Infection
https://doi.org/10.1007/s15010-022-01887-8

ORIGINAL PAPER

Non-HIV-related comorbidities and uncontrolled HIV replication are independent factors increasing the odds of hospitalization due to COVID-19 among HIV-positive patients in Poland

Justyna D. Kowalska[1,2] · Martyna Lara[3,4] · Maria Hlebowicz[5] · Elżbieta Mularska[6] · Elżbieta Jabłonowska[7] · Ewa Siwak[2,8] · Alicja Wandałowicz[9] · Magdalena Witak-Jędra[10] · Anita Olczak[11] · Monika Bociąga-Jasik[12] · Magdalena Suchacz[8] · Justyna Stempkowska-Rejek[13] · Piotr Wasilewski[14] · Miłosz Parczewski[10]

Received: 29 March 2022 / Accepted: 8 July 2022

Abstract

Purpose Immunocompromised patients are postulated to be at elevated risk of unfavorable outcomes of COVID-19. The exact effect of HIV infection on the course of COVID-19 remains to be elucidated. The aim of the study was to describe the epidemiological and clinical aspects of SARS-CoV-2 infection in HIV-infected individuals.

Methods The HIV-positive patients who were diagnosed with SARS-CoV-2 infection were identified through thirteen specialist HIV clinics routinely following them due to HIV treatment. The data were collected between November 2020 and May 2021 through an on-line electronical case report form (SurveyMonkey®). The collected information included demographics, lifestyle, comorbidities, HIV care history, COVID-19 clinical course and treatment. Logistic regression models were used to identify factors associated with the odds of death or hospitalization due to COVID-19.

Results One hundred and seventy-three patients with HIV-SARS-CoV-2 coinfection were included in the analysis. One hundred and sixty-one (93.1%) subjects had a symptomatic course of the disease. Thirty-nine (23.1%) of them were hospitalized, 23 (13.3%) necessitated oxygen therapy. Three (1.8%) patients required admission to the intensive care unit and 6 (3.5%) patients died. The presence of comorbidities and an HIV viral load of more than 50 copies/mL were linked to the increased odds of hospitalization (OR 3.24 [95% CI 1.27–8.28]) and OR 5.12 [95% CI 1.35–19.6], respectively).

Conclusions As depicted by our analyses, HIV-positive patients with comorbidities and/or uncontrolled HIV replication who are diagnosed with SARS-CoV-2 infection should be considered of high risk of poor COVID-19 outcome and followed up carefully.

Keywords HIV · COVID-19 · SARS-CoV-2 · Death · Hospitalization

Introduction

Severe acute respiratory syndrome coronavirus 2 or SARS-CoV-2 emerged in Wuhan, China, in December 2019 and quickly disseminated causing a global pandemic [1].

The first cases were reported in Poland in March 2020 and by the end of July 2021, 2,883,120 people were infected and 75,261 of them died of COVID-19 [2]. As in many other countries, Polish health care system was overwhelmed, what resulted in serious limitations in access to health care.

People suffering from immunodeficiency, including those with HIV infection, are postulated to be at higher risk of acquiring infection and death from COVID-19 [3]. However, recent reports concerning HIV, yield contradictory results [4, 5]. One possible explanation is that people living with HIV (PLHIV) are not a homogeneous group and numerous factors contribute to the effect of HIV infection on SARS-CoV-2 response. The role of immune deficiency, effectiveness and components of antiretroviral therapy (ART), the history of opportunistic infections, including those affecting respiratory tract, remain to be elucidated. Moreover, local factors may contribute to the course of COVID-19, such as access to general healthcare, causal COVID-19 treatment and vaccine strategies [6–8].

✉ Martyna Lara
gomulskamartyna@gmail.com

Extended author information available on the last page of the article

Published online: 27 July 2022

On the other hand, COVID-19 pandemic may affect the linkage to and retention in HIV care. As reported by Euroguidelines in Central and Eastern Europe Network Group in the beginning of COVID-19 pandemic, 60% of HIV practitioners were also involved in COVID-19 care [9].

Therefore, it is necessary to review epidemiological and clinical characteristic of SARS-CoV-2–HIV coinfection in national healthcare systems.

Methods

In November 2020, the Polish AIDS Society initiated a project to identify HIV and SARS-CoV-2 coinfection cases in Poland. In Poland HIV-positive patients were tested for SARS-CoV-2 infection in the same settings and for the same purposes as the general population. The HIV-positive patients who were diagnosed with SARS-CoV-2 infection were identified through thirteen specialist HIV clinics routinely following them due to HIV infection. Patients with confirmed diagnosis were included in the study irrespective of the presence of symptoms. COVID-19 diagnosis, according to national standards, was based on the positive reverse transcriptase real-time polymerase chain reaction (RT-PCR) test or the presence of characteristic clinical and radiological symptoms in combination with epidemiological context.

