	77	33 (9–86)	79.5	24.16–41.89
Procalcitonin (ng/ml)	37	0.46 (0.1–1.3)	22.05	0.2662–1.044
Sodium (mmol/l)	81	140 (137–142)	5.784	138.1–140.6
Potassium (mmol/l)	81	4.4 (3.9–4.9)	0.8257	4.157–4.517
Urea (mmol/l)	81	5.2 (3.6–8.5)	11.13	4.855–6.855
Creatinine (μmol/l)	80	89 (70.3–114.8)	363	87.92–124.5
D-dimers (mg/l)	56	0.59 (0.27–1.42)	12.23	0.5789–1.158
Ferritin (ng/ml)	60	532.5 (285.3–1367)	4198	418.4–792.5
HS Troponin T (ng/l)	38	10.5 (4.8–42)	47.95	8.289–20.76
LDH (U/l)	35	356 (289–526)	216.6	326.1–440.5
Total protein (g/l)	63	69 (63–73)	7.45	66.42–70.22
Albumin (g/l)	66	37.5 (32–41)	6.455	34.2–37.67
Total bilirubin (μmol/l)	67	9 (6–12)	7.609	7.581–10.18
Conjugated bilirubin (μmol/l)	67	4 (2–5)	3.767	3.269–4.288
Alanine transaminase (U/l)	68	27 (19–44.3)	390.2	26.74–41.45
Aspartate transaminase (U/l)	68	38.5 (23–61.8)	630.2	33.85–53.01
Alkaline phosphatase (U/l)	66	82.5 (60–125.3)	47.82	76.75–97.79
Gamma-glutamyl transferase (U/l)	66	56.5 (28–128.3)	118.6	49.01–80.96

symptomatic). A summary of the comorbidities per patient group is presented in Table 5. Notably there was a statistically significant difference in patients admitted with diabetes mellitus between the two groups (0 vs. 23.1%, $p = 0.01$), and a high prevalence of the patients admitted had an endomorphic phenotype (47%).

We noted a statistically significant difference in the median respiratory rate, oxygen saturation and pulse rate between the two groups, but no difference in median temperature, systolic blood pressure or qSOFA scores. Even when the qSOFA was analysed with a Fisher's exact test comparing patients with a score <0 and those with a score ≥ 1 against asymptomatic and symptomatic patients, no significant difference could be demonstrated ($p = 0.174$). Median urea, ferritin, C-reactive protein, alanine and aspartate transaminase were significantly higher in the symptomatic group compared to that of the asymptomatic group, with alkaline phosphatase higher in the asymptomatic group. Comparative analysis is presented in Table 6 and Figures 1–4.

Table 4: Therapeutic intervention

Therapeutic intervention	*N* (%)
Chloroquine	14 (14%)
Vitamin D	16 (16%)
Lopinavir/Ritonavir	1 (1%)
Ribavirin	1 (1%)
Tocilizumab	1 (1%)
Zinc	16 (16%)
Corticosteroids	25 (25%)
Antibiotics	34 (34%)
Vitamin C	9 (9%)

Table 5: Comparison of comorbidities

	Asymptomatic, *N* = 22 (22%)	Symptomatic, *N* = 78 (78%)	*p*-Value (Fisher's exact test)
Chronic kidney disease	2 (9.1)	5 (6.41)	0.65
Diabetes mellitus	0	18 (23.1%)	0.01
HIV	4 (18.2)	7 (9)	0.25
Ischaemic heart disease	0	2 (2.6)	0.99
Hypertension	6 (27)	25 (32)	0.8
Endomorphic phenotype	8 (33.4)	39 (50)	0.34
TB	0	2 (2.6)	0.99
Liver cirrhosis	0	1 (1.3)	0.99
Smoking	2 (9.1)	4 (5.1)	0.61

HIV, Human immunodeficiency virus; TB, tuberculosis; *N*, number.

DISCUSSION

To our knowledge, this is the first detailed case series of patients with COVID-19 hospitalised in South Africa. South African data thus far suggests a female preponderance in cases of COVID-19 (58% female overall, 54% in hospitalised patients).(14,15) Our cohort shows a mild male predominance as has been reported in many case series globally.(16–19) Three of the female patients were pregnant (6.4%) at the time of diagnosis, one in the second trimester and who was still pregnant at the time of this report, and two at term who went on to deliver healthy infants without complications.

