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PROFILE OF PATIENTS DIAGNOSED WITH COVID-19 INFECTION: A SINGLE-CENTER RETROSPECTIVE STUDY

PROFIL PACJENTÓW Z INFEKCJĄ COVID-19: RETROSPEKTYWNE BADANIE JEDNOOŚRODKOWE

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Summary

Background. The purpose of this study was to examine the profile of COVID-19 patients hospitalized at the Department of Internal, Autoimmune and Metabolic Diseases of Central Clinical Hospital of the Medical University of Silesia in Katowice.

Material and methods. A retrospective analysis included all patients admitted to COVID-19 Internal Medicine Ward from November 2020 to June 2021. Collected data embraced: gender, age, date of admission, length of hospital stays, the mode of admission, main diagnoses and comorbidities, discharge mode from the hospital, and cause of death.

Results. The study group comprised 232 patients (124 (53.4%) males) diagnosed with COVID-19, mean age of 66.5±14.7 (24-96) years old. The number of coexisting cardiovascular diseases, diagnosis of chronic heart failure, and ischemic heart disease were statistically significantly associated with mortality of patients. The average length of hospitalization was 9.96±6.35 (0-35) days. It was significantly longer among patients diagnosed with kidney and urinary tract diseases (11 (6.0-14.0) vs. 9 (5.0-15.0) days, p=0.022), especially with urinary tract infection (13.5 (9.0-18.8) vs. 9 (5.0-12.0) days, p=0.003). Coexisting infections other than COVID-19 (9 (5.0-12.0) vs. 5 (10.3-23.0) days, p<0.001) and vitamin D deficiency (8 (4.0-12.0) vs. 12 (10.0-17.0) days, p<0.001) were also significant factors in prolonging hospital stay.

Conclusions. Among hospitalized COVID-19 patients, cardiovascular diseases are significant