The data were collected between November 2020 and May 2021 through an on-line electronical case report form (eCRF) build on SurveyMonkey® platform. The collected information included demographics, lifestyle, comorbidities, HIV care history and COVID-19 clinical course. The clinical course of COVID-19 infection was assessed on day 0, 7, 14 and 28 according to WHO Ordinal Scale [10] (Score 1—ambulatory, no limitation of activities, 2—ambulatory, limitation of activities or home oxygen therapy, 3—hospitalized with mild disease, no oxygen therapy, 4—hospitalized with mild disease, oxygen by mask or nasal cannula, 5—hospitalized with severe disease on non-invasive ventilation or high-flow oxygen, 6—hospitalized with severe disease on mechanical ventilation, 7—hospitalized with severe disease on mechanical ventilation or organ support, 8—death). Comorbidities groups included: respiratory, kidney, cardiovascular disease, diabetes and malignancy. In statistical analyses logistic regression models were used to identify factors associated with the odds of death or hospitalization due to COVID-19. Factors significant in univariate models ($p < 0.1$) were included in multivariate model. A confidence interval (CI) of 95% was accepted. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

All patient information obtained was anonymized prior to data collection. The study received approval from Bioethical Committee of Medical University of Warsaw (Komisja Bietyczna Medycznego Uniwersytetu, Nr AKBE/155/2020) and a waiver for informed consent was granted.

A total of 193 patients with SARS-CoV-2 and HIV coinfection were reported and assessed for eligibility. Eleven of the patients were diagnosed with HIV during COVID-19 and they were excluded from the study as well as nine individuals who have not yet recovered by the end of the study and their clinical outcome was unknown. The study design is depicted in the flow chart (Fig. 1). The results are reported in concordance with STROBE statement. [11]

Results

Baseline characteristics

In total, 173 patients were included into analyses, of whom 32 were female (18.6%). Median age was 42 (IQR: 36–50), median BMI 24 (IQR: 22–27).

One hundred and forty-four patients (85.2%) were employed, among them 112 (80%) were working in close contact with other people. Ninety-nine (58.6%) patients stated to never have used drugs, 71 (42.3%) have never smoked. Sixty patients (34.9%) had preexisting comorbidities, 28 (15.4%) had HBV and/or HCV coinfection.

In terms of comorbidities, 85 patients (48.1%) had at least one underlying condition, the most common were: cardiovascular diseases—diagnosed in 39 patients (22.5%), respiratory—in 14 patients (8.1%) and malignancies—11 patients (6.4%). Psychiatric disorders were known in 9

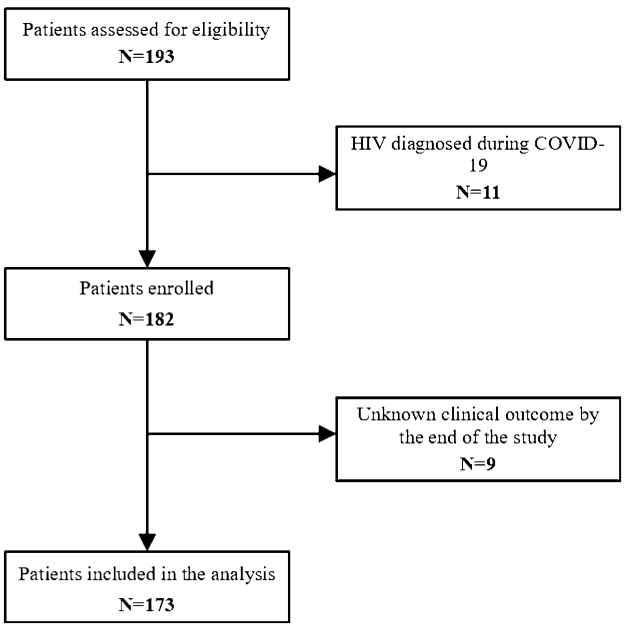

Fig. 1 Flow chart—study design

patients (5.2%), diabetes in 7 patients (4%), inflammatory bowel diseases in 5 patients (3%), neurological diseases in 4 patients (2.3%), renal disease in one patient (0.6%). Twenty-six of the patients (15%) had more than one comorbid condition diagnosed before the onset of COVID-19.

HIV outcomes

Median time since HIV diagnosis was 8 years (IQR: 3–14). Route of transmission was identified as MSM contact in 111 (64.2%) subjects, heterosexual in 22 (12.7%), IDU in 32 (18.5%), in 8 (4.6%) patients it remained unknown. One hundred and sixty-nine (97.7%) patients have been receiving cART before COVID-19 and 149 of them (88,2%) had HIV viral load < 50 copies/mL. Median CD4 + cell count was 587 cells/µl (IQR: 375–790) before contracting SARS-CoV-2. In terms of antiretroviral therapy, 114 patients (67.5%) received an integrase inhibitor-based therapy, 32 patients (18.9%) were on a protease inhibitor based regimen and 30 patients (17.8%) were receiving a non-nucleoside reverse transcriptase inhibitors.

COVID-19 outcomes

COVID-19 diagnosis was based on the quantitative polymerase chain reaction (RT-PCR) in 137 (79.6%) patients. The remaining patients were diagnosed by serologic tests or the presence of characteristic signs and symptoms in combination with epidemiological context. This group includes mostly non-severe cases of the patients who were treated in outpatient clinics. One hundred and sixty-one (93.1%) patients had a symptomatic course of the disease. Thirty-nine (23.1%) of them were hospitalized, 27 (15.6%) received COVID-19 specific treatment and 23 (13.3%) necessitated oxygen therapy. Three (1.8%) patients required admission to the intensive care unit and 6 (3.5%) patients died. One hundred and forty-six (84.4%) subjects showed complete and 21 (12.1%) partial recovery.