The median age in our cohort was younger than that of hospitalised cases reported nationally (42 vs. 49 years old),(14) but similar to the median age for all the overall cases reported in South Africa to date (42 vs. 39 years old).(15) This may be explained by the admission of asymptomatic (who could not self-isolate) and stable patients at the beginning of the pandemic and the fact that asymptomatic patients tended to be younger. Also, the age of our patients was similar to the age of patients reported in case series from Brazil, India and China but younger than those in Italy and the United States, possibly reflecting the younger median age of the population in the BRICS (Brazil, Russia, India, China and South Africa) countries compared to the United States and Italy.(16–21)

More than half of our patient cohort had at least one comorbidity, similar to the data emerging internationally, with hypertension and diabetes being the most common comorbidities (31% and 18%, respectively). We were unable to assess body mass index (BMI) of our patients due to logistical limitations. However, an endomorphic phenotype, verified clinically and radiologically, was reported in 47% of the total cohort. Notably of the patients who died, 5 were of an endomorphic phenotype (83%), 1 had hypertension without diabetes (17%) and 3 were both hypertensive and diabetic (50%).

The prevalence of HIV in our cohort was 11%, which is similar to that seen in the general population in South Africa (14%).(9) This suggests that there is no increased risk of COVID-19 in PLWH as is seen with other respiratory viruses. However, a larger cohort of HIV positive patients is needed to assess the association between HIV and COVID-19. There was no in-hospital mortality amongst HIV-positive patients in our cohort.

A large number (22%) of our patients were asymptomatic on admission – these patients were, for the most part, contacts of patients with confirmed COVID-19 who underwent asymptomatic screening and subsequently tested positive but were unable to self-isolate. We believe

Table 6: Comparison of vital statistics and laboratory results

Variable	Total number with data available	Asymptomatic, $N = 22$ Median (IQR)	Symptomatic, $N = 78$ Median (IQR)	p-Value (Mann–Whitney U)
Temperature (°C)	100	36.5 (36.48–36.83)	36.7 (36.5–37.5)	0.17
Respiratory rate (bpm)	100	18 (16–19.25)	18 (18–22)	0.03
Oxygen saturation (%)	100	96 (94–97)	93 (90–96)	0.001
Pulse rate (bpm)	100	88 (74–97)	100 (86–110)	0.002
Systolic blood pressure (mmHg)	100	130 (119–143)	129 (117–140)	0.58
qSOFA score	96	0 (0–0)	0 (0–1)	0.18
Haemoglobin (g/dl)	86	12.70 (11.75–14.10)	13.7 (12.2–15.05)	0.14
White cell count ($\times 10^9$/l)	86	6.64 (4.4–9.3)	7.08 (4.85–9.54)	0.62
Neutrophil count ($\times 10^9$/l)	54	3.48 (2.56–5.57)	5.74 (3.44–8.01)	0.16
Lymphocyte count ($\times 10^9$/l)	54	1.5 (0.86–3.17)	1.3 (0.94–1.90)	0.36
Platelets ($\times 10^9$/l)	74	268 (155–352)	228 (182–281)	0.25
Urea (mmol/l)	81	4.4 (3.45–10.45)	5.25 (3.6–8.28)	0.026
Creatinine (μmol/l)	80	82 (70–117)	92 (71–116)	0.6
C-reactive protein (mg/l)	77	9 (9–27)	42 (9–99)	0.02
Procalcitonin (ng/ml)	37	0.12 (0.05–0.70)	0.48 (0.13–1.52)	0.29
Total bilirubin (μmol/l)	67	7 (4.5–11.25)	10 (6–12)	0.27
Conjugated bilirubin (μmol/l)	67	3 (2–7)	4 (2.5–5)	0.58
Alanine transaminase (U/l)	68	17 (13–24)	32 (22.5–48)	<0.001
Aspartate transaminase (U/l)	68	27 (14–43)	40 (24–63)	0.06
Alkaline phosphatase (U/l)	66	117.5 (86.25–133.5)	78.5 (58.25–115.5)	0.07
Gamma-glutamyl transferase (U/l)	66	45.5 (27.5–117.5)	60.5 (28.25–132.75)	0.42
Ferritin (ng/ml)	60	261 (169.25–371.75)	593 (365.75–177.50)	0.008
D-dimers (mg/l)	56	0.31 (0.24–0.75)	0.75 (0.31–1.58)	0.16
Albumin (g/l)	66	37 (30.5–41.75)	37.5 (33–41)	0.75
Highly sensitive troponin T (ng/l)	38	13 (6.5–82)	10 (3.5–43)	0.53

that this may be a situation unique to low-middle income countries such as South Africa, as globally patients who are asymptomatic or mild are discharged home for self-isolation. In South Africa, however, approximately 10% of the population (5.5 million people) live in overcrowded, densely populated informal settlements where it is impossible to appropriately self-isolate for prolonged periods of time.(22,23) Whilst these patients did not present a significant challenge medically, they allowed us to start learning and preparing for the complexity of managing a highly contagious disease.

