SHORT COMMUNICATION

COVID-19 in hospitalized HIV-positive and HIV-negative patients: A matched study

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Abstract

Objectives: We compared the characteristics and clinical outcomes of hospitalized individuals with COVID-19 with [people with HIV (PWH)] and without (non-PWH) HIV co-infection in Spain during the first wave of the pandemic.

*Members of the the Spanish HIV Research Network Cohort (CoRIS) are given in the Appendix.
INTRODUCTION

Since the beginning of the COVID-19 pandemic, HIV has been uncommonly listed as an underlying condition in case series of hospitalized patients with COVID-19 [1, 2]. This is likely because of the much lower prevalence of HIV among the general population than that of other prevailing diseases and because the number of older individuals is much lower among people with HIV (PWH) than among the HIV-uninfected population (non-PWH). Notwithstanding this, whether HIV increases the risk of acquiring SARS-CoV-2 or the severity or mortality of COVID-19 has stirred substantial research. Many studies have analysed the characteristics and outcomes of COVID-19 in PWH, but to the best of our knowledge, only in eight of these has some comparison been made between PWH and people without HIV (non-PWH) [3–10]. In four of these studies, worse outcomes in PWH vs. non-PWH have been reported [3,7,9,10].

We assessed the frequency of COVID-19 within a large prospective cohort of PWH in Spain during the first wave of the pandemic and compared the characteristics and clinical outcomes of hospitalized PWH with COVID-19 with an age/sex-matched control group of non-PWH.

METHODS

We performed a retrospective study of individuals with reverse transcription polymerase chain reaction (PCR)-confirmed COVID-19 among PWH in active follow-up within the Spanish HIV Research Network (CoRIS) up to 30 June 2020. Each hospitalized PWH was matched with five non-PWH of the same age and sex randomly selected from COVID-19@Spain, a multicentre cohort of 4035 patients hospitalized with confirmed COVID-19. The main outcome was all-cause in-hospital mortality.

Results: Forty-five PWH with PCR-confirmed COVID-19 were identified in CoRIS, 21 of whom were hospitalized. A total of 105 age/sex-matched controls were selected from the COVID-19@Spain cohort. The median age in both groups was 53 (Q1–Q3, 46–56) years, and 90.5% were men. In PWH, 19.1% were injecting drug users, 95.2% were on antiretroviral therapy, 94.4% had HIV-RNA < 50 copies/mL, and the median (Q1–Q3) CD4 count was 595 (349–798) cells/μL. No statistically significant differences were found between PWH and non-PWH in number of comorbidities, presenting signs and symptoms, laboratory parameters, radiology findings and severity scores on admission. Corticosteroids were administered to 33.3% and 27.4% of PWH and non-PWH, respectively (P = 0.580). Deaths during admission were documented in two (9.5%) PWH and 12 (11.4%) non-PWH (P = 0.800).

Conclusions: Our findings suggest that well-controlled HIV infection does not modify the clinical presentation or worsen clinical outcomes of COVID-19 hospitalization.

KEYWORDS

Coronavirus, COVID-19, HIV, SARS-CoV-2
| Characteristic                               | Non-hospitalized (N = 24) | Hospitalized (N = 21) | P      | Total (N = 45) |
|----------------------------------------------|----------------------------|-----------------------|--------|---------------|
| **Sex [n/N (%)]**                            |                            |                       |        |               |
| Male                                         | 20/24 (83.3)               | 19/21 (90.5)          | 0.482  | 39/45 (86.7)  |
| Female                                       | 4/24 (16.7)                | 2/21 (9.5)            |        | 6/45 (13.3)   |
| **Age (years)**                              |                            |                       |        |               |
| Median (Q1–Q3)                               | 38 (34–48)                 | 53 (46–56)            | 0.001  | 46 (37–56)    |
| **Distribution [n/no. with data (%)]**       |                            |                       |        |               |
| 0–20 years                                   | 0/23 (0)                   | 0/21 (0)              | 0.007  | 0/44 (0)      |
| 21–30 years                                  | 5/23 (21.7)                | 0/21 (0)              |        | 5/44 (11.4)   |
| 31–40 years                                  | 9/23 (39.1)                | 1/21 (4.8)            |        | 10/44 (22.7)  |
| 41–50 years                                  | 4/23 (17.4)                | 8/21 (38.1)           |        | 12/44 (27.3)  |
| 51–60 years                                  | 4/23 (17.4)                | 8/21 (38.1)           |        | 12/44 (27.3)  |
| 61–70 years                                  | 1/23 (4.3)                 | 3/21 (14.3)           |        | 4/44 (9.1)    |
| 71–80 years                                  | 0/23 (0)                   | 1/21 (4.8)            |        | 1/44 (2.3)    |
| ≥ 81 years                                   | 0/23 (0)                   | 0/21 (0)              |        | 0 (0)         |
| **Country of birth [n/no. with data (%)]**   |                            |                       | 0.205  |               |
| Spain                                        | 18/24 (75.0)               | 12/21 (57.1)          |        | 30/45 (66.7)  |
| Other                                        | 6/24 (25.0)                | 9/21 (42.9)           |        | 15/45 (33.3)  |
| **Transmission category [n/no. with data (%)]** |                        |                       | 0.051  |               |
| Homo/bisexual intercourse                    | 16/24 (66.7)               | 7/21 (33.3)           |        | 23/45 (51.1)  |
| Heterosexual intercourse                     | 7/24 (29.2)                | 8/21 (38.1)           |        | 15/45 (33.3)  |
| Injecting drug use                           | 0/24 (0)                   | 4/21 (19.1)           |        | 4/45 (8.9)    |
| Other/unknown                                | 1/24 (4.2)                 | 2/21 (9.5)            |        | 3/45 (6.7)    |
| **Antiretroviral therapy [n/no. with data (%)]** |                     |                       | 0.280  |               |
| 24/24 (100.0)                                | 20/21 (95.2)               |                       |        | 44/45 (97.8)  |
| **Last median CD4 count (Q1–Q3) (cells/μL)** | 434 (418–870)              | 495 (349–798)         | 0.958  | 481 (418–823) |
| **HIV-RNA <50 copies/mL [n/no. with data (%)]** |                     |                       | 0.967  |               |
| 16/17 (94.1)                                 | 17/18 (94.4)               |                       |        | 33/35 (94.3)  |
| **Comorbid conditions [n/no. with data (%)]**|                            |                       |        |               |
| Hypertension                                 | 2/24 (8.3)                 | 9/21 (42.9)           | 0.007  | 11/45 (24.4)  |
| Coronary heart disease                       | 0/24 (0)                   | 2/21 (9.5)            | 0.122  | 2/45 (4.4)    |
| Prior heart failure                          | 0/24 (0)                   | 2/21 (9.5)            | 0.122  | 2/45 (4.4)    |
| Cerebrovascular disease                      | 0/24 (0)                   | 0/21 (0)              |        | 0/45 (0)      |
| Diabetes                                     | 2/24 (8.3)                 | 4/21 (19.0)           | 0.292  | 6/45 (13.3)   |
| Chronic lung disease (not asthma)            | 0/24 (0)                   | 4/21 (19.0)           | 0.025  | 4/45 (8.9)    |
| Obesity (BMI ≥ 30 kg/m²)                     | 0/24 (0)                   | 1/18 (5.6)            | 0.243  | 1/42 (2.4)    |
| Epilepsy                                     | 0/24 (0)                   | 0/21 (0)              |        | 0/45 (0)      |
| Other chronic neurological disorder          | 1/24 (4.2)                 | 0/21 (0)              | 0.344  | 1/45 (2.2)    |
| Asthma                                       | 3/24 (12.5)                | 0/21 (0)              | 0.094  | 3/45 (6.7)    |
| Solid cancer (active)                        | 0/24 (0)                   | 1/21 (4.8)            | 0.280  | 1/45 (2.2)    |
| Haematological cancer (active)               | 0/24 (0)                   | 0/21 (0)              |        | 0/45 (0)      |
| Chronic kidney disease (GFR < 60)            | 1/24 (4.2)                 | 3/21 (14.3)           | 0.234  | 4/45 (8.9)    |
| Liver cirrhosis                              | 0/24 (0)                   | 0/21 (0)              |        | 0/45 (0)      |
| Inflammatory disease                         | 0/24 (0)                   | 0/21 (0)              |        | 0/45 (0)      |
| Dementia                                     | 0/23 (0)                   | 0/21 (0)              |        | 0/44 (0)      |

(Continues)
PCR-confirmed COVID-19 in Spain [2]. The COVID-19 SEIMC score (predictive of 30-day mortality), based on age, sex, dyspnoea, oxygen saturation, neutrophil-lymphocyte ratio and estimated glomerular filtration rate, was calculated retrospectively at admission in all patients [12].

The main outcome was all-cause in-hospital mortality. Descriptive analysis of individuals’ characteristics was carried out using frequency tables with percentages for categorical variables and median and quartiles for continuous variables. The study was approved by the Ethics Committee of Hospital General Universitario Gregorio Marañón.

RESULTS

Among 10 922 PWH in active-follow-up within CoRIS during the study period, 45 (0.41%) had a recorded diagnosis of COVID-19, 21 of whom (46.7%) were hospitalized. The demographics and clinical characteristics of the 45 PWH with COVID-19 are shown in Table 1, categorized according to whether they were hospitalized.

In comparison with non-hospitalized PWH, those hospitalized were older (median age 38 vs. 53 years, \(P = 0.001\)) and more frequently diagnosed with arterial hypertension (8.3% vs. 42.9%, \(P = 0.007\)) or chronic lung disease, not including asthma (0% vs. 19%, \(P = 0.025\)). No statistically significant differences were found between both groups in the proportion of individuals on ART, CD4 cell counts or the proportion of those with HIV-RNA load < 50 copies/mL. Among non-hospitalized PWH, 23 had a mild illness and one had moderate disease (pneumonia), whereas among hospitalized PWH, two had a mild illness, six had moderate disease, 12 had severe disease (severe pneumonia), and one had critical disease (acute respiratory distress syndrome). Two of the 45 PWH with COVID-19, both hospitalized, died.

The clinical characteristics and outcomes of the 21 hospitalized PWH with COVID-19 and the 105 age/sex-matched non-PWH are shown in Table 2. In both groups, the median [quartile 1 (Q1)–quartile 3 (Q3)] age was 53 (46–56) years, and 90.5% were men. In PWH, 19.1% acquired HIV by injecting drug use, 95.2% were on ART, 94.4% had an HIV-RNA < 50 copies/mL, and the median (Q1–Q3) CD4 count was 495 (349–798) cells/μL.

A higher proportion of PWH than non-PWH were born abroad (42.9% vs. 20.4%, \(P = 0.028\)), particularly in Latin American countries. Likewise, a higher proportion of PWH than non-PWH had chronic kidney disease defined as an estimated glomerular filtration rate (eGFR) by the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formula of < 60 mL/min/1.73 m² for 3 months or more, irrespective of cause (14.3% vs. 2.9%, \(P = 0.026\)). C-reactive protein (CRP) concentrations at baseline were statistically significantly lower in PWH than in non-PWH (median 13 vs. 49 mg/L, respectively, \(P < 0.001\)). No statistically significant differences were found between PWH and non-PWH in the number of comorbidities, presenting signs and symptoms, chest radiology findings, oxygen saturation at room air, other laboratory parameters and COVID-19 SEIMC score on admission.

During the hospital course, 61.9% of PWH and 78.4% of non-PWH received oxygen therapy, and 9.5% and 23.3%, respectively, underwent mechanical ventilation (\(P = 0.158\)). No statistically significant differences were found between PWH and non-PWH in the percentage of patients receiving corticosteroids (33.3% vs. 27.4%, \(P = 0.586\)), tocilizumab (4.8% vs. 16.7%, \(P = 0.160\)) and remdesivir (0 vs. 2.9%, \(P = 0.426\)). Death during admission was documented in two (9.5%) PWH and 12 (11.4%) non-PWH (\(P = 0.800\)).
TABLE 2  Clinical characteristics, treatment and outcome of hospitalized patients with COVID-19

|                              | PWH (N = 21) | Non-PWH (N = 105) | P   |
|------------------------------|--------------|-------------------|-----|
| Sociodemographic characteristics |              |                   |     |
| Male sex [n/N (%)]           | 19/21 (90.5) | 95/105 (90.5)     | 1.00|
| Age (no. with data)          | 21           | 105               |     |
| Median (Q1–Q3) (years)       | 53 (46–56)   | 53 (46–56)        | 1.00|
| Country of birth [n/no. with data (%)] | |                   |     |
| Spain                        | 12/21 (57.1) | 82/103 (79.6)     | 0.028|
| Other                        | 9/21 (42.9)  | 21/103 (20.4)     |     |
| Number of comorbidities [n/no. with data (%)] | |                   |     |
| None                         | 8/18 (44.4)  | 36/91 (39.6)      | 0.798|
| 1–2                          | 7/18 (38.9)  | 43/91 (47.3)      |     |
| ≥ 3                          | 3/18 (16.7)  | 12/91 (13.2)      |     |
| Types of comorbidity [n/no. with data (%)] | |                   |     |
| Hypertension                 | 9/21 (42.9)  | 37/103 (35.9)     | 0.549|
| Chronic heart disease        | 3/21 (14.3)  | 6/104 (5.8)       | 0.168|
| Diabetes                     | 4/21 (19.0)  | 17/104 (16.3)     | 0.763|
| Chronic lung disease (not asthma) | 4/21 (19.0)  | 13/105 (12.4)     | 0.414|
| Obesity (BMI ≥ 30 kg/m²)     | 1/18 (5.6)   | 19/94 (20.2)      | 0.137|
| Other chronic neurological disorder | 0/21 (0)    | 5/104 (4.8)       | 0.305|
| Asthma                       | 0/21 (0)     | 6/105 (5.7)       | 0.262|
| Solid cancer (active)        | 1/21 (4.8)   | 2/105 (1.9)       | 0.433|
| Haematological cancer (active) | 0/21 (0)    | 2/104 (1.9)       | 0.522|
| Chronic kidney disease       | 3/21 (14.3)  | 3/104 (2.9)       | 0.026|
| Liver cirrhosis              | 0/21 (0)     | 3/104 (2.9)       | 0.431|
| Inflammatory disease         | 0/21 (0)     | 4/105 (3.8)       | 0.363|
| Dementia                     | 0/21 (0)     | 3/105 (2.9)       | 0.433|
| Signs and symptoms (>10%) [n/no. with data (%)] | |                   |     |
| History of fever             | 19/21 (90.5) | 94/105 (89.5)     | 0.896|
| Cough                        | 14/21 (66.7) | 80/105 (76.2)     | 0.360|
| Malaise                      | 12/21 (57.1) | 71/102 (69.6)     | 0.267|
| Dyspnoea                     | 14/21 (66.7) | 59/103 (57.3)     | 0.426|
| Upper respiratory tract symptoms | 9/21 (42.9)  | 30/103 (29.1)     | 0.217|
| Myalgia/arthritisia          | 4/21 (19.0)  | 27/97 (27.8)      | 0.407|
| Diarrhoea                    | 4/21 (19.0)  | 16/103 (15.5)     | 0.690|
| Headache                     | 4/21 (19.0)  | 13/98 (13.3)      | 0.492|
| Vomiting/nausea              | 3/21 (14.3)  | 16/99 (16.2)      | 0.831|
| Chest pain                   | 2/21 (9.5)   | 13/98 (13.3)      | 0.639|
| Chest radiography [n/no. with data (%)] | |                   |     |
| Infiltrates present at baseline | 18/20 (90.0) | 86/100 (86.0)     | 0.631|
| Bilateral opacities          | 15/18 (83.3) | 62/82 (75.6)      | 0.481|
| Capillary O₂ saturation at room air (%) | |                   |     |
| No. with data                | 19           | 89                |     |
| Median (Q1–Q3)               | 95 (89–97)   | 95 (92–97)        | 0.647|
| Laboratory parameters        |              |                   |     |
| Leukocyte count (n with data) | 17           | 103               |     |
| Median (Q1–Q3) (cells/µL)   | 6540 (5590–8120) | 6400 (4580–7900) | 0.489|

(Continues)
DISCUSSION

In this retrospective study nested in a large prospective cohort of PWH in Spain, COVID-19 was reported as confirmed in 0.4% of individuals up to 30 June 2020, 46.7% of whom were hospitalized. Most individuals had well-controlled HIV infection; however, those hospitalized were older and more frequently afflicted with underlying comorbidities than those managed ambulatorily. These findings are similar to those reported in two other sizeable multicentre retrospective studies with PWH in Spain and Italy, where 0.4% and 0.3% of PWH developed COVID-19, and 63.9% and 55.1%, respectively, were hospitalized [13,14]. A higher frequency of COVID-19 was found in a population-based study in the West Cape region in South Africa, in which the infection was confirmed in 7.4% of PWH [3].

We also compared the characteristics and outcomes of hospitalized PWH with COVID-19 with age/sex-matched non-PWH controls from a cohort of hospitalized individuals with COVID-19 in Spain [2]. Clinical features and severity score on admission were well matched between the groups. However, serum CRP concentrations indicative of systemic inflammation were lower in PWH than in non-PWH. Notwithstanding this, median serum concentrations of CRP in both groups were

| TABLE 2 (Continued) | PWH (N = 21) | Non-PWH (N = 105) | P   |
|----------------------|-------------|-------------------|-----|
| Lymphocyte count (n with data) | 17          | 102               |     |
| Median (Q1–Q3) (cells/µL) | 1170 (930–1500) | 1100 (820–1450) | 0.247 |
| Neutrophil count (n with data) | 17          | 104               |     |
| Median (Q1–Q3) (cells/µL) | 4370 (3780–6730) | 4310 (2900–6050) | 0.497 |
| Neutrophil-to-lymphocyte ratio [n with data (%)] | 17          | 102               |     |
| Median (Q1–Q3) | 3.6 (2.2–5.9) | 3.7 (2.4–6.6) | 0.838 |
| D-Dimer [n with data] | 13          | 45                |     |
| Median (Q1–Q3) (ng/mL) | 591 (349–1324) | 490 (310–880) | 0.508 |
| ALT (n with data) | 16          | 93                |     |
| Median (Q1–Q3) (U/L) | 29 (12–46) | 39 (22–58) | 0.234 |
| Creatinine (n with data) | 17          | 104               |     |
| Median (Q1–Q3) (mg/dL) | 0.9 (0.8–1.0) | 0.9 (0.8–1.1) | 0.932 |
| C-reactive protein (n with data) | 17          | 98                |     |
| Median (Q1–Q3) (mg/L) | 13 (9–17) | 49 (21–116) | <0.001 |
| COVID-19 SEIMC score | No. with data | 15               | 85   | 0.996 |
| Median (Q1–Q3) | 4 (2–7) | 5 (3–7) |     |
| Supportive therapy [n/no. with data (%)] | | | |
| Oxygen therapy (nasal, reservoir, mask) | 13/21 (61.9) | 88/102 (78.4) | 0.108 |
| BiPAP, CPAP, HFNO | 0/21 (0) | 20/102 (19.6) | 0.027 |
| Mechanical ventilation | 2/21 (9.5) | 24/103 (23.3) | 0.158 |
| Inotropes/vasopressors | 2/21 (9.5) | 17/102 (16.7) | 0.409 |
| Renal replacement therapy/dialysis | 1/21 (4.8) | 3/100 (3.0) | 0.681 |
| Treatment [n/no. with data (%)] | | | |
| Remdesivir | 0/21 | 3/102 (2.9) | 0.426 |
| Corticosteroids | 7/21 (33.3) | 28/102 (27.4) | 0.586 |
| Tocilizumab | 1/21 (4.8) | 17/102 (16.7) | 0.160 |
| Outcomes [n/no. with data (%)] | | | |
| Death | 2/21 (9.5) | 12/105 (11.4) | 0.800 |

Abbreviations: ALT, alanine aminotransferase; BiPAP, bilevel positive airway pressure; BMI, body mass index; CPAP, continuous positive airways pressure; HFNO, high-flow nasal oxygen therapy; non-PWH, people not infected with HIV; PWH, people with HIV; Q1/Q3, first/third quartile; SEIMC, Spanish Society of Infectious Diseases and Clinical Microbiology.

*Defined as an estimated glomerular filtration rate by the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formula of <60 mL/min/1.73 m² for 3 months or more, irrespective of cause.
below the cut-off values associated with severe disease and fatal outcomes (50 and 75 mg/L, respectively) [15].

It is notable that a higher proportion of PWH than non-PWH were born abroad, particularly in Latin American countries, most likely because these individuals are overrepresented in CoRIS compared with Spain's general population. Other explanations include increased exposure to SARS-CoV-2 due to differences in societal factors or differences in the genetic background that could influence COVID-19 acquisition. In a single-centre case series from the UK, hospitalized PWH with COVID-19 were more likely to be of black ethnicity [4]. However, no differences in race/ethnicity between hospitalized PWH and non-PWH were found in two multicentre case series from the USA [5,6].

We found that mortality for COVID-19 among PWH was 4.4% overall and 9.5% among those hospitalized, a figure not significantly different from the 11.4% seen in the age/sex-matched non-PWH controls. Of note, approximately a third of hospitalized patients with COVID-19 received corticosteroids, and a smaller proportion received tocilizumab or remdesivir, with no statistically significant differences found between PWH and non-PWH. No significant differences in mortality between PWH and non-PWH have been described in four studies from the UK and the USA [4-6,8], including a large retrospective study of the US Veterans Aging Cohort Study that included all veterans with HIV and 1:2 age-, race/ethnicity-, sex- and site-matched uninfected veterans, in which no evidence was found of increased risk of severe COVID-19 outcomes including death by HIV status [8]. Nevertheless, an association between HIV infection and COVID-19 death has been found in South Africa [3] and two extensive studies from the UK [7,9], although one or more confounding factors (socioeconomic status and type of occupation, comorbidities, body mass index, smoking and markers of HIV control) could not be ruled out in these studies. In a recent cohort study of linked HIV diagnosis, COVID-19 laboratory diagnosis and hospitalization databases in New York State, PWH were more likely to receive a diagnosis of, be hospitalized with, and die in-hospital with COVID-19 compared with non-PWH [10]. In this study, COVID-19 hospitalization and mortality remained significantly elevated for PWH after demographic adjustment; but again, the role played by comorbidities, risk behaviours and socioeconomic status could not be determined.

Our study is limited by retrospective design and by the small number of PWH with COVID-19. Our work is also limited by the absence of critical socioeconomic information about housing, employment and level of education. Strengths include having been carried out in a prospective cohort of PWH, a comparison with age- and sex-matched non-PWH controls, and the use of a validated predictive scoring system.

In conclusion, our findings suggest that well-controlled HIV infection does not modify the clinical presentation or worsen clinical outcomes in patients hospitalized with COVID-19.

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CONFLICT OF INTEREST
JCL reports honoraria for advice or public speaking from Gilead, MSD, Janssen and ViiV Healthcare. JRB reports honoraria for advice or public speaking from Abbvie, Gilead, MSD, Janssen and ViiV Healthcare, and grants from Gilead. LG-J-F reports honoraria for advice or public speaking from MSD and grants from GILEAD. FG reports honoraria for advice or public speaking from Janssen and ViiV Healthcare. IS-G reports honoraria for advice or public speaking from Gilead, MSD and ViiV Healthcare. JRA reports honoraria for advice or public speaking from Alexa, Gilead, MSD, Janssen, Serono, Teva and ViiV Healthcare, and grants from Alexa, Gilead, Janssen, MSD, Serono, Teva and ViiV Healthcare. SM reports honoraria for advice or public speaking from Gilead, MSD and ViiV Healthcare. JG reports honoraria for advice or public speaking from Alexa, Gilead, MSD, Janssen and ViiV Healthcare, and grants from Alexa, Gilead, MSD and ViiV Healthcare. JG-F reports honoraria for advice or public speaking from Gilead, MSD, Janssen and ViiV Healthcare, and grants from Gilead, MSD and ViiV Healthcare. JRB reports honoraria for advice or public speaking from Abbvie, Gilead, MSD, Janssen and ViiV Healthcare. JG reports honoraria for advice or public speaking from Gilead, MSD and ViiV Healthcare. JG reports honoraria for advice or public speaking from Abbvie, Gilead, MSD, Janssen and ViiV Healthcare, and grants from Abbvie, Gilead, Janssen, MSD and ViiV Healthcare. CD, JDR-R, RM, SC, GS, JP, LG-J-F, JLG-S, CA and MN have nothing to disclose.

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AUTHOR CONTRIBUTIONS
JB conceived the study. CD, JRA, SM, JG and IJ made substantial contributions to the conception and design. JDR and IJ analysed the data. RM, JCL, JRB, SC, GS, JP, LG-J-F, FG, JLG, IS, CA and MN made substantial contributions to the acquisition of data. JB drafted the manuscript, and all authors revised it critically and approved the final version.

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REFERENCES

1. Docherty AB, Harrison EM, Green CA, et al. Features of 20 133 UK patients in hospital with covid-19 using the ISARIC WHO Clinical Characterisation Protocol: prospective observational cohort study. BMJ 2020;369:m1985.

2. Berenguer J, Ryan P, Rodriguez-Bano J, et al. Characteristics and predictors of death among 4035 consecutively hospitalized patients with COVID-19 in Spain. Clin Microbiol Infect. 2020;26(11):1525-1536.

3. Boullé A, Davies MA, Hussey H, et al. Risk factors for COVID-19 death in a population cohort study from the Western Cape Province, South Africa. Clin Infect Dis 2020. Online ahead of print. https://doi.org/10.1093/cid/ciaa1198

4. Childs K, Post FA, Norcross C, et al. Hospitalized patients with COVID-19 and human immunodeficiency virus: a case series. Clin Infect Dis. 2020;71(8):2021-2022.

5. Karmen-Tuohy S, Carlucci PM, Zervou FN, et al. Outcomes among HIV-positive patients hospitalized with COVID-19. J Acquir Immune Defic Syndr. 2020;85 (1):6-10.

6. Sigel K, Swartz T, Golden E, et al. Coronavirus 2019 and people living with human immunodeficiency virus: outcomes for hospitalized patients in New York City. Clin Infect Dis. 2020;71(11):2933-2938.

7. Geretti AM, Stockdale AJ, Kelly SH, et al. Outcomes of COVID-19 related hospitalization among people with HIV in the ISARIC WHO Clinical Characterization Protocol (UK): a prospective observational study. Clin Infect Dis 2020. Online ahead of print. https://doi.org/10.1093/cid/ciaa1605

8. Park LS, Rentsch CT, Sigel K, Rodriguez-Barradas M, Brown ST, Goetz MB, et al. COVID-19 in the largest US HIV cohort 23rd International AIDS Conference. Abstract # LBPEC23; 6-10 July; Virtual meeting. 2020.

9. Bhaskaran K, Rentsch CT, MacKenna B, et al. HIV infection and COVID-19 death: a population-based cohort analysis of UK primary care data and linked national death registrations within the OpenSAFEy platform. Lancet HIV. 2021;8(1):e24-e32.

10. Tesoriero JM, Swain CE, Pierce JL, et al. COVID-19 outcomes among persons living with or without diagnosed HIV infection in New York State. JAMA Netw Open. 2021;4(2):e2037069.

11. Sobrino-Vegas P, Gutiérrez F, Berenguer J, et al. The Cohort of the Spanish HIV Research Network (CoRIS) and its associated biobank; organizational issues, main findings and losses to follow-up. Enferm Infecc Microbiol Clin. 2011;29(9):645-653.

12. Berenguer J, Borobia AM, Ryan P, et al. Development and validation of a prediction model for 30-day mortality in hospitalised patients with COVID-19: the COVID-19 SEIMC score. Thorax. 2021. Online ahead of print. https://doi.org/10.1136/thoraxjnl-2020-216001

13. Del Amo J, Polo R, Moreno S, et al. Incidence and Severity of COVID-19 in HIV-positive persons receiving antiretroviral therapy: a cohort study. Ann Intern Med. 2020;173(7):536-541.

14. Di Biagio A, Ricci E, Calza L, et al. Factors associated with hospital admission for COVID-19 in HIV patients. AIDS 2020; 34(13):1983-1985.

15. Recovery Collaborative Group. Tocilizumab in patients admitted to hospital with COVID-19 (RECOVERY): a randomised, controlled, open-label, platform trial. Lancet 2021; 397(10285):1637-1645.

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APPENDIX

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