Table 1 Characteristics of the participants with regard to the need of hospitalization

Variable	Nr with data	All	Hospitalized	Not hospitalized	*p*-value
Women, *N* (%)	168	31 (18.45)	10 (26.32)	21 (16.15)	0.1610
Age, median (IQR)	171	42 (36–50)	43.5 (39–50)	41 (36–50)	0.2319
BMI, median (IQR)	155	24.21 (22–27.2)	24 (19.37–29.16)	24.21 (22–26.7)	0.6736
Time since HIV diagnosis in years, median (IQR)	172	8 (3–14)	9 (4–14)	8 (3–13.5)	0.9154
Employed, *N* (%)	165	140 (84.85)	26 (66.67)	114 (90.48)	0.0007
Type of work	136				0.1616
In contact with the same group of people (e.g., office), *N* (%)		75 (55.15)	11 (42.31)	64 (58.18)	
In contact with changing group of people (e.g., waiter), *N* (%)		33 (24.26)	10 (38.46)	23 (20.91)	
Isolated workplace, *N* (%)		18 (13.24)	2 (7.69)	16 (14.55)	
At home, *N* (%)		10 (7.35)	3 (11.54)	7 (6.36)	
Use of psychoactive substances:					
Active use, *N* (%)	165	9 (5.45)	2 (5.26)	7 (5.51)	0.9357
History of use, *N* (%)	165	61 (36.97)	15 (39.47)	46 (36.22)	0.9357
Smoking:					
Currently, *N* (%)	164	41 (25)	11 (30.56)	30 (23.44)	0.4976
In the past, *N* (%)	164	55 (33.54)	13 (36.11)	42 (32.81)	0.4976
Route of HIV transmission	161				0.0003
IDU, *N* (%)		32 (19.88)	10 (30.3)	22 (17.19)	
MSM, *N* (%)		108 (67.08)	16 (48.48)	92 (71.88)	
Heterosexual, *N* (%)		21 (13.04)	7 (21.21)	14 (10.94)	
VL before COVID	165				< 0.0001
VL < 50 copies/mL, *N* (%)		146 (88.48)	23 (65.71)	123 (94.62)	
VL > 50 copies/mL, *N* (%)		19 (11.52)	12 (34.29)	7 (5.38)	
Last CD4 + count before COVID, median (IQR)	169	587 (375–790)	488 (145.5–771)	604 (421–798)	0.0402
ART before COVID, *N* (%)	169	166 (98.22)	37 (94.87)	129 (99.23)	0.1335
Coinfections present, *N* (%)	173	36 (20.81)	1 (16.67)	35 (20.96)	1.0000
Symptomatic COVID, *N* (%)	169	158 (93.49)	37 (94.87)	121 (93.08)	1.0000
Comorbidities present, *N* (%)	168	60 (35.71)	21 (53.85)	39 (30.23)	0.0124

In terms of COVID-19 therapy, 28 patients (16.2%) received heparin in prophylactic dose, five patients (2.9%) in therapeutic dose, 24 patients (13.9%) received dexamethasone, ten patients (5.8%) were treated with remdesivir, two patients (1.2%) were eligible for tocilizumab therapy and one of the patients (0.6%) received convalescent plasma.

Number of the patients assigned to each WHO category in on days 0, 7, 14 and 28 is depicted in Fig. 2.

The characteristics of the patients stratified by the adverse outcomes are shown in Tables 1 and 2.

In general, patients admitted to the hospital, as compared to those who were not hospitalized, were less likely to be employed (66.7% vs. 90.5%; $p=0.0007$), but more likely to acquire HIV through injecting drug use (30.3 vs. 17.2%; $p=0.0003$) or heterosexual mode (21.2% vs. 10.9%; $p=0.0003$), to be virologically unsuppressed (34.3% vs. 5.4%; $p<0.0001$), to have at least one comorbidity (53.8% vs. 30.2%; $p=0.0124$) and to have lower CD4 count (488 cells/µl vs. 604 cells/µl; $p=0.0402$) (Table 1).

Patients who died, as compared to those who survived, were less likely to be employed (50.0% vs. 86.5%; $p=0.0426$) and more likely to be virologically unsuppressed (66.7% vs. 9.82%; $p=0.0019$) and to have at least one comorbidity (83.3% vs. 33.1%; $p=0.0201$) (Table 2).

The odds of hospitalization

In univariate regression models, being employed, having comorbidity or coinfections, unknown route of HIV transmission, VL > 50 copies/ml and the CD4 + count before COVID-19 were associated with the odds of hospitalization.

After adjustment, two factors were independently associated with the increased odds of hospitalization, namely the presence of comorbidities (OR 3.24 [95% CI 1.27–8.28]) and VL > 50 copies/mL (OR 5.12 [95% CI 1.35–19.6]). Being employed was identified as a factor lowering the odds of hospitalization (OR 0.31 [95% CI 0.10–0.95]) (Table 3).

The odds of death

In univariate regression models, BMI, being employed, having comorbidity and a VL > 50 copies/ml were associated with the odds of death. After adjusting for all the significant factors in the multivariate model, none of them continued to be independently associated with death in the course of COVID-19, most likely in relation to low statistical power (Table 4).

Discussion

More than ninety percent of our patients presented symptoms of SARS-CoV-2 infection. Similar percentage was reported in the systematic review of 252 patients with SARS-CoV-2–HIV coinfection [12]. Estimates of the prevalence of asymptomatic COVID-19 in general population are varying, but seem to oscillate around 17%. [13]. As asymptomatic individuals are less likely to be tested and do not seek medical consultations it is possible that our study is overestimating the proportion of symptomatic COVID-19 among HIV-positive persons. It is important to note that the most patients included in our analysis were relatively young, with normal BMI and on antiretroviral therapy with well-controlled infection. This reflects well the general population of HIV-infected individuals in Poland [14–16].