In our cohort, the majority of patients presented with cough (62.8%) and fever (53.8%), as was the case in China and Brazil.(17,19) We found a statistically significant difference in the admission respiratory rate, oxygen saturation and pulse rate between the asymptomatic and symptomatic groups. To date, we cannot find reports comparing asymptomatic and symptomatic patients, a situation unique to our setting wherein asymptomatic patients who are unable to safely self-isolate required admission.

Lymphopenia, low procalcitonin, elevated C-reactive protein (CRP), elevated ferritin and elevated D-dimers have been universally reported in patients diagnosed with COVID-19 and this is reflected by our data.(16,19) Unique to our cohort, we report an elevated median lactate dehydrogenase. Notably, the alanine transaminase was significantly elevated in the symptomatic patients when compared to the asymptomatic patients, as was evident in the

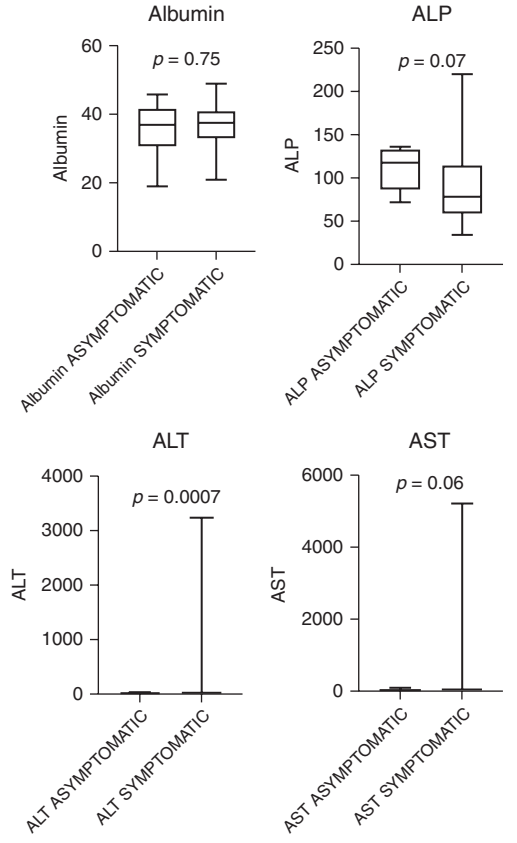

Fig 1: Liver functions (ALP - alkaline phosphatase, ALT - alanine transaminase, AST - aspartate transaminase)

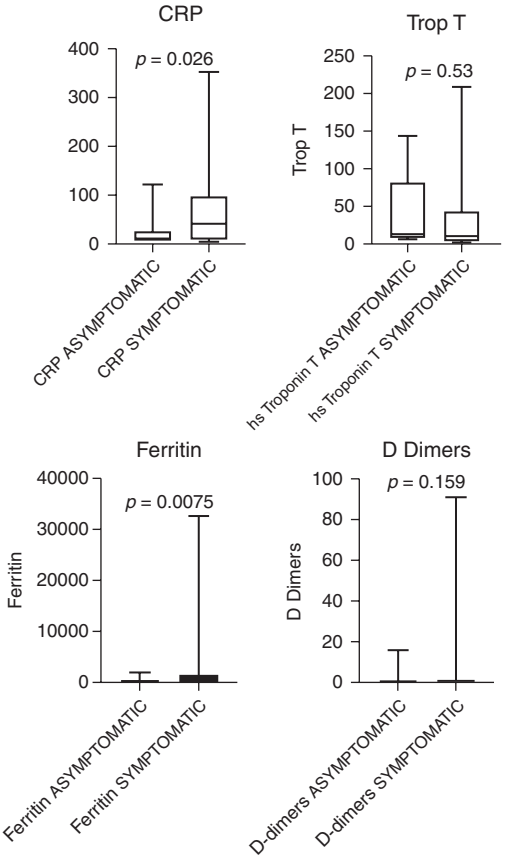

Fig 2: Inflammatory markers (CRP - C-reactive protein, Trop T - highly sensitive troponin T)

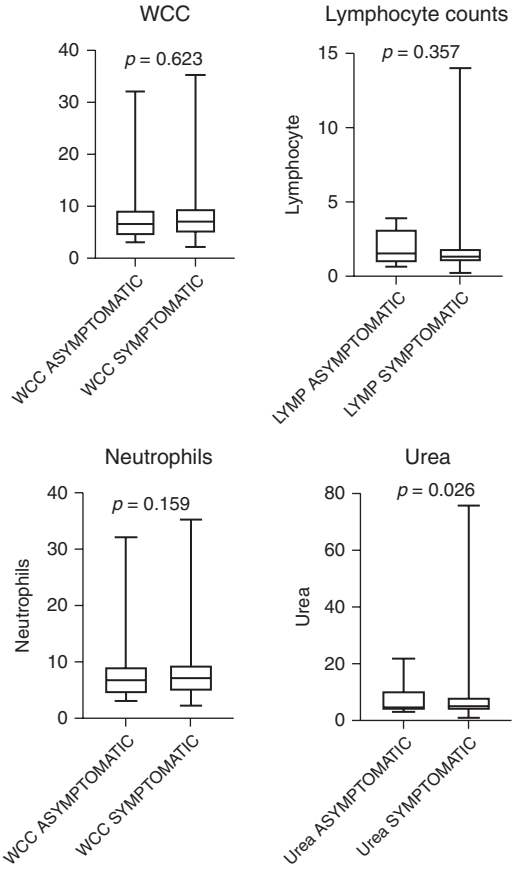

Fig 3: Haematology (WCC - white cell count)

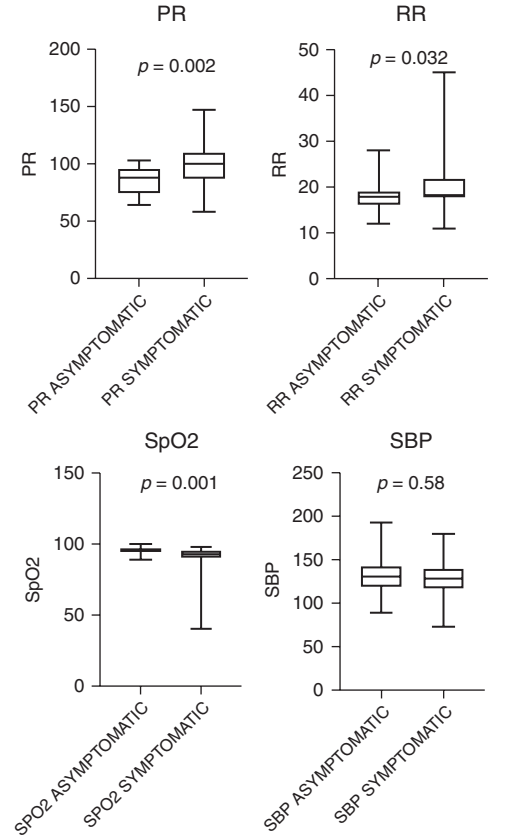

Fig 4: Vital statistics (PR - pulse rate, RR - respiratory rate, SpO2 - oxygen saturation, SBP - systolic blood pressure)

levels of CRP, urea and ferritin. This is likely explained in the symptomatic patients by a dysregulated immune system characteristically seen in patients with severe COVID-19.(24) Alkaline phosphatase was significantly reduced in the symptomatic cohort. We are unable to fully explain this finding, but a possible pathophysiological mechanism may be related to a relative zinc deficiency but more research in this area is required.

LIMITATIONS

Despite including all patients with COVID-19 admitted at the time of writing, our case series is limited by the small sample size. The small numbers are a result of being in the early stages of the pandemic and the nationwide lockdown enacted in late March 2020. A large proportion of our patients (42%) were still admitted at the time of this report, so mortality and discharge outcomes cannot be reported for this group as a whole. Also, there were limitations by the absence of defined protocols for patients admitted in March and early April. At that time, management and laboratory tests were at the discretion of the treating clinician and asymptomatic patients did not have comprehensive laboratory tests done. We are aware that the absence of BMI data is a limiting factor; however, this has now been included in our protocol going forward.

CONCLUSION

In this case series, we report on the first 100 patients admitted with COVID-19 to a large public hospital in Johannesburg, South Africa. Our findings are concordant with universally reported data of COVID-19 hospitalised patients; however, we are at the base of our pandemic and this data set will evolve with time. Our data also suggests that HIV positive were not at higher risk than the general population for COVID-19 infection nor did they have a higher mortality risk. However, we clearly acknowledge that more data is needed on COVID-19 in a South African setting, specifically related to co-infections with tuberculosis and HIV.

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