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Characteristics of the COVID-19 Patients Treated at Gulu Regional Referral Hospital, Northern Uganda: A Cross-Sectional Study

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Abstract

Background: Coronavirus Disease 2019 (COVID-19) is a severe respiratory disease that results from infection with a new coronavirus (SARS-CoV-2). One of the most critical issues related to the COVID-19 is the high rate of spread, millions of people have been infected around the world, and hundreds of thousands of people have died till now. However, reports from Africa paint a different picture of the SARS-CoV-2 and its effects on the population.

Objectives: The objective of this study was to describe the characteristics of the COVID-19 patients treated at the Gulu Regional Referral Hospital and determine factors associated with COVID-19 manifestations, socio-demographic characteristics, and treatment outcomes from March 2020 to October 2021.

Methods: A retrospective data abstraction of all COVID-19 hospital admissions registered in the Gulu Health Management Information System (HMIS) database and other tools were conducted. The period of study was from March 2020 to October 2021. Data that met the inclusion criteria were consecutively abstracted from the Gulu Hospital HMIS database. A local IRB approved the study. SPSS version 25.0 was used for data analysis, and a p-value of 0.05 was considered significant.

Results: Data suggests there were three waves of COVID-19 in Uganda. Those with comorbidities, e.g., Diabetes mellitus 38(5.7%), hypertension 83(12.5%), cardiovascular diseases 58(8.7%), HIV and AIDS 61(9.2%), and other comorbidities such as liver cirrhosis and Hepatitis B 40(6.0%) were more susceptible and presented with more severe forms of the disease. Antibiotics 662(99.7%), steroids 73(11.0%), vitamin C 564(84.9%), Ivermectin 7(1.1%), and Vitamin D 24(3.6%) were the most used medicines for the treatment of COVID-19 patients. Most COVID-19 patients were unvaccinated 661(99.5%). However, the recovery rate was 632(95.2%). The commonest complications were pneumonia 60(9.0%), chronic fatigue 49(7.4%), acute respiratory distress syndrome (ARDS) 37(5.6%), depression 20(3.0%), systemic infections 19(2.9%), nightmares 15(2.3%) and septic shock 8(1.2%). The Adjusted Odds Ratios (AOR) on factors associated with recovery were treatment with steroids AOR=138.835 at 95% CI:12.258-1572.50;p<0.000 and Vitamin D AOR=31.4780 at 95% CI:1.902-520.98; p=0.016.

Conclusion: This study showed successful management of COVID-19 patients in low-resource settings with a recovery rate of 95.2%. The admission pattern suggests Uganda had three waves of COVID-19, contrary to the official government position of two. Treatment with steroids and Vitamin D is associated with the recovery among COVID-19 patients. There is a need to conduct more extensive studies on the role played by the two drugs in the successful recovery of COVID-19 patients.

Keywords: COVID-19; Comorbidities; Treatment; Complications; Steroids; Vitamin-D

Introduction

Coronavirus Disease 2019 (COVID-19) is a severe respiratory disease that results from infection with a new coronavirus (SARS-COV-2) [1]. One of the most critical issues related to the COVID-19 is the high rate of spread, millions of people have been infected around the world, and hundreds of thousands of deaths till now have been recorded [1]. Patients suffering from different symptoms like fever, dry cough, and fatigue are usually mild in about 80% of cases. Still, the more severe cases may develop respiratory distress or respiratory failure, hence the increased need for intensive care unit (ICU) services [1].

The severity of the disease is related to the age and comorbidities of the infected person; elderly persons are affected more severely with a need for ICU services [2]. The severity of symptoms is also related to its duration, where for mild cases, symptoms may last for two weeks, while for severe cases, it ranges from 3 to 6 weeks [3]. Direct contacts to confirmed cases are the disease's primary way of spreading because the SARS-COV-2 is transmitted through exhaled air and aerosols [4]. Diagnosis of COVID-19 is conducted using Reverse Transcriptase Polymer Chain Reaction (RT-PCR), Computed Tomography (CT) scan,

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and blood tests [5]. Supportive treatment is the primary choice for mild cases, including antibiotics, vitamins, trace elements, and antipyretics [6]. At the same time, oxygen therapy with or without mechanical ventilation is introduced and individualized according to each case [6].

Many drugs have been included in clinical trials to act as antiviral agents to the coronavirus disease. Still, no precise results indicate the confirmed effect for any investigated drugs [7-9]. In addition to symptomatic therapy, corticosteroids as an anti-inflammatory agent have been found to play a vital role in the management of severe cases of the COVID-19 [10].

Thousands of infected patients have recovered from the disease. This recovery is confirmed by conducting another RT-PCR test or by the absence of the symptoms of the disease for several days. However, few documented studies in Uganda provide information on the clinical characterization of COVID-19 cases, treatment outcomes, and factors associated with clinical presentations and treatment outcomes.

The objective of this study was to describe the characteristics of the COVID-19 patients treated at the Gulu Regional Referral Hospital and determine factors associated with the COVID-19 manifestations, socio-demographic characteristics, and treatment outcomes.

Materials and Methods

Study site

This study was conducted in Gulu Regional Referral Hospital in Northern Uganda, covering admissions of COVID-19 patients from March 2020 to October 2021. Gulu Hospital is a regional referral centre for patients from Northern Uganda. However, it receives patients from neighbouring countries, for example, South Sudan and the Democratic Republic of Congo (DR Congo). It is also a teaching hospital for Gulu University Medical School and many other health training institutions in the region. It is a 394-bed capacity hospital with outpatient and inpatients services estimated at 120,000 patients every year. The Hospital has specialized units such as internal medicine, surgery, paediatrics, reproductive health, TB, HIV, cardiac, chest, dental, dermatology, sickle cell disease, diabetes, hypertension, ear, nose and throat, nutrition, accident and emergency, laboratory, ophthalmology, mental health, and orthopaedic clinics that consultants from Gulu Regional Referral Hospital and Gulu University manage.

Gulu Regional Referral Hospital was designated by the Ugandan Ministry of Health as a treatment centre for COVID-19 patients in March 2020 when COVID-19 was declared a pandemic. As a result, a particular treatment unit for the management of COVID-19 (Gulu CTU) was established with a fully-fledged high dependency unit (HDU), with oxygen supply and staff to manage the department. The team leader for the Gulu CTU is a consultant physician who cares for all the COVID-19 patients admitted to the unit. In addition, the Ugandan Ministry of Health and WHO health experts provided additional support for managing the COVID-19 patients at the centre using standard protocols developed and practiced in Uganda.

Study design

A retrospective data review and abstraction of all COVID-19 hospital admissions registered in the Gulu Health Management Information System (HMIS) database and other tools were conducted. The period of the review was March 2020 to October 2021. Established by the Ugandan Ministry of Health, HMIS has been the primary source of information on COVID-19 hospital admissions and deaths. COVID-19 notification is compulsory in Uganda, and the emergency operation centre at the Uganda National Public Health Institute receives reports on patients admitted to both public and private hospitals with COVID-19.

Sources of data

For the period of this study, COVID-19 patients admitted to Gulu Regional Referral Hospital with COVID-19 were estimated at nine hundred and forty-four (944). We included every patient registered in the HMIS database. Information on individual's socio-demographic characteristics, self-reported symptoms, signs, comorbidities, COVID-19 Treatment Unit (CTU) admissions, ICU admissions, and ventilatory support, dates of symptoms' onset, dates of hospital admissions, dates of discharges/releases, duration of the hospital stay, the reported circumstances of contracting the coronavirus, the vaccination status and hospital outcomes (deaths, referrals, and releases/discharges) were documented. HMIS data were accessed, which were already de-identified and publicly available documents. Following ethically agreed principles on open data access, this review did not require stringent ethical approval in Uganda as we mainly worked on records with no identifiers included. However, we obtained ethical and administrative licenses from the Gulu Regional Referral Hospital Institution and Ethics Review Committee to access the archived Gulu Hospital data on COVID-19 patients.

Selection criteria

Inclusion criteria:

- Confirmed cases of COVID-19 with RT-PCR.
- Records of patients 12 years and above.
- Completed information on the chart and other medical tools.
- Admission records.

Exclusion criteria:

We excluded:

- Incomplete records.
- Records with no RT-PCR results.
- Participants below 12 years.

Selection of records: The medical records for the COVID-19 patients in Gulu Regional Referral Hospital archives were accessed. The selection of the COVID-19 patients' files was conducted consecutively and reviewed by the research team. The selection criteria were applied to each admission file (a total of nine hundred and forty-four files); seven (7) were excluded due to lack of RT-PCR results; thirteen (13) patients were less than twelve years; fifty-six (56) patients had incomplete files; ninety-six (96) patients appeared in HMIS database without admission files; one hundred and five (108) patients had insufficient medical history on the file, and finally a total of six hundred and sixty-four (664) files were included in the participating medical records for this research.

Sample size: We determined the sample size for the study population using the selection criteria on the medical records. Six hundred and sixty-four (664) records were included as the sampled population.

Training of research assistants: To obtain excellent and clean information from these COVID-19 patients' medical files, the research team trained the research assistants who were four in number (two medical officers, one clinical officer, and one nurse) on how to use the selection criteria, accurately record data from the admission forms and exclude forms that were considered incomplete. The research assistants

were trained on infection, prevention, and control of COVID-19 and were required to use facemasks, eye shields, and sanitizers during and after reviewing documents. The corresponding author supervised the data collection exercise from the beginning to the end, ensuring that he checked every file to confirm the completeness of the data collected.

Procedures for data collection: Consecutively registered COVID-19 patients treated at Gulu Regional Referral Hospital with a positive quantitative RT-PCR test result for SARS-CoV-2 admitted to Gulu Hospital were recruited. SARS-CoV-2 diagnostic tests followed National and International standards. They were conducted in certified laboratories of Gulu Regional Referral Hospital and Uganda Virus Research Institute (UVRI) as the Ugandan Ministry of Health protocols required.

Variables for the study: The dependent variables for this study were treatment outcomes (alive or dead). The independent variables were the socio-demographic characteristics of the COVID-19 patients (age, sex, occupation, religion, tribe, districts, and level of education), comorbidities and treatments used, oxygen saturation at admission, date of discharge from the hospital, duration of hospital stay, disease severity, and others), clinical presentations (signs and symptoms), vaccination status, residences, and circumstances under which COVID-19 patients contracted the coronavirus.

Data analysis: The analysis period was from the epidemiological week (starting month and date of March 2020) to the epidemiological week (until month and date of October 2021). The analysis was pre-specified and defined before reading the medical data in the Gulu Regional Referral Hospital records. The sample size was all patients (aged ≥ 12 years) with confirmed COVID-19 diagnosis who were admitted to the Gulu Hospital and registered in the database between the epidemiological weeks of March 2020 and October 2021.

Means, standard deviations, bar graphs, histograms, frequencies, and percentages were used to summarize continuous variables, while frequencies and proportions were calculated for categorical variables. Age-adjusted and sex-adjusted rates for each district by the direct method using the estimated Ugandan population for 2020 as a reference were calculated.

We used the Chi-Square tests at bivariate analysis to observe associations between independent and dependent variables at 95% confidence Intervals. Factors with p-values less or equal to 0.2 were entered into a multivariable regression analysis to determine factors associated with COVID-19 patients treated at GRRH. However, the Gulu Hospital HMIS data contained much-missing information for some variables, such as reported symptoms, medicines used, and comorbidities. Therefore, we used additional GRRH records to fill in the missing data. Also, in the post hoc analysis, we evaluated the missing data pattern and conducted a sensitivity analysis *via* multiple imputations by chained equations, generating 30 imputed datasets. SPSS version 25.0 was used for data analysis, and various imputations were performed utilizing the STROBE guideline recommendations. In addition, Adjusted Odds Ratios (AOR) for independent variables were calculated for the COVID-19 patients treated at the Gulu Regional Referral Hospital from March 2020 to October 2021.

Ethical considerations: This retrospective data review of COVID-19 patients' medical files at the Gulu Regional Referral Hospital was approved by the Gulu Regional Hospital Institutional, Ethics, and Review Committee.

Results

This study abstracted six hundred and sixty-four (664) medical records of COVID-19 patients treated at the Gulu Regional Referral Hospital from March 2020 to October 2021. Only medical records of COVID-19 patients that met the inclusion criteria for the study were included. Most COVID-19 patients treated at the GRRH recovered from the disease with a recovery rate of 632(95.2%) and a mortality rate of 32(4.8%). In addition, most COVID-19 patients treated at the Hospital were unvaccinated 661(99.5%) for COVID-19.

In Figure 1, there were three waves of COVID-19 in Gulu, Northern Uganda, and these were May and September in 2020. In addition, there was a small observable wave in July 2021.

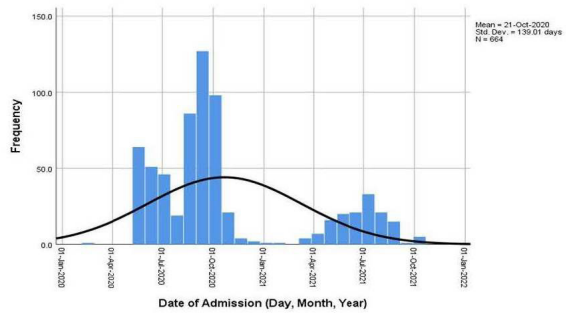

Figure 1: The pattern of COVID-19 admissions to the Gulu Treatment Unit (CTU).

In Figure 2, COVID-19 discharges from the CTU of Gulu Regional Referral Hospital mirrored the admission pattern where June, October of 2020, and July 2021 registered the most releases from the CTU.

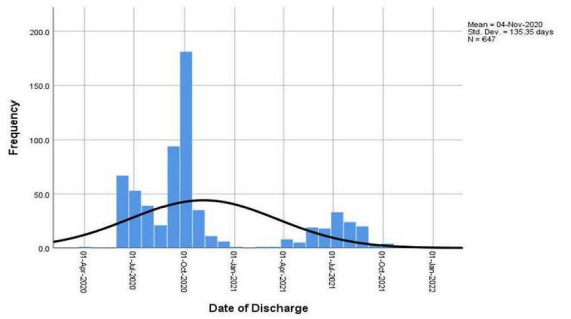

Figure 2: The pattern of discharges of COVID-19 patients treated at the CTU of Gulu Regional Referral Hospital.

Figure 3 shows the peak duration of Hospital stays (days) among COVID-19 patients treated at GRRH as 16 days.

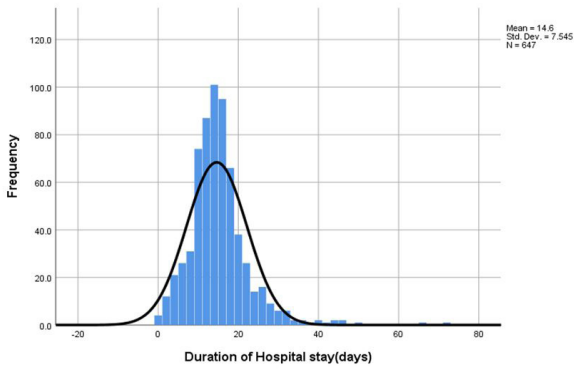

Figure 3: Duration of hospital stays (days) of COVID-19 patients treated at Gulu Regional Hospital.

In Table 1, most COVID-19 patients treated at the Gulu Regional Referral Hospital from March 2020 to October 2021 were males 443(66.7%), age group 30-39 years old 204(30.7%); Certificate holders of education 152(32.6%), Acholi 386(59.2%), Catholics 95(46.3%), Civil Servants 97(19.0%) and from Gulu District 226(34.0%).

Variables	Frequency	Percent (%)
Gender		
Male	443	66.7
Female	221	33.3
Age (years)	664	100
<20	41	6.2
20-29	139	20.9
30-39	204	30.7
40-49	151	22.7
>50	129	19.4
Subtotal	664	100
Tribes		
Acholi	386	59.2
Lango	19	2.9
Baganda	70	10.7
Madi	22	3.4
Others	155	23.8
Subtotal	652	100
Religion		
Catholics	95	46.3
Protestants	51	24.9
Born Again	6	2.9
Muslims	44	21.5
Others	9	4.4
Subtotal	205	100
The highest level of education attained		
No formal education	64	13.7
Primary	43	9.2
Secondary	59	12.7
Certificates	152	32.6
Diploma	65	13.9
Degrees	72	15.5
Postgraduate degrees	11	2.4
Subtotal	466	100
Occupation		
Business	95	18.6
Civil Servants	97	19
Health workers	47	9.2
Teachers	7	1.4
Uniformed security forces	27	5.3
Peasant Farmers	76	14.9
Others	161	31.6
Subtotal	510	100
Districts		
Agago	9	1.4
Amuru	59	8.9
Gulu	226	34
Kitgum	50	7.5
Lamwo	16	2.4
Nwoya	16	2.4
Omoro	37	5.6
Pader	24	3.6
Others	227	34.2
Subtotal	664	100

Table 1: Socio-demographic characteristics of COVID-19 patients treated at Gulu Regional Hospital.

Tables 2 and 3 shows drugs used for the treatment of COVID-19 at GRRH: antibiotics 662(99.7%), Vitamin C 564(84.9%), steroids 73(11.0%), Vitamin D 24(3.6%), Ivermectin 7(1.1%), and Aspirin 2(0.3%) in the descending order.

Symptoms and signs	Yes (%)	No (%)
Cough	331(49.8)	331(49.8)
Tiredness	128(19.3)	536(80.7)
Body aches and pains	192(28.9)	472(71.1)
Sore throat	117(17.6)	546(82.2)
Headache	225(33.9	438(66.1)
Loss of taste	44(6.6)	619(93.2)
Loss of smell	43(6.5)	621(93.5)
Shortness of breath	171(25.8)	493(74.2)
Loss of speech	20(3.0)	644(97.0)
Vomiting	21(3.2)	643(96.8)
Diarrhoea	20(3.0)	643(96.8)
Conjunctivitis	1(0.2)	662(99.7)
Comorbidities		
Diabetes Mellitus (DM)	38(5.7)	626(94.3)
Chronic Obstructive Pulmonary Diseases (COPDs)	38(5.5)	656(94.5)
Hypertension	83(12.5)	581(87.5)
Other Cardiovascular Diseases (CVDs), e.g., Stroke and heart failures	58(8.7)	605(91.3)
Obesity	3(0.5)	661(99.5)
Asthma	15(2.3)	648(97.7)
Cancers	4(0.6)	648(99.4)
HIV and AIDS	61(9.2)	603(90.8)
Other comorbidities (Hepatitis B, Liver diseases, Severe malaria)	40(6.0)	624(94.0)
Systolic blood pressure (mmHg)		
<120	177(26.7)	
121-140	298(44.9)	
>140	169(25.5)	
Diastolic blood pressure (mmHg)		
< 80	329(49.5)	
81-120	183(27.6)	
121-140	132(19.9)	
Duration of symptoms (days)		
1-7 days	236(63.1)	
8-14 days	107(28.6)	
15-21 days	22(5.9)	
22-28 days	16(2.4)	
>28 days	9(2.4)	
Duration of hospital stay (Weeks)		
0-1	318(47.9)	
2-4	300(45.2)	
>4	24(3.6)	
Oxygen saturation (SpO_2) of COVID-19 patients at admission		
<80	9(1.4)	
80-95	85(12.8)	
>96	403(60.7)	
Clinical presentations		
Symptomatic	509(76.7)	
Asymptomatic	154(23.2)	
Body Temperature (0°C)	41	
< 37.2	525(79.1)	
37.3-38.9	11(1.7)	
>39	2(0.3)	
Random blood sugar level (RBS)		
Normal (<8 mmol/L)	11(25.6)	
Abnormal (>8mmol/L)	32(74.4)	
Fasting Blood Sugar level (FBS)		
Normal (<7 mmol/L)	9(36.0)	
Abnormal (>7mmol/L)	16(64.0)	
The circumstance of contracting the virus (at Elegu border point with international truck drivers)	50(7.5)	
Number of COVID-19 patients who died from Gulu Regional Referral Hospital	32(4.8)	
Number of unvaccinated COVID-19 patients treated at Gulu Hospital	661(99.5)	

Table 2: Symptoms and comorbidities among COVID-19 patients treated at Gulu Regional Hospital.

Medicine used	Frequency (n=664)	Percent (%)
Hydroxychloroquine	0	0
Chloroquine	0	0
Steroids	73	11
Aspirin	2	0.3
Antibiotics	662	99.7
Vitamin D	24	3.6
Vitamin C	564	84.9
Ivermectin	7	1.1

Table 3: Drugs used for the treatment of COVID-19 patients at Gulu Regional Referral Hospital.

In Table 4, complications observed in COVID-19 patients treated at GRRH were pneumonia 60(9.0%), chronic fatigue 49(7.4%), acute respiratory distress syndrome (ARDS) 37(5.6%), acute respiratory failure 30(4.5%); depression 20(3.0%), systemic infections 19(2.9%), nightmares 15(2.3%) and septic shock 8(1.2%).

Complications	Frequency (n=664)	Percent (%)
Depression	20	3
Nightmares	15	2.3
Multiple Organ Failure (MOF)	5	0.8
Acute Respiratory Failure (ARF)	30	4.5
Pneumonia	60	9
Acute Respiratory Distress Syndrome (ARDS)	37	5.6
Acute Liver Injury	2	0.3
Acute Cardiac Injury	2	0.3
Systemic infections	19	2.9
Acute kidney injury	5	0.8
Blood clots	3	0.5
Chronic fatigue	49	7.4
Septic Shock	8	1.2
Disseminated Intravascular Coagulation (DIC)	3	0.5

Table 4: Complications in the COVID-19 patients treated at the Gulu Regional Hospital.

In Tables 5 and 6, most COVID-19 patients treated in GRRH were in the hospital for one week 216(44.9%); oxygen saturation (SpO_2) at admission was >96 394(81.9%); did not use Aspirin 479(99.6%), steroids 415 (86.3%), Garlic 480 (99.8%), Lemon 478(99.4%), Ivermectin 474(98.4%), Vitamin D 458(95.2%), and steaming 479 (99.6%) but used Antibiotics 480(99.8%) for treatment.

In Table 7, factors associated with COVID-19 patients treated at Gulu Regional Referral Hospital were Diabetes mellitus χ^2=1.156; df=1; p<0.0000; other cardiovascular diseases (CVDs) χ^2=34.819; df=1; p<0.0000; hypertension χ^2=10.807; df=1; p=0.0010; HIV and AIDs χ^2=6.488; df=1; p=0.011; treatment with steroids χ^2=157.639; df=1; p<0.0000;Vitamin D χ^2=113.521; df=1; p<0.0000; vitamin C χ^2=56.548; df=1; p<0.0000; Ivermectin χ^2=82.886; df=1; 0.0000; Oxygen saturation(SpO_2) 80-96 χ^2=29.357; df=1; p<0.0000; Oxygen saturation (<96) χ^2=42.962; df=1; p<0.0000; duration of hospital stay (less than one week) χ^2=57.690; df=1; p<0.0000; duration of hospital stay (two weeks) χ^2=6.569; df=1; p=0.010 and duration of hospital stay (six weeks) χ^2=4.180; df=1; 0.041

In Table 8, the Adjusted Odds Ratios (AOR) for factors associated with COVID-19 patients treated at Gulu Regional Referral Hospital. Treatment with steroids AOR=138.835 at 95% CI: 12.258-1572.50; p<0.000 and Vitamin D AOR=31.4780 at 95% CI:1.902-520.98; p=0.016.

Variables	Chi-square	df	p-value
Cross tabulations between duration of symptoms (days) and other variables			
Symptomatic patients	10.301	4	0.036
Age of patients	14.585	16	0.555
Gender of patients	6.284	4	0.179
The highest level of education attained	30.42	32	0.547
Cross tabulations between Diabetes mellitus and other variables			
Symptomatic patients	5.314	1	0.021
Age of patients	22.66	4	0
Gender of patients	0.016	1	0.901
The highest level of education attained	32.532	8	0
Cross tabulations between Chronic obstructive pulmonary diseases (COPDs) and other variables			
Symptomatic patients	0.014	1	0.905
Age of patients	6.195	4	0.185
Gender of patients	6.346	1	0.032
The highest level of education attained			
Cross tabulations between other cardiovascular diseases (CVDs) and other variables			
Symptomatic patients	4.462	1	0.035
Age of the patients	22.562	1	0
Gender of the patients	4.996	1	0.025
The highest level of education attained	22.451	8	0.004
Cross tabulations between Hypertension and other variables			
Symptomatic patients	3.045	1	0.081
Age of the patients	35.169	4	0
Gender of patients	1.187	1	0.276
The highest level of education attained	21.624	8	0.006
Cross tabulations between obesity and other variables			
Symptomatic patients	0.173	1	0.678
Age of patients	1.272	4	0.866
Gender of patients	1.512	1	0.219
The highest level of education attained	2.083	8	0.978
Cross tabulations between Asthma and other variables			
Symptomatic patients	0.092	1	0.762
Age of patients	3.77	4	0.438
Gender of patients	2.811	1	0.094
The highest level of education attained	10.379	8	0.239
Cross tabulations between Cancer and other variables			

Symptomatic patients	1.22	1	0.269
Age of patients	1.747	4	0.782
Gender of patients	3.144	1	0.076
The highest level of education attained	12.648	8	0.125
Cross tabulations between HIV and AIDS and other variables			
Symptomatic patients	0.07	1	0.791
Age of patients	8.515	4	0.074
Gender of patients	3.646	1	0.056
The highest level of education attained	2.107	8	0.978

Table 5: Cross tabulations between variables in COVID-19 patients treated at Gulu Regional Referral Hospital.

Variables		**Frequency**	**Percent (%)**
Duration of Hospital Stay (Weeks)	less than a week	56	11.6
	One	216	44.9
	Two	158	32.8
	Three	39	8.1
	Four	5	1
	Five	4	0.8
	Six	3	0.6
Oxygen saturation at admission (SpO_2)	<80	7	1.5
	80-96	80	16.6
	>96	394	81.9
Aspirin	Yes	2	0.4
	No	479	99.6
Antibiotics	Yes	480	99.8
	No	1	0.2
Vitamin D	Yes	23	4.8
	No	458	95.2
Steaming	Yes	2	0.4
	No	479	99.6
Vitamin C	Yes	385	80
	No	96	20
Ivermectin	Yes	7	1.5
	No	474	98.5
Lemon	Yes	3	0.6
	No	478	99.4
Ginger	Yes	1	0.2
	No	480	99.8
Garlic	Yes	2	0.4
	No	479	99.6
Steroids	Yes	66	13.7
	No	415	86.3

Table 6: Characteristics of COVID-19 patients treated at Gulu Regional Referral Hospital.

Variables	**Freq (n=664)**	**χ^2**	**df**	**p-value**
Duration of symptoms (1-7 days)	236(35.5%)	1.101	4	0.894
Diabetes Mellitus	38(5.7%)	51.156	1	0
Chronic obstructive pulmonary diseases (COPDs)	8(1.2%)	1.041	1	0.307
Other Cardiovascular diseases (CVDs)	58(8.7%)	34.819	1	0
Hypertension	83(12.5%)	10.807	1	0.001
Obesity	3(0.5%)	0.153	1	0.696
Asthma	15(2.3%)	0.113	1	0.737
Cancers	4(0.6%)	3.565	1	0.059
HIV and AIDS	61(9.2%)	6.488	1	0.011
Pregnancy	1(0.2%)	1.011	1	0.856
Other comorbidities	40(6.0%)	37.013	1	0
Symptomatic	509(76.7%)	2.17	1	0.141
Age (>50 years)	129(19.4%)	40.601	1	0
Gender (Females)	221(33.3%)	7.986	1	0.0005

The highest level of education attained (graduates)	72(10.8%)	39.213	1	0
Steroids (1)	66(13.7%)	157.639	1	0
Aspirin (1)	2(4.16%)	0.124	1	0.725
Antibiotics (1)	480(99.8%)	0.062	1	0.804
Vitamin D (1)	23(4.8%)	113.521	1	0
Steaming (1)	2(0.4%)	0.124	1	0.725
Vitamin C (1)	385(80.0%)	56.548	1	0
Ivermectin (1)	7(1.5%)	82.886	1	0
Garlic (1)	2(0.4%)	0.124	1	0.725
Ginger (1)	1(0.2%)	0.062	1	0.804
Lemon (1)	3(0.6%)	0.186	1	0.666
Oxygen Saturation (SpO_2) (<80)	7(1.5%)	49.799	2	0
Oxygen Saturation (SpO_2) (80-96)	80(16.6%)	29.357	1	0
Oxygen Saturation (SpO_2) (>96)	394(81.9%)	42.962	1	0
Duration of Stay (Less than one week)	56(11.6%)	57.69	6	0
Duration of Stay (One week)	216(44.9%)	1.93	1	0.165
Duration of Stay (Two weeks)	158(32.8%)	6.569	1	0.01
Duration of Stay (Three weeks)	39(8.1%)	2.69	1	0.101
Duration of Stay (Four weeks)	5(1.0%)	0.312	1	0.577
Duration of Stay (Five weeks)	4(0.8%)	0.249	1	0.618
Duration of Stay (Six weeks)	3(0.6%)	4.18	1	0.041
Overall Statistics		256.221	18	0

Table 7: Factors associated with COVID-19 patients treated at Gulu Regional Referral Hospital CTU.

		B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for Exp (B)	
								Lower	Upper
Step 1[a]	Steroids (1)	4.933	1.238	15.87	1	0	138.835	12.258	1572.5
	Aspirin (1)	-18.74	26237.08	0	1	0.999	0	0	0
	Antibiotics (1)	14.645	40192.96	0	1	1	2292669	0	0
	Vitamin D (1)	3.449	1.432	5.803	1	0.016	31.478	1.902	520.975
	Steaming (1)	-20.277	40192.97	0	1	1	0	0	0
	Vitamin C (1)	-0.42	0.68	0.38	1	0.537	0.657	0.173	2.494
	Ivermectin (1)	3.504	3.438	1.039	1	0.308	33.262	0.039	28095.88
	Garlic (1)	4.933	56841.43	0	1	1	138.833	0	0
	Ginger (1)	16.441	69616.26	0	1	1	13810167	0	0
	Lemon (1)	-19.579	40192.87	0	1	1	0	0	0
	Oxygen (SpO_2) <80)			1.124	2	0.57			
	Oxygen (80-96)	0.174	1.502	0.013	1	0.908	1.19	0.063	22.603
	Oxygen (>96)	0.873	1.5	0.338	1	0.561	2.393	0.126	45.291
	DoS (<1week)			7.14	6	0.308			
	DoS (1 week)	1.126	0.723	2.423	1	0.12	3.082	0.747	12.718
	DoS (2 weeks)	2.222	1.188	3.498	1	0.061	9.229	0.899	94.744
	DoS (3 weeks)	18.867	5359.821	0	1	0.997	1.56E+08	0	0
	DoS (4 weeks)	19.883	15112.35	0	1	0.999	4.32E+08	0	0
	DoS (5 weeks)	15.986	19996.24	0	1	0.999	8765685	0	0
	DoS (6 weeks)	-2.766	2.391	1.338	1	0.247	0.063	0.001	6.825
	Constant	29.894	47998.53	0	1	1	9.61E+12		
Note: DoS: Duration of Hospital Stay.									

Table 8: Multivariable logistic regression showing treatment, Oxygen saturation (SpO_2), and duration of hospital stay for COVID-19 patients treated at GRRH.

Discussion

The most significant findings were the three waves of COVID-19 in Gulu in Northern Uganda, and these were in May and September of 2020 and July of 2021 (Figures 1-3). The third wave of COVID-19 in 2021 was less pronounced (Figures 1-3). This finding contrasts with the official Ugandan Ministry of Health position on the number of COVID-19 waves Uganda has gone through since the pandemic began in March 2020. The Ugandan Ministry of Health specified two waves of the COVID-19: one in 2020 and another in June 2021. This Ugandan Ministry of Health report is not surprising as regional waves of COVID-19 have been reported in many studies [11-14]. This finding has implications on how Uganda could respond to the COVID-19 waves as the regional approach to managing and controlling the pandemic has become eminent. The regional occurrence of the COVID-19 wave has advantages in that the Ugandan Ministry of Health could use this information to harness support and allocate resources to effectively manage and control the pandemic at the regional level in different parts

of the Country. This may include mass mobilization and sensitization of the population at a regional level to embrace mass vaccination with the COVID-19 vaccines now that they are available in the Country. It is expected that this approach could limit the spreading of COVID-19 country-wide and reduce the morbidity and mortality of the coronavirus in Northern Uganda.

Socio-demographic characteristics of the COVID-19 patients

Findings from this study show that most COVID-19 patients treated at the Gulu Regional Referral Hospital were males, 30-39 years-old, Acholi, Catholics with certificates as the highest level of education, civil servants, and from Gulu District (Table 1). These socio-demographic characteristics are comparable to previous studies conducted in Northern Uganda, where the most affected people were males and certificates at their highest level of education attained (Table 1). What is different in this study population is that the most affected age group is a decade older (Table 1) compared to previous studies in Northern Uganda, where most participants were 20–29-years-old [15,16].

The age factor could be explained by the susceptibility pattern of the COVID-19 among the older population of Northern Uganda and elsewhere. The aging population appears more vulnerable and susceptible. The overall reasons for the susceptibility in the older people in Northern Uganda may not be known for now but perhaps attributable to lifestyles, exposure to multiple risk factors, comorbidities, and immunity problems of the more aging population. As shown in Table 1, the younger age groups were least affected as per the GRRH COVID-19 treatment centre's admission details. However, it could also mean that many of the younger age groups got affected but remained asymptomatic, did not test for COVID-19, did not develop severe disease, and did not get hospitalized with the coronavirus.

Findings from this current study show that nearly one-fourth of the COVID-19 patients treated were asymptomatic, and less than 10% of the patients were below 20 years of age (Table 3). These authors argue that this information was not wholly new. Similar findings in many studies conducted elsewhere in the world show that younger persons were least susceptible to severe COVID-19 and chances of hospitalization [13,14,17].

Factors associated with the COVID-19 patients treated at the Gulu Regional Referral Hospital

This report shows that most COVID-19 patients treated for severe COVID-19 and died at the GRRH had comorbidities, for example, Diabetes mellitus, cardiovascular diseases (CVDs) including (Stroke, valvular heart diseases, dysrhythmias, heart failure, and cardiac septal defects), hypertension, and symptomatic cases (Tables 2 and 3). Many studies have observed similar findings, particularly those with comorbidities [2,17,18]. This finding implies that the Ugandan Ministry of Health could adopt the "Enhanced shielding" approach, where persons with comorbidities and the elderly are shielded from the general population to protect them from contracting the COVID-19 virus [12,19]. These suggestions have implications on the approach the Ugandan health systems could adopt to control the spreading of COVID-19 among the elderly and those with comorbid conditions. The rural structure and relationship between the elderly and younger generation need thorough analysis as the elderly in the rural communities live with and together with young people who provide support and protection to the elderly. The practicality of this approach needs thorough thinking as this new approach may disrupt traditional ways of how people in the African rural communities live. These authors argue that with the lockdown, the economy, and health systems collapsing in many African countries, it is high time government planners came with solutions that allow the economy to be opened but ensure a reduced incidence and prevalence of COVID-19 in communities. One of the recommended approaches was to practice the enhanced shielding approach, which is more favourable to a country's social and economic systems. In addition, there is a need to sensitize and mobilize the population to embrace mass COVID-19 vaccination as vaccines are now available in the country to reduce the incidence of severe COVID-19, which require hospitalization.

Treatment and complications observed among COVID-19 patients in Gulu Regional Referral Hospital

Findings from this study show that most COVID-19 patients were treated with antibiotics, vitamin C, steroids, Ivermectin, and vitamin D (Tables 3-7) and the outcomes of the treatment have been encouraging as shown by the very high recovery rate at 95.2% and a statistically significant association with steroid and Vitamin D treatment (Table 8).

In the same study, the most typical complications observed among the COVID-19 patients were pneumonia, acute respiratory distress syndrome (ARDS), systemic infections, septic shock, chronic fatigue, depression, and nightmares (Table 4). These authors argue that there were justified reasons for using antibiotics in treating COVID-19 patients at Gulu Hospital, as many cases developed complications treated with antibiotics.

In addition, the role played by the other drugs in the management of COVID-19 was suggested by scholars and academicians across the world and particularly their use as immune system modulators [17]. To come up with a conclusive decision on the beneficial effects of the two drugs for managing COVID-19 patients at GRRH, formal Randomized Controlled Trials will be required.

On the mental health complications observed among the COVID-19 patients treated at the Gulu Regional Referral Hospital, authors recommend comprehensive mental health support for COVID-19 patients and the follow-up after recovery. Effective management of mental health conditions such as depression relieves the ever-increasing sense of depression and isolation experienced by the COVID-19 patients. If the numbers of mental health cases become widespread, a grass-root approach using trained village health teams (VHTs) would be the recommended approach for handling the problem. Notably, the VHTs should be trained and capable of dealing with COVID-19 related Psychosocial symptoms in the community. This idea is supported by studies conducted elsewhere in Africa, which suggest a grass-root approach to mental health problems after African countries' lockdown [12,19].

The independent determinants of COVID-19 cases treated at Gulu Regional Referral Hospital

This study showed that the recovery rate from the COVID-19 treated at the Gulu Hospital was 95.2%, yet 99.5% of the COVID-19 patients were unvaccinated (Table 3). Furthermore, this study found the Adjusted Odds Ratios (AOR) for factors associated with COVID-19 patients' recovery at GRRH were treatment with steroids AOR=138.835 at 95% CI:12.258-1572.50;$p<0.000$ and Vitamin D AOR=31.4780 at 95% CI:1.902-520.98;$p=0.016$ (Table 8). Statistically significant associations of Vitamin D and steroids with favourable treatment and management outcomes of COVID 19 patients in our study have also been observed in previous studies [20,21]. Could these successes be specific for this centre, or could this apply to diverse settings worldwide? A formal review study in different locations would be required in the long term

to determine the effectiveness of the drugs in managing mild and severe cases of COVID-19. Authors recommend global studies on the two drugs to assess their effects on the treatment outcomes of COVID-19 patients.

Circumstances under which the coronavirus infected participants

Findings show that most of the circumstances were unknown 581(87.5%), others were congregated situations such overcrowding at Elegu border and interacting with international truck drivers 50(7.5%), Aswa dam construction workers 12(1.8%) who lived in dormitories, health facility 2(0.3%), persons who nursed a relative with COVID-19 2(0.3%), bars 1(0.2%) and others 16(2.4%). This finding implies that the known source of the COVID-19 infection in Northern Uganda was from contacts with international truck drivers and mainly at the Elegu border point. Other sources such as bars, churches, and markets were fewer. Authors argue that regional controls of COVID-19 would be ideal for the East African region, where there is brisk trade among the countries. Therefore, the management and surveillance of international truck drivers as a regional approach would be suitable for controlling the coronavirus, ensuring that COVID-19 testing and management are conducted as per the international protocols across all the East African countries [11].

Strengths and Limitations of the Study

This study was a retrospective review of datasets from the COVID-19 medical records of Gulu Regional Referral Hospital. The period of the evaluation was from March 2020 to October 2021. The study has limitations on how Gulu Hospital handled records and record keeping. In addition, vital information, for example, weight, height, and BMI of COVID-19 patients, was not recorded due to the emergency handling of the cases at the beginning of the pandemic in March 2020. The missing variables in the Gulu Hospital HMIS records excluded some files from participating in this study. In this, authors have suggested a need for a prospective or longitudinal assessment of the COVID-19 cases in the future, ensuring that all data were measured and recorded accordingly.

This data is vital as it is one of the well-documented completed data for over 664 cases of COVID-19 treated in a Regional Referral Hospital in Uganda. Findings from this study show tremendous and good clinical practices at Gulu Regional Referral Hospital despite the challenges faced during the pandemic.

Generalization of the Data from this Study

These findings should be cautiously interpreted and generalized only to Regional Referral Hospitals in Uganda. However, they could be similarly observed in many hospitals in African countries with low-resource settings.

Conclusion

This study shows successful management of COVID-19 patients in low resource settings in Gulu Regional Referral Hospital with a recovery rate of 95.2%. The pattern of admission to the Hospital suggests Uganda has experienced three waves of COVID-19, contrary to the official government position of two waves. Treatment of COVID-19 patients with steroids and Vitamin D is associated with recovery of COVID 19 patients. However, there is a need for Randomized Controlled Trials to determine the actual effects of these drugs in the treatment of COVID-19 infections.

Declarations

Ethics approval and consent to participate

The Gulu Regional Referral Hospital Institutional and Ethics Committee approved this study. In addition, the study was conducted following the relevant institutional guidelines and regulations.

Availability of Data and Material

All datasets supporting the conclusion in this article is within this article and is accessible by a reasonable request to the corresponding author.

Competing Interests

All authors declare no conflict of interest.

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Authors Contributions

DLK, ENI, PL, JNO, JA, and FWDO participated in designing the study, SB and DLK were responsible for data abstraction supervision, BS, JA, ENI, and DLK were responsible for data analysis, interpretation, writing, and CO, NAO, WAO, BT, JE, PA, PL, FPP, DA, JNO, FWDO, for revising the manuscript.

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