At the time, when our study was conducted, the new SARS-CoV-2 variant, B.1.1.7, emerged in the United Kingdom and began to dominate in Poland, accounting for more than 90% of all infections by March 2021 [17]. COVID-19 vaccines have been available in Poland, as in the rest

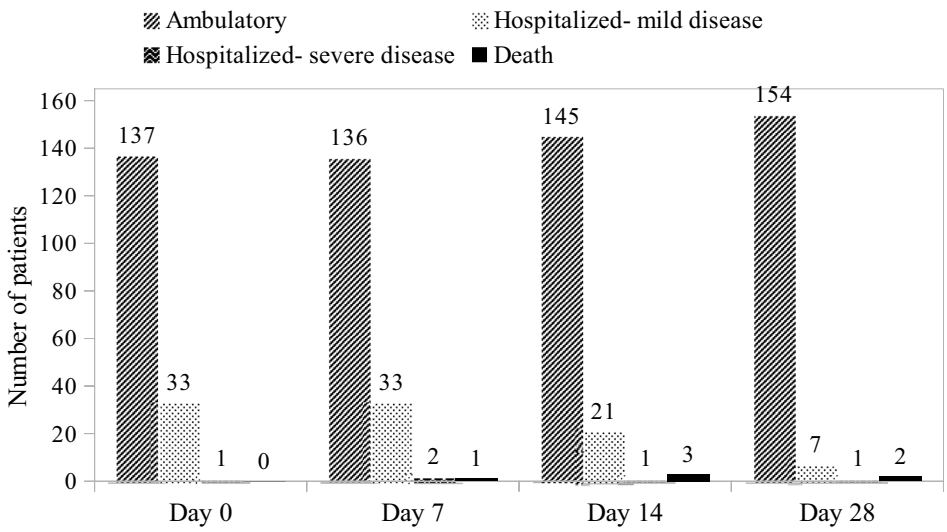

Fig. 2 Clinical progression according to WHO Ordinal Scale of Clinical Improvement

Table 2 Characteristics of the participants stratified by death outcome

Variable	Nr with data	All	Died	Survived	*p*-value
Women, *N* (%)	172	32 (18.60)	1 (16.67)	31 (18.67)	1.0000
Age, median (IQR)	171	42 (36–50)	46.5 (39–52)	42 (36–50)	0.4778
BMI, median (IQR)	155	24.21 (22–27.2)	18.29 (12.4–28)	24.22 (22–27.1)	0.1746
Time since HIV diagnosis in years, median (IQR)	172	8 (3–14)	6 (1–10)	8 (3–14)	0.1604
Employed, *N* (%)	169	144 (85.21)	3 (50.00)	141 (86.50)	0.0426
Type of work:	140				0.8569
In contact with the same group of people (e.g., office), *N* (%)		76 (54.29)	2 (66.67)	74 (54.01)	
In contact with changing group of people (e.g., waiter), *N* (%)		36 (25.71)	1 (33.33)	35 (25.55)	
Isolated workplace, *N* (%)		18 (12.86)	0	18 (13.14)	
At home, *N* (%)		10 (7.14)	0	10 (7.30)	
Use of psychoactive substances:					
Active use, *N* (%)	169	9 (5.33)	0	9 (5.52)	0.8131
History of use, *N* (%)	169	61 (36.09)	2 (33.33)	59 (36.20)	0.8131
Smoking:					
Currently, *N* (%)	168	42 (25)	0	42 (25.93)	0.1451
In the past, *N* (%)	168	55 (32.74)	4 (66.67)	51 (31.48)	0.1451
Route of HIV transmission	165				0.2975
IDU, *N* (%)		32 (19.40)	2 (40)	30 (18.75)	
MSM, *N* (%)		111 (67.27)	2 (40)	109 (68.13)	
Heterosexual, *N* (%)		22 (13.33)	1 (20)	21 (13.13)	
VL before COVID	169				0.0019
VL < 50 copies/mL, *N* (%)		149 (88.17)	2 (33.33)	147 (90.18)	
VL > 50 copies/mL, *N* (%)		20 (11.83)	4 (66.67)	16 (9.82)	
VL after COVID	124				0.1171
VL < 50 copies/mL, *N* (%)		119 (95.97)	2 (66.67)	117 (96.69)	
VL > 50 copies/mL, *N* (%)		5 (4.03)	1 (33.33)	4 (3.31)	
Last CD4 + count before COVID, median (IQR)	169	587 (375–790)	40 (24–865)	589 (397–788)	0.2443
First CD4 + count after COVID, median (IQR)	129	555 (363–805)	56 (9–623)	555 (366–808)	0.0856
ART before COVID, *N* (%)	173	169 (97.69)	6 (100)	163 (97.60)	1.0000
Coinfections present, *N* (%)	173	36 (20.81)	1 (16.67)	35 (20.96)	1.0000
Symptomatic COVID, *N* (%)	173	161 (93.06)	6 (100)	155 (92.81)	1.0000
Comorbidities present, *N* (%)	172	60 (34.88)	5 (83.34)	55 (33.13)	0.0201

of Europe, since late December 2020. Initially, vaccines were distributed among healthcare professionals, followed by selected populations (PLHIV not being one of them). Universal access to the vaccines was granted in May 2021. [18] We did not include the vaccination status of the patients in our analyses, but based on the time of the data collection (November 2020–May 2021), it is safe to assume that a great majority of our patients were not vaccinated.

