Comparison of Clinical Characteristics and Outcomes of Hospitalized Patients with Seasonal Coronavirus Infection and COVID-19: A Retrospective Cohort Study

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Keywords: COVID-19, human coronavirus, seasonal coronavirus, SARS, MERS

Posted Date: July 12th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-701660/v1>

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Abstract

Background: Unlike SARS-CoV and MERS-CoV, SARS-CoV-2 can become a recurrent seasonal infection; hence, it is essential to compare the clinical spectrum of COVID-19 to the existent endemic coronaviruses. We conducted a retrospective cohort study of hospitalized patients with seasonal coronavirus (sCoV) infection and COVID-19 to compare their clinical characteristics and outcomes.

Methods: A total of 190 patients hospitalized with any documented respiratory tract infection and a positive respiratory viral panel for sCoV from January 1, 2011, to March 31, 2020, were included. Those patients were compared with 190 hospitalized adult patients with molecularly confirmed symptomatic COVID-19 admitted from March 1, 2020, to May 25, 2020.

Results: Among 190 patients with sCoV infection, the Human Coronavirus-OC93 was the most common coronavirus with 47.4% of the cases. When comparing demographics and baseline characteristics, both groups were of similar age (sCoV: 74 years vs. COVID-19: 69 years) and presented similar proportions of two or more comorbidities (sCoV: 85.8% vs. COVID-19: 81.6%). More patients with COVID-19 presented with severe disease (78.4% vs. 67.9%), sepsis (36.3% vs. 20.5%), and developed ARDS (15.8% vs. 2.6%) compared to patients with sCoV infection. Patients with COVID-19 had an almost 4-fold increased risk of in-hospital death than patients with sCoV infection (OR 3.86, CI1.99 – 7.49; $p < .001$).

Conclusion: Hospitalized patients with COVID-19 had similar demographics and baseline characteristics to hospitalized patients with sCoV infection; however, patients with COVID-19 presented with higher disease severity, had a higher case fatality rate, and increased risk of death than patients with sCoV.

Background

Coronaviruses are large, enveloped, single-stranded RNA viruses found in humans and other animals, such as dogs, cats, bats, chickens, cattle, pigs, and birds. These viruses have the potential to cause respiratory, enteric, hepatic, and neurologic diseases. The most common coronaviruses in clinical practice are 229E, OC43, NL63, and HKU1, which typically cause common cold symptoms in immunocompetent individuals and contribute 15–30% of common cold cases [1, 2]. Two other strains, the severe acute respiratory syndrome coronavirus (SARS-CoV) and the Middle East respiratory syndrome coronavirus (MERS-CoV), are associated with severe respiratory disease and are responsible for the first significant coronavirus outbreaks [2, 3].

On December 21, 2019, a novel coronavirus was identified in hospitalized patients with pneumonia in Wuhan, China. Genetic analysis revealed that this novel coronavirus fits into the genus betacoronavirus. Further phylogenetic analysis showed that the SARS-CoV-2 virus belongs to the subgenus Sarbecovirus and that is more similar to two bat-derived coronavirus strains, bat-SL-CoVZC45 and bat-SL-CoVZXC21, than to known human-infecting coronaviruses, including SARS-CoV [3, 4].

Epidemiological knowledge surrounding seasonal coronaviruses (sCoVs) has been limited for many settings owing to their historical association with mild illness. In recent years, the increased availability of molecular test methods has led to the adoption of sCoV testing as part of routine multiplex diagnostic screens, resulting in increased recognition of the associated disease spectrum [5, 6]. The clinical presentation, diagnostics, and outcomes of patients with COVID-19 have been well described in multiple case series and cohort studies [7–10] and compared to hospitalized patients with other respiratory viruses [11, 12]. Unlike SARS-CoV and MERS-CoV, SARS-CoV-2 can become a recurrent seasonal infection; hence, it is essential to compare the clinical spectrum of COVID-19 to the existent endemic coronaviruses [5, 13, 14]. This study compares the clinical characteristics, course, and outcomes of hospitalized patients with COVID-19 with hospitalized patients with sCoV infection.

Methods

Design and participants

This retrospective cohort study included 380 hospitalized adult patients (18 years or older) with sCoV or COVID19 across four AMITA Health hospitals located in the Chicago metropolitan area. A total of 190 patients hospitalized with pneumonia (ICD-10-CM Code J18.9), upper respiratory tract infection (ICD-10-CM Code J06.9) or lower respiratory tract infection (ICD-10-CM Code J22), and a positive respiratory viral panel (BioFire® FilmArray Respiratory Panel) for sCoV from January 1, 2011, to March 31, 2020, were identified. Those patients were compared with 190 patients randomly selected from a de-identified dataset that included 313 hospitalized adult patients with molecularly confirmed symptomatic COVID-19 (Abbott™ RealTime™ SARS-CoV-2 assay or Abbott™ ID NOW COVID-19™ assay) admitted from March 1, 2020, to May 25, 2020.

Data Collection

Clinical data were manually extracted from an electronic medical record system (Epic). Information collected included demographic data, medical history, underlying comorbidities, symptoms, signs, laboratory findings, imaging studies, treatment measures, survival to hospital discharge (survivors), and in-hospital death or referral to hospice (nonsurvivors). The study was approved by the Institutional Review Board of AMITA Health System (2021-0180-02). The Ethics Commission waived the requirement for informed consent, given that this research involves no more than minimal risk to participants.

Definitions

Respiratory failure was defined as room air oxygen saturation less than or equal to 90% or using any means of supplemental oxygen associated with shortness of breath. Sepsis and septic shock were defined according to the 2016 Third International Consensus Definition for Sepsis and Septic Shock [15]. Acute kidney injury (AKI) was diagnosed according to the KDIGO clinical practice guidelines [16], and

acute respiratory distress syndrome (ARDS) was diagnosed according to the Berlin Definition [17]. Troponin leak was defined as non-ACS cardiac troponin elevation above reference range levels [18]. The severity of COVID-19 illness and sCoV infections was defined and unified according to the National Institutes of Health guidelines for the management of COVID-19 [19]. Other definitions include: residents of long-term care facilities as residents of group, board and care homes, assisted living facilities, nursing homes, or continuing care retirement communities; neurocognitive impairment as any dementia, Parkinson's disease with cognitive impairment, intellectual disability, or cerebral palsy; altered mental status as any alteration in alertness, orientation or level of consciousness; immunosuppression as patients on daily dose ≥ 20 mg of prednisone or equivalent, active chemotherapy, immunotherapy, immunomodulators (immunosuppressants), or patients diagnosed with any hematological neoplasia.

Statistical analysis

Descriptive statistics were used to summarize the data; categorical variables were described as frequency and percentages, and continuous variables were described using median and interquartile range (IQR) values. We used the Mann-Whitney U test, Chi-squared test, or Fisher exact test to compare differences between patients with sCoV infection and COVID-19 when appropriate. An exploratory unconditional logistic regression model with generalized estimating equations with exchangeable correlation structure correcting standard error estimates for site-level clustering was used to assess differences in case-fatality between patients with sCoV infection and participants with COVID-19 [20], adjusting for age, residence (home or long-term care facility [LTCF]), do-not-resuscitate/do-not-intubate (DNR/DNI) status and quick Sequential Organ Failure Assessment (qSOFA) score. A two-sided α of less than .05 was considered statistically significant.

Results

Demographics and baseline characteristics

The median age of the base cohort was 72 years (IQR, 59.0–83.0 years; range 21–98 years) and 203 (53.4%) were male. Among patients with sCoV infection, the Human Coronavirus (HCoV)-OC93 was the most common coronavirus with 47.4% of the cases, followed by HCoV-HKU1 (20.5%), HCoV-229E (17.4%), and HCoV-NL63 (14.7%) (Fig. 1). When comparing demographics and baseline characteristics, both groups were of similar age (sCoV: 74 years vs. COVID-19: 69 years), more patients with sCoV infection were female (53.2% vs. 40%), White (62.6% vs. 40%), and admitted from home (63.7% vs. 35.3%), while patients with COVID-19 were more likely to be male (60% vs. 46.8%), black or African American (30% vs. 9.5%), and admitted from an LTCF (64.7% vs. 36.3%). Of note, more patients with COVID-19 were admitted with DNR/DNI orders (38.9% vs. 27.9%) (Table 1).

Table 1
Demographics and baseline characteristics

	sCoV (N = 190)	COVID-19 (N = 190)	Pvalue
Age in years	74 (59–84)	69 (59–82)	.081
Sex			.01
Male	89 (46.8%)	114 (60%)	
Female	101 (53.2%)	76 (40%)	
Ethnicity			
White	119 (62.6%)	76 (40%)	< .001
Hispanic	40 (21.1%)	27 (14.2%)	.078
Black or African American	18 (9.5%)	57 (30%)	< .001
Asian	10 (5.3%)	15 (7.9%)	.308
Middle Eastern	1 (0.5%)	3 (1.6%)	.293
Other	2 (1.1%)	12 (6.3%)	.007
Living			< .001
Home	121 (63.7%)	67 (35.3%)	
LTCF	69 (36.3%)	123 (64.7%)	
DNR/DNI	53 (27.9%)	74 (38.9%)	.022
Comorbidities			
Two or more	163 (85.8%)	155 (81.6%)	.267
Hypertension	140 (73.7%)	139 (73.2%)	.908
Cardiovascular	89 (46.8%)	65 (34.2%)	.012
Obesity	59 (31.1%)	55 (28.9%)	.654
Diabetes	73 (38.4%)	92 (48.4%)	.049
Chronic liver disease	5 (2.6%)	6 (3.2%)	.76
Malignant disease or mass	42 (22.1%)	20 (10.5%)	.002
Cerebrovascular	31 (16.3%)	39 (20.5%)	.290

Abbreviations: COPD, chronic obstructive pulmonary disease; COVID-19, coronavirus disease 2019; DNR/DNI, do-not-intubate and do-not-resuscitate; ESRD, end-stage renal disease; HIV, human immunodeficiency virus; LTCF, long-term care facility; sCoV, seasonal coronavirus; VTE, venous thromboembolism.

	sCoV (N = 190)	COVID-19 (N = 190)	P value
Neurocognitive	51 (26.8%)	69 (36.3%)	.047
COPD or asthma	68 (35.8%)	42 (22.1%)	.003
ESRD	12 (6.3%)	11 (5.8%)	.83
VTE	9 (4.7%)	12 (6.3%)	.501
HIV or other immunodeficiency	23 (12.1%)	3 (1.6%)	< .001
Smoking status			
Nonsmoker	103 (54.2%)	110 (57.9%)	.468
Former	68 (35.8%)	58 (30.5%)	.273
Current	19 (10%)	22 (11.6%)	.615
Abbreviations: COPD, chronic obstructive pulmonary disease; COVID-19, coronavirus disease 2019; DNR/DNI, do-not-intubate and do-not-resuscitate; ESRD, end-stage renal disease; HIV, human immunodeficiency virus; LTCF, long-term care facility; sCoV, seasonal coronavirus; VTE, venous thromboembolism.			

The proportion of patients with two or more comorbidities, obesity, and smokers was not significantly different between patients with sCoV infection and COVID-19. However, patients with sCoV infection presented higher rates of cardiovascular disease (46.8% vs. 34.2%), history of malignancies (22.1% vs. 10.5%), COPD or asthma (35.8% vs. 22.1%), and immunodeficiency (12.1% vs. 1.6%), whereas patients with COVID-19 presented higher rates of diabetes (48.4% vs. 38.4%) and neurocognitive disorders (36.3% vs. 26.8%) (Table 1).

Clinical Presentation And Interventions

Clinical presentation and interventions

Upon presentation to the hospital, more patients with sCoV infection reported chills (24.2% vs. 8.4%) and cough (75.3% vs. 54.2%), while more patients with COVID-19 reported fever (61.6% vs. 50.5%), anosmia (3.7% vs. 0.5%), and diarrhea (13.2% vs. 3.7%). The rates of shortness of breath were not different between groups. Clinically, patients with COVID-19 presented higher rates of altered mental status (46.3% vs. 22.6%), higher body temperature (37.8°C [IQR, 37–38.625°C] vs. 37.1°C [IQR, 36.7–38.1°C]), and lower blood pressure (120.5 mmHg [IQR, 102–139.25 mmHg] vs. 132 mmHg [114–160 mmHg]) than patients with sCoV infection (Table 2). Patients with sCoV infection presented a higher white blood count (10.75 x10⁹/L [IQR, 7.3–15.025 x10⁹/L] vs. 7.9 [IQR, 5.575–11.70 x10⁹/L], while patients with COVID-19 presented higher serum creatinine levels (1.31 mg/dL [IQR, 0.93–2.17 mg/dL] vs. 1.01 [IQR, 0.77–1.43 mg/dL]) and blood urea nitrogen (28 mg/dL [IQR, 17–46 mg/dL] vs. 23 [15–36.25 mg/dL]) (Table 3). Between patients with sCoV and COVID-19, there were no differences in the rates of leukopenia (white

blood cells $< 4.0 \times 10^9/L$, 6.3% vs. 9.5%; $p = .254$), lymphopenia (lymphocyte count $< 0.6 \times 10^9/L$, 71.6% vs. 78.9%; $p = .096$), or thrombocytopenia (platelet count $< 150 \times 10^9/L$, 13.2 vs. 19.5%; $p = .096$). On imaging, a more significant proportion of patients with sCoV infection showed no acute findings or unilateral opacities (25.3% vs. 14.7% and 43.2% vs. 23.7%, respectively), whereas more patients with COVID-19 were found to have bilateral or diffuse opacities (48.4% vs. 25.8% and 13.2% vs. 4.7%, respectively) (Table 3).

Table 2
Clinical presentation

	sCoV (N = 190)	COVID-19 (N = 190)	<i>P</i> value
Symptoms			
Fever	96 (50.5%)	117 (61.6%)	.03
Chills	46 (24.2%)	16 (8.4%)	< .001
Fatigue or malaise	61 (32.3%)	55 (28.9%)	.482
Myalgias or body aches	26 (13.7%)	27 (14.2%)	.882
Cough	143 (75.3%)	103 (54.2%)	< .001
Shortness of breath	143 (75.3%)	130 (68.4%)	.138
Sore throat	13 (6.8%)	10 (5.3%)	.519
Headache	8 (4.2%)	16 (8.4%)	.092
Anorexia	19 (10%)	30 (15.8%)	.092
Anosmia	1 (0.5%)	7 (3.7%)	.032
Abdominal pain	9 (4.7%)	13 (6.8%)	.38
Diarrhea	7 (3.7%)	25 (13.2%)	.001
Nausea or vomiting	19 (10%)	17 (8.9%)	.726
Signs			
Altered mental status	43 (22.6%)	88 (46.3%)	< .001
Temperature (°C)	37.1 (36.7–38.1)	37.8 (37–38.625)	< .001
Lowest SpO2 in the ED (%)	93 (88–95)	93 (88–95)	.68
Systolic blood pressure (mmHg)	132 (114–160)	120.5 (102–139.25)	.014
Heart rate (bpm)	100.5 (86–116.25)	97 (81–111)	.259
Respiratory rate (rpm)	22 (20–28)	22 (20–28)	.757
The most clinically relevant vital signs documented in the emergency department were collected.			
Abbreviations: COVID-19, coronavirus disease 2019; ED, emergency department; sCoV, seasonal coronavirus; SpO2, peripheral oxygen saturation.			

Table 3
Laboratory values and imaging on presentation.

	sCoV (N = 190)	COVID-19 (N = 190)	<i>P</i> value
Labs			
White blood cells (4.0–11.0, x10 ⁹ /L)	10.75 (7.3–15.025)	7.9 (5.575–11.70)	< .001
Lymphocyte count (0.6–3.4, x 10 ⁹ /L)	1 (0.6–1.625)	0.9 (0.6–1.3)	0.148
Hemoglobin (12.0–15.3, g/dL)	12.1 (10.675–13.60)	12.8 (11.4–14.2)	.01
Platelets (150–450, x10 ⁹ /L)	216.5 (162.5–292)	206 (160.5–277.5)	.473
Serum sodium (133–144, mmol/L)	137 (133–139)	137 (132.75–141)	.836
Serum creatinine (0.6–1.3, mg/dL)	1.01 (0.77–1.43)	1.31 (0.93–2.17)	< .001
Blood urea nitrogen (7–25, mg/dL)	23 (15–36.25)	28 (17–46)	0.01
Lactic acid (0.7–2.0, mmol/L)	1.8 (1.3–2.75)	1.7 (1.2–2.4)	.621
Chest x-rays			
No acute findings	50 (25.3%)	28 (14.7%)	.009
Unilateral opacities	82 (43.2%)	45 (23.7%)	< .001
Bilateral opacities	49 (25.8%)	92 (48.4%)	< .001
Diffuse opacities	9 (4.7%)	25 (13.2%)	.003
Laboratory and imaging findings on presentation include those collected up to 72 h from presentation.			
Abbreviations: COVID-19, coronavirus disease 2019; sCoV, seasonal coronavirus.			

With regards to interventions (Table 4), more patients with sCoV infection were placed on nonrebreather masks (12.1% vs. 6.3%) and noninvasive ventilation (13.2% vs. 1.1%) in the Emergency Department. On the other hand, more patients with COVID-19 were placed on high-flow nasal cannula (8.9% vs. 0.5%) and humidified high-flow system (3.7% vs. 0%). A similar proportion of patients required invasive mechanical ventilation (IMV) on presentation and later during the hospital stay. Both groups of patients with sCoV infection and COVID-19 were administered similar rates of steroids (45.3% vs. 43.7%) and antibiotics (95.8% vs. 91.1%). A larger proportion of patients with COVID-19 required vasopressors (16.8% vs. 10%), neuromuscular blockers (17.9% vs. 0.5%), and prone positioning (11.1% vs. 1.1%).

Table 4
Interventions

	sCoV (N = 190)	COVID-19 (N = 190)	<i>P</i> value
Steroids	86 (45.3%)	83 (43.7%)	.757
Antibiotics	182 (95.8%)	175 (92.1%)	.132
Maximal respiratory support in the ED			
None	56 (29.5%)	56 (29.5%)	1.0
Nasal cannula	71 (37.4%)	82 (43.2%)	.249
High flow nasal cannula	1 (0.5%)	17 (8.9%)	< .001
Nonrebreather	23 (12.1%)	12 (6.3%)	.05
Humidified high flow nasal cannula	0 (0%)	7 (3.7%)	.007
NIV	25 (13.2%)	2 (1.1%)	< .001
IMV	14 (7.4%)	14 (7.4%)	1.0
New onset dialysis	4 (2.1%)	6 (3.2%)	.522
IMV	27 (14.2%)	37 (19.5%)	.17
Prone position	2 (1.1%)	21 (11.1%)	< .001
Neuromuscular blockade	1 (0.5%)	34 (17.9%)	< .001
Vasopressors	19 (10%)	32 (16.8%)	.05
Abbreviations: COVID-19, coronavirus disease 2019; ED, emergency department; IMV, invasive mechanical ventilation; NIV, noninvasive ventilation; sCoV, seasonal coronavirus.			

Outcomes

Regarding inpatient outcomes (Table 5), patients with sCoV infection and COVID-19 developed similar respiratory failure rates (70.5% vs. 71.1%). Patients with COVID-19 presented higher rates of sepsis (36.3% vs. 20.5%), AKI (44.2% vs. 25.3%), and ARDS (15.8% vs. 2.6%). A higher number of individuals with sCoV were found to have co-infective organisms than individuals with COVID-19 (25.8% vs. 13.2%). Rates of mild and moderate illness were similar among both groups of patients on presentation, but significantly more patients with COVID-19 presented with severe disease (78.4% vs. 67.9%). The time from symptom onset to discharge or death was not significantly different between patients with sCoV infection and COVID-19 (9 days [IQR, 6–13.75 days] vs. 9.5 days [IQR, 7–16.75 days] and 9 days [IQR, 5.75–15.25 days] vs. 10 days [IQR, 6.75–16.25 days], respectively). Though, patients admitted with COVID-19 had a higher length of hospital stay than patients with sCoV (7 days [IQR, 4–12 days] vs. 5

days [IQR, 3–8 days]). Rates of intensive care unit (ICU) admissions were similar between both groups; however, more patients with sCoV were successfully extubated (59.3% vs. 35.1%) and successfully discharged from the ICU (73% vs. 43.3%) than patients with COVID-19. The inpatient case fatality rate was significantly higher in patients with COVID-19 compared with patients with sCoV infection (34.7% vs. 11.6%).

Table 5
Complications and clinical outcomes.

	sCoV (N = 190)	COVID-19 (N = 190)	<i>P</i> value
Respiratory failure	134 (70.5%)	135 (71.1%)	.910
Sepsis			
SIRS	124 (65.3%)	120 (63.2%)	.669
qSOFA	39 (20.5%)	69 (36.3%)	.001
Septic shock	27 (14.2%)	38 (20%)	.134
ARDS	6 (2.6%)	38 (15.8%)	< .001
Acute kidney injury	48 (25.3%)	84 (44.2%)	< .001
Troponin leak	49 (25.8%)	55 (29.9%)	.373
Coinfection	49 (25.8%)	25 (13.2%)	.002
NIH severity			
Mild	14 (7.4%)	8 (4.2%)	.188
Moderate	47 (24.7%)	33 (17.4%)	.078
Severe	129 (67.9%)	149 (78.4%)	.021
Time from symptom onset to admission (d)	3 (1–7)	2 (1–6)	.916
Hospital length of stay (d)	5 (3–8)	7 (4–12)	.013
ICU admission	67 (35.3%)	61 (32.1%)	.515
Successfully extubated	16/27 (59.3%)	13/37 (35.1%)	.056
Successfully discharged from ICU	46/67 (73%)	26/61 (43.3%)	.001
Onset to discharge (d)	9 (6–13.75)	9.5 (7–16.75)	0.902
Onset to death (d)	9 (5.75–15.25)	10 (6.75–16.25)	0.855
Case fatality rate	22 (11.6%)	66 (34.7%)	< .001
Abbreviations: ARDS, acute respiratory distress syndrome; COVID-19, coronavirus disease 2019; ICU, intensive care unit; NIH, National Institutes of Health; qSOFA, quick sequential organ failure assessment; sCoV, seasonal coronavirus; SIRS, systemic inflammatory response syndrome.			

An exploratory unconditional logistic regression model with generalized estimating equations with exchangeable correlation structure correcting standard error estimates for site-level clustering was used to assess differences in case-fatality between patients with COVID-19 and sCoV infection. Patients with

COVID-19 presented a significantly increased risk of death compared to patients with sCoV infection (Odds Ratio 3.86, Confidence Interval 1.99–7.49; $p < .001$).

Discussion

This retrospective cohort study examined the characteristics and clinical outcomes of hospitalized patients with sCoV infection compared to patients with COVID-19. Patients with COVID-19 presented a higher case fatality rate and an almost 4-fold increased risk of death than patients with sCoV. Interestingly, the rates of ICU admission and IMV use were not significantly different. However, more patients with sCoV were extubated and were more likely discharged from the ICU than patients with COVID-19. Seasonal coronaviruses are usually associated with mild upper respiratory illness in adults and are not a considerable public health burden [14]. Though, elderly individuals and immunocompromised hosts can sometimes develop life-threatening bronchiolitis, pneumonia, and even neurological infection (hCoV-OC43) [2]. In one study of community-acquired pneumonia requiring hospitalization among U.S. adults, the incidence of coronaviruses in individuals 80 years of age or older was similar to that of *Streptococcus pneumoniae* [21]. Besides, previous studies have linked common respiratory viruses, including sCoV, with COPD exacerbations, asthma exacerbations, and worsening cardiovascular disease [22–25]. In our cohort, patients admitted with sCoV were found to be initially admitted due to exacerbation of a pre-existing condition, namely heart failure exacerbation and COPD or asthma exacerbation, and later found to have a sCoV infection, where coronaviruses were likely responsible for disease aggravation, as demonstrated by the significantly higher proportions of patients with sCoV infection and underlying cardiovascular disease, obstructive pulmonary disease, and immunodeficiency in comparison to patients with COVID-19. In contrast, most patients with SARS-CoV-2 infection were merely admitted due to COVID-19 and its complications.

The clinical spectrum of hospitalized patients with SARS-CoV-2 infection has been mainly compared to SARS, MERS, and other pandemic viruses [26, 27]; nevertheless, our data shows significant differences with these viruses and important similarities with hospitalized patients with sCoV infection. For instance, although all coronaviruses can affect persons in all age groups, hospitalized patients with COVID-19 and sCoV infection were found to be older (median age 69 and 74 years, respectively). In contrast, previous series reported younger populations affected by SARS and MERS (median age 39 and 56 years, respectively) [28–33]. COVID-19 and MERS affected more male patients, while sCoV and SARS affected predominately female patients. Overall, SARS series reported fewer patients with pre-existing underlying conditions (10 to 30%) [28–30], while in MERS series, 50 to 96% of patients were reported to have at least one underlying condition [31–33]. Similar to MERS series, more than 80% of hospitalized patients with sCoV and COVID-19 had two or more underlying comorbidities in our cohorts. For COVID-19, sCoV, and MERS, the most common presenting symptoms included fever, cough, and shortness of breath, while in SARS series, fever and cough were more prominent relative to shortness of breath [28–33]. Leukopenia on admission was less common in our cohort of patients with sCoV (6.3%) and COVID-19 (9.5%) compared to previous MERS (14–42%) and SARS (25–35%) series [32, 33], whereas lymphopenia rates were similar in patients with sCoV (71.6%), COVID-19 (78.9%), and SARS (68–85%) in comparison to

MERS (34%) [33]. As expected, rates of bilateral or multifocal infiltrates at admission were overall higher in patients with COVID-19 (61.6%), SARS (29–45%), and MERS (26–80.3%) than in patients with sCoV infection (30.5%) [28–30, 31–32]. The rates of ICU admission among patients with sCoV (35.3%) and COVID-19 (32.1%) in our cohorts were higher than in SARS series (20–26%) but lower than in MERS series (78–89%) [28–30, 31, 33]. Overall, the rates of IMV were higher in MERS series (24.5–80%), followed by our cohort of patients with COVID-19 (19.5%), SARS series (13.8–21%), and our cohort of patients with sCoV infection (14.2%) [28–33]. Case fatality rates were higher in series of hospitalized patients with MERS (20.4–65%), followed by our cohort of hospitalized patients with COVID-19 (34.7%), SARS series (3.6–13.6%), and our cohort of hospitalized patients with sCoV infection (11.6%) [28–33]. Considering all patients, including outpatients and inpatients, the estimated case-fatality rate of COVID-19 is around 1–3%, 9.5–15% for SARS, and 34.4% for MERS. The overall case-fatality rate for seasonal coronaviruses is not well described [26,27]. However, using data from the Underlying Cause of Death tool in the CDC Wide-ranging ONline Data for Epidemiologic Research (CDC WONDER) Online Database and the National Respiratory and Enteric Virus Surveillance System (NREVS), we estimated a rough case fatality rate of 0.0027% (108 deaths from unspecified coronavirus illness reported between the years 2014–2017 in the CDC WONDER Online Database and 39 588 cases of HCoV reported to the NREVSS during the same period) [6, 34].

With the expansion of SARS-CoV-2 worldwide, the emergence of new, more transmissible variants [35, 36], and the variable effectiveness of current vaccines against those variants [37], there is little hope for eliminating the virus from the human population. Unlike SARS-CoV and MERS-CoV, which were locally contained, SARS-CoV-2 will likely transition to endemicity and continued circulation with the other sCoVs [14]. Seasonal coronaviruses have annual circulation peaks in the winter months in the U.S., and individual species show variable circulation from year to year [6]. The most recent data from the NREVSS showed that during the 2019-20 winter season, HCoV-HKU1 was the most common sCoV circulating in the U.S., followed by HCoV-NL63. In comparison, during the 2020-21 winter season, HCoV-OC43 was the most common sCoV circulating in the U.S., again followed by HCoV-NL63 [38]. In our cohort, encompassing nine years, the most common isolated sCoV was HCoV-OC42, followed by HCoV-HKU1. Although it is not clear whether COVID-19 will become a chronic seasonal disease, numerous epidemiological studies and models have explored the relationship between COVID-19 transmission and meteorological factors and shown that infectivity of SARS-CoV-2 and mortality of COVID-19 are both more substantial in colder climates and that COVID-19 seasonality is more pronounced at higher latitudes where larger seasonal amplitudes of environmental indicators are observed [13, 39].

This study has several limitations. First, this was a retrospective cohort study, and clinical data were retrospectively collected through electronic medical records and manual chart review. Therefore, a degree of inter-rater variability is expected. Second, the present study was observational and included populations of patients distributed at different points in time, and thus, unknown risk factors and bias might have been unequally distributed between the two groups in the analysis. Third, the subjects with COVID-19 included for analysis encompass a series of consecutively admitted patients early in the pandemic before using steroids as the standard of care and the development of standardized, evidence-

based management guidelines, which have shown to impact the inpatient case-fatality rate. On the other hand, the cohort of subjects with sCoV infection included patients from a period of 9 years, during which progress in medical knowledge and patient care are expected; hence, the crude case-fatality ratio must be taken with caution. Finally, the analyzed population was limited to one Integrated-Delivery Health system in the Chicago metropolitan area and may have limited external generalizability.

In conclusion, the clinical spectrum of hospitalized patients with COVID-19 is more similar to SARS and MERS in terms of illness severity and case-fatality rate than hospitalized patients with sCoV infection. However, the demographics and baseline characteristics of patients hospitalized with COVID-19 and sCoV infection are more in alignment, affecting older populations with many underlying conditions. Further population studies will elucidate the endemicity and seasonality of SARS-CoV-2, the effect of the vaccines in the severity of the illness, and the ecological interactions between SARS-CoV-2 and sCoVs.

Abbreviations

AKI

Acute kidney injury; ARDS:Acute respiratory distress syndrome; CDC WONDER:CDC Wide-ranging ONline Data for Epidemiologic Research; COVID-19:Coronavirus disease 2019; DNR/DNI:do-not-resuscitate/do-not-intubate; HCoV:Human Coronavirus; IQR:interquartile range; IVM:invasive mechanical ventilation; LTCF:Long-term care facility; MERS:Middle East respiratory syndrome coronavirus; NREVSS:National Respiratory Enteric Virus Surveillance System; qSOFA:quick Sequential Organ Failure Assessment; sCoV:Seasonal coronavirus; SARS:Severe acute respiratory syndrome.

Declarations

Ethics approval and consent to participate

The study was approved by the Institutional Review Board of AMITA Health System (2021-0180-02). The Ethics Commission waived the requirement for informed consent, given that this research involves no more than minimal risk to participants.

Consent for publication

All authors have authorized the final manuscript and have provided consent for publication.

Availability of data and materials

The data and materials used to support the findings of this study are available from the corresponding author upon reasonable request.

Competing interests

The authors of this manuscript have no conflicts of interest to disclose.

Funding

There has been no financial support for this work.

CRediT Author Statement

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Acknowledgments

None.

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Figures

Figure 1

Distribution of Human Coronaviruses among 190 patients with seasonal coronavirus infection This figure shows the proportion of each human coronavirus species isolated among 190 hospitalized patients with seasonal coronavirus infection.