Thirty-nine of our patients (22.5%) required hospitalization (WHO Ordinal Scale 3 and more). According to the literature, hospitalization rates vary widely, depending on multiple factors. One of them is the period of the pandemic. Marchant et al. reported a drop in case hospitalization rate from 65% in the first pandemic wave to 15% in November 2020. [19] Mahajan et al. pointed to the fact, that the case hospitalization rate (referring to the number of hospitalizations divided by the number of confirmed COVID-19 cases) is much larger than the infection hospitalization rate (related to the assessed number of actual cases based on the SARS-CoV-2 antibodies seroprevalence in the population) 6,9% vs. 14% at the same time [20].

Overall mortality reported in our analysis (6 out of 173 patients, 3.47%) is consistent with the results of the large meta-analysis, where 1416 out of 41,113 (3.44%) HIV–SARS-CoV-2-coinfected individuals died [21] and slightly lower than the overall case-fatality ratio of 5.43% estimated by a large Polish study conducted in the first months of pandemic, before the first variants of concern were identified [22].

Non-HIV-related comorbidities are among main mortality risk factors in COVID-19 [23, 24]. Since the advent of antiretroviral therapy, life expectancy of PLHIV has risen

Table 3 Risk factors of hospitalization in the course of COVID-19

Factor	Nr with data	Univariate OR (95% CI)	*p*-value	Multivariate OR (95% CI)	*p*-value
Male sex	172	0.54 (0.23–1.27)	0.1595	–	–
Age in years (10 units)	167	1.21 (0.87–1.70)	0.2572	–	–
BMI	151	0.99 (0.91–1.09)	0.8770	–	–
Currently employed	169	0.21 (0.07–0.51)	0.0006	0.31 (0.10–0.95)	0.0401
At least one comorbidity[a]	172	2.69 (1.29–5.60)	0.0081	3.24 (1.27–8.28)	0.0140
At least one coinfection	169	2.75 (1.24–6.11)	0.0131	1.50 (0.48–4.66)	0.4840
Route of HIV transmission	178				
MSM		1.00	–	1.00	–
IDU		3.12 (1.33–7.30)	0.7502	1.35 (0.40–4.53)	0.4242
Heterosexual		3.02 (1.10–8.23)	0.7166	3.22 (0.85–12.2)	0.3821
Unknown		15.8 (2.96–84.8)	0.0167	3.39 (0.44–25.8)	0.4780
VL > 50 copies/mL before COVID-19	165	9.17 (3.26–25.7)	< 0.0001	5.12 (1.35–19.6)	0.0171
CD4 + count in cells/µl before COVID-19	169	0.06 (0.75–0.98)	0.0233	0.97 (0.83–1.14)	0.7341

N = 151, 38 hospitalized

[a]Cardiovascular, diabetes mellitus, neoplasm, renal disease

Table 4 Risk factors of death in the course of COVID-19

Factor	*N*	Univariate OR (95% CI)	*p*-value
Male sex	172	1.15 (0.13–10.2)	0.9012
Age in years (10 units)	171	1.60 (0.08–3.20)	0.1796
BMI	155	0.69 (0.05–0.96)	0.0261
Currently employed	169	0.156 (0.03–0.82)	0.0285
At least one comorbidity[a]	172	10.1 (1.15–88.5)	0.0369
VL > 50 copies/mL before COVID-19[b]	169	18.4 (3.12–108.3)	0.0013
CD4 + before COVID-19 cells/µl	169	0.75 (0.53–1.08)	0.1197

N = 151, 3 deaths

[a]Cardiovascular, diabetes mellitus, neoplasm, renal disease

[b]No deaths reported in patients with VL < 50 copies/mL

and they are more likely to develop chronic conditions characteristic to older population. Furthermore, it has been reported that PLHIV develop comorbidities more often and earlier than general population [25], what combined with impaired immune system makes HIV-positive people a particularly vulnerable population [26]. According to WHO report, HIV infection and multimorbidity independently elevate the risk of death from COVID-19 [27].

In our study, comorbidities were fairly common and were also the main driving factor for the severe course of SARS-CoV-2 infection requiring hospitalization. Our analysis did not directly link multimorbidity to the risk of death from COVID-19 in PLHIV what may be caused by a relatively small sample size and few reported deaths.

Above results point out to the importance of timely diagnosis of comorbid conditions in HIV-positive patients. Healthcare professionals should be aware of the early signs and symptoms of cardiovascular, metabolic and renal diseases, malignancy, as well as known side effects of antiretroviral therapy and address them properly according to local or European guidelines [28]. Taking into account the possibility of underdiagnosed comorbidities, as well as lack of certainty for the course of COVID-19 and possible drug–drug interactions, it seems rational to propose different indications for hospitalization in this group of patients [29].

The other factor that influenced the course of COVID-19 in our patients was a detectable viral load of more than 50 copies/mL. The exact impact of HIV viral load on COVID-19 severity remains unclear and many reports lack the appropriate subgroup analysis.

In a case series of 33 patients described by Härter et al., only two patients were not virally suppressed and both of them required intensive care, one of them died [30]. Analogous results were reported by the Euroguidelines in Central and Eastern Europe (ECEE) Network Group in a cohort of 34 patients. Two of the three patients necessitating admission to intensive care unit had a detectable HIV RNA, one of these patients died [31]. The opposite pattern was observed by Patel et al. in a larger cohort [32]. In a meta-analysis by Lee et al., no correlation was found between HIV viral load and severity of COVID-19 [5]. Tesoriero et al. found that the hospitalization rate was higher in those patients who were not virally suppressed and was also increasing with the stage of HIV infection (defined by CD4 + count) [33].

Several studies have investigated the occupational risk for SARS-CoV-2 infection. In a large study based in UK, the

authors postulated that healthcare workers were at higher risk of severe COVID-19 [34], whereas the analysis of excess mortality associated with COVID-19 revealed that other groups of essential workers may be even more affected [35]. We observed that being employed reduced the risk of hospitalization, however, had no effect on COVID-19 mortality. The possible explanation of this effect is the reluctance of the employed patients, who are in good condition, to stay in hospital in order to continue working from home and avoid sick leave.

Limitations to our study include the lack of the control group of HIV-negative individuals and a limited number of endpoints included in the analysis. Unfortunately, a low number of study outcomes prevent in depth analyses of related risk factors, both in our study and in already existing reports. On the other hand, this is, to our knowledge, the first Polish study investigating COVID-19 course and epidemiology in the population of people living with HIV/AIDS.

Conclusions

As depicted by our analyses, HIV-positive patients with comorbidities and/or uncontrolled HIV replication who are diagnosed with SARS-CoV-2 infection should be considered of high risk of poor COVID-19 outcome and followed up carefully**.**

Author contributions JDK: study design, data collection, data analysis, writing. ML: data collection, writing. MH: Data collection. EM: data collection. EJ: data collection. ES: data collection. AW: data collection. MW-J: data collection. AO: data collection. MB-J: data collection. MS: data collection. JS-R: data collection. PW: data collection. MP: data collection. All authors read and approved the final manuscript.

Funding No funds, grants, or other support was received.

Declarations

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval The study received approval from Bioethical Committee of Medical University of Warsaw (Komisja Bietyczna Medycznego Uniwersytetu, Nr AKBE/155/2020) and a waiver for informed consent was granted.

References

1. Castel AD, Wilbourn B, Magnus M, Greenberg AE. SARS-COV-2 and HIV: Epidemiology, treatment, and lessons learned from HIV. AIDS Rev Publicaciones Permanyer. 2020;22:133–42.
2. Poland: Coronavirus Pandemic Country Profile-Our World in Data [Internet]. [**cited 2021 Nov 15**] https://ourworldindata.org/coronavirus/country/poland.
3. Wang L, Sun Y, Yuan Y, Mei Q, Yuan X. Clinical challenges in cancer patients with COVID-19: aging, immunosuppression, and comorbidities. Aging (Albany NY) [Internet]. 2020(**cited 2021 Nov 15, /pmc/articles/PMC7762454/**);12:2462 .
4. Ssentongo P, Heilbrunn ES, Ssentongo AE, Advani S, Chinchilli VM, Nunez JJ, et al. Epidemiology and outcomes of COVID-19 in HIV-infected individuals: a systematic review and meta-analysis. Sci Rep [Internet]. 2021 (**cited 2021 Aug 20],/pmc/articles/PMC7973415/**);11:6283. Accessed 20 Aug 2021
5. Lee KW, Yap SF, Ngeow YF, Lye MS. Covid-19 in people living with hiv: A systematic review and meta-analysis. Int J Environ Res Public Health. 2021;18:3554.
6. Jilich D, Skrzat-Klapaczyńska A, Fleischhans L, Bursa D, Antoniak S, Balayan T, et al. National strategies for vaccination against COVID-19 in people living with HIV in Central and Eastern European region. HIV Med [Internet]. HIV Med; 2021[**cited 2021 Nov 15**]; https://pubmed.ncbi.nlm.nih.gov/34704331/.
7. Zarębska-Michaluk D, Jaroszewicz J, Rogalska M, Martonik D, Pabjan P, Berkan-Kawińska A, et al. Effectiveness of tocilizumab with and without dexamethasone in patients with severe COVID-19: a retrospective study. J Inflamm Res [Internet]. 2021[**cited 2021 Nov 15**];14:3359–66. https://pubmed.ncbi.nlm.nih.gov/34295173/.
8. Flisiak R, Zarębska-Michaluk D, Berkan-Kawińska A, Tudrujek-Zdunek M, Rogalska M, Piekarska A, et al. Remdesivir-based therapy improved the recovery of patients with COVID-19 in the multicenter, real-world SARSTer study. Polish Arch Intern Med [Internet]. 2021[**cited 2021 Nov 15**];131:103–10. https://pubmed.ncbi.nlm.nih.gov/33382547/.
9. Kowalska JD, Skrzat-Klapaczyńska A, Bursa D, Balayan T, Begovac J, Chkhartishvili N, et al. HIV care in times of the COVID-19 crisis—where are we now in Central and Eastern Europe? Int J Infect Dis [Internet]. 2020 (**cited 2021 Aug 21 /pmc/articles/PMC7211569/**);96:311.
10. WHO R&D Blueprint novel Coronavirus COVID-19 Therapeutic Trial Synopsis. 2020;
11. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for Reporting Observational Studies. PLOS Med [Internet]. 2007(**cited 2021 Oct 3**);4:e296. https://doi.org/10.1371/journal.pmed.0040296 .
12. Mirzaei H, McFarland W, Karamouzian M, Sharifi H. COVID-19 Among People Living with HIV: A Systematic Review. AIDS Behav [Internet]. 2021(**cited 2021 Oct 5 /pmc/articles/PMC7391049/**);25:1.
13. Byambasuren O, Cardona M, Bell K, Clark J, McLaws M-L, Glasziou P. Estimating the extent of asymptomatic COVID-19 and its potential for community transmission: Systematic review and meta-analysis. JAMMI [Internet]. 2020 (**cited 2021 Oct 22**);5:223–34. https://doi.org/10.3138/jammi-2020-0030.
14. Kwiatkowska W, Knysz B, Drelichowska-Durawa J, Czarnecki M, Gasiorowski J, Biłyk E, Karczewski M WW. Wystepowanie nadwagi, otyłości i niedoboru masy ciała u pacjentów zakazonych HIV [Overweight, obesity and underweight in HIV infected patients]. Przegl Lek [Internet]. 2013 [**cited 2021 Nov 16**];70:113–7. https://pubmed.ncbi.nlm.nih.gov/24003663/
15. Siwak E, Horban A, Witak-Jędra M, Cielniak I, Firląg-Burkacka E, Leszczyszyn-Pynka M, et al. Long-term trends in HIV care entry: over 15 years of clinical experience from Poland. HIV Med [Internet]. 2019(**cited 2021 Aug 23**);20:581–90. https://doi.org/10.1111/hiv.12762 .

16. Poland – Krajowe Centrum ds AIDS [Internet]. 2020[**cited 2021 Aug 20**]. https://aids.gov.pl/epidemiology/poland/.
17. Monitor wariantów SARS-CoV-2 w Polsce [Internet].[**cited 2022 May 13**] https://monitor.crs19.pl/2021-03-26/poland/.
18. Od kiedy mogę się zaszczepić? - Szczepienie przeciwko COVID-19 - Portal Gov.pl [Internet].[**cited 2022 May 13**] https://www.gov.pl/web/szczepimysie/od-kiedy-moge-sie-zaszczepic.
19. Merchant HA, Kow CS, Hasan SS. COVID-19 first anniversary review of cases, hospitalization, and mortality in the UK. Expert Rev Respir Med [Internet]. 2021;15:973–8. https://doi.org/10.1080/17476348.2021.1890035.
20. Mahajan S, Caraballo C, Li SX, Dong Y, Chen L, Huston SK, et al. SARS-CoV-2 infection hospitalization rate and infection fatality rate among the non-congregate population in connecticut. Am J Med. 2021;134:812-816.e2.
21. Dong Y, Li Z, Ding S, Liu S, Tang Z, Jia L, et al. HIV infection and risk of COVID-19 mortality: A meta-analysis. Medicine (Baltimore) [Internet]. NLM (Medline); 2021;100:e26573. https://journals.lww.com/md-journal/Fulltext/2021/07020/HIV_infection_and_risk_of_COVID_19_mortality__A.60.aspx.
22. Gogolewski K, Miasojedow B, Sadkowska-Todys M, Stepień M, Demkow U, Lech A, et al. Data-driven case fatality rate estimation for the primary lineage of SARS-CoV-2 in Poland. Methods. Academic Press Inc.; 2022.
23. Gujski M, Jankowski M, Rabczenko D, Goryński P, Juszczyk G. Characteristics and clinical outcomes of 116,539 patients hospitalized with COVID-19—Poland, March–December 2020. Viruses. 2021; 13:1458. https://www.mdpi.com/1999-4915/13/8/1458/htm.
24. Gao Y, Ding M, Dong X, Zhang J, Azkur AK, Azkur D, et al. Risk factors for severe and critically ill COVID-19 patients: a review. Allergy [Internet]. 2021(**cited 2021 Oct 22**);76:428–55. https://doi.org/10.1111/all.14657 .
25. Maciel RA, Klück HM, Durand M, Sprinz E. Comorbidity is more common and occurs earlier in persons living with HIV than in HIV-uninfected matched controls, aged 50 years and older: a cross-sectional study. Int J Infect Dis [Internet]. 2018;70:30–5. http://www.ijidonline.com/article/S1201971218300456/fulltext.
26. Smith CJ, Ryom L, Weber R, Morlat P, Pradier C, Reiss P, et al. Trends in underlying causes of death in people with HIV from 1999 to 2011 (D:A:D): a multicohort collaboration. Lancet (London, England) [Internet]. Lancet; 2014[**cited 2022 Jan 16**];384:241–8. https://pubmed.ncbi.nlm.nih.gov/25042234/.
27. Clinical features and prognostic factors of COVID-19 in people living with HIV hospitalized with suspected or confirmed SARS-CoV-2 infection [Internet].[**cited 2022 Jan 29**] https://www.who.int/publications/i/item/WHO-2019-nCoV-Clinical-HIV-2021.1.
28. Ryom L, Cotter A, De Miguel R, Béguelin C, Podlekareva D, Arribas JR, et al. 2019 update of the European AIDS Clinical Society Guidelines for treatment of people living with HIV version 10.0. HIV Med [Internet]. 2020; 21:617–24. https://pubmed.ncbi.nlm.nih.gov/32885559/.
29. Kowalska JD, Kase K, Vassilenko A, Harxhi A, Lakatos B, Lukić GD, et al. The characteristics of HIV-positive patients with mild/asymptomatic and moderate/severe course of COVID-19 disease—a report from Central and Eastern Europe. Int J Infect Dis [Internet]. 2021;104:293–6. https://pubmed.ncbi.nlm.nih.gov/33326871/.
30. Härter G, Spinner CD, Roider J, Bickel M, Krznaric I, Grunwald S, et al. COVID-19 in people living with human immunodeficiency virus: a case series of 33 patients. Infect [Internet]. 2020 (**cited 2021 Oct 27**);48:681–6. https://doi.org/10.1007/s15010-020-01438-z.
31. Skrzat-Klapaczyńska A, Kase K, Vassilenko A, Harxhi A, Lakatos B, Dragović Lukić G, et al. The case series of 34 patients with COVID-19 diagnosed with HIV infection from Central and Eastern European Countries-Euroguidelines in Central and Eastern Europe Network Group Data. 2020 [**cited 2021 Nov 17**]; https://doi.org/10.21203/rs.3.rs-100707/v1.
32. Patel V V., Felsen UR, Fisher M, Fazzari MJ, Ginsberg MS, Beil R, et al. Clinical outcomes and inflammatory markers by HIV serostatus and viral suppression in a large cohort of patients hospitalized with COVID-19. J Acquir Immune Defic Syndr [Internet]. 2021;86:224–30. https://pubmed.ncbi.nlm.nih.gov/33433966/.
33. Tesoriero JM, Swain C-AE, Pierce JL, Zamboni L, Wu M, Holtgrave DR, et al. COVID-19 outcomes among persons living with or without diagnosed HIV infection in New York State. JAMA Netw Open [Internet]. 2021;4:e2037069. https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2775827.
34. Mutambudzi M, Niedzwiedz C, Macdonald EB, Leyland A, Mair F, Anderson J, et al. Occupation and risk of severe COVID-19: prospective cohort study of 120 075 UK Biobank participants. Occup Env Med [Internet]. 2021;78:307–14. http://oem.bmj.com/. [**cited 2021 Oct 28**]
35. Chen Y-H, Glymour M, Riley A, Balmes J, Duchowny K, Harrison R, et al. Excess mortality associated with the COVID-19 pandemic among Californians 18–65 years of age, by occupational sector and occupation: March through November 2020. PLoS One [Internet]. 2021;16:e0252454. https://doi.org/10.1371/journal.pone.0252454.

Authors and Affiliations

Justyna D. Kowalska[1,2] · Martyna Lara[3,4] · Maria Hlebowicz[5] · Elżbieta Mularska[6] · Elżbieta Jabłonowska[7] · Ewa Siwak[2,8] · Alicja Wandałowicz[9] · Magdalena Witak-Jędra[10] · Anita Olczak[11] · Monika Bociąga-Jasik[12] · Magdalena Suchacz[8] · Justyna Stempkowska-Rejek[13] · Piotr Wasilewski[14] · Miłosz Parczewski[10]

Justyna D. Kowalska
jdkowalska@gmail.com

Maria Hlebowicz
mhleb@gumed.edu.pl

Elżbieta Mularska
mulusus@yahoo.com

Elżbieta Jabłonowska
elajablonowska@gmail.com

Ewa Siwak
siwakeb@gmail.com

Alicja Wandałowicz
alicja_wandalowicz@o2.pl

Magdalena Witak-Jędra
magdalenka72@o2.pl

Anita Olczak
anita_olczak@interia.pl

Monika Bociąga-Jasik
monika.bociagajasik@gmail.com

Magdalena Suchacz
m.dabrowska@op.pl

Justyna Stempkowska-Rejek
justyna.stempkowska@gmail.com

Piotr Wasilewski
p.wasilewski@onet.eu

Miłosz Parczewski
mparczewski@yahoo.co.uk

[1] Department of Adults' Infectious Diseases, Medical University in Warsaw, Warsaw, Poland

[2] HIV Out-Patient Clinic, Hospital for Infectious Diseases in Warsaw, Warsaw, Poland

[3] 3rd Department, Hospital for Infectious Diseases in Warsaw, Warsaw, Poland

[4] Present Address: Department of Infectious Diseases, University Hospital in Cracow, ul. Jakubowskiego 2, 30-688 Kraków, Poland

[5] Department of Infectious Diseases, Faculty of Medicine, Medical University of Gdansk, Gdańsk, Poland

[6] Outpatient Clinic for AIDS Diagnostics and Therapy Specialistic Hospital, Chorzow, Poland

[7] Department of Infectious Diseases and Hepatology, Medical University of Lodz, Lodz, Poland

[8] Department of Infectious and Tropical Diseases and Hepatology, Medical University of Warsaw, Warsaw, Poland

[9] Department of Infectious Diseases and Hepatology, Medical University of Bialystok, Białystok, Poland

[10] Department of Infectious, Tropical Diseases and Immune Deficiency, Pomeranian Medical University in Szczecin, Szczecin, Poland

[11] Department of Infectious Diseases and Hepatology, Nicolaus Copernicus University Collegium Medicum in Bydgoszcz, Bydgoszcz, Poland

[12] Department of Infectious and Tropical Diseases, Faculty of Medicine, Jagiellonian University Medical College, 30-688, Kraków, Poland

[13] Department of Infectious Diseases, Medical University of Lublin, Lublin, Poland

[14] 4Th Department, Hospital for Infectious Diseases in Warsaw, Warsaw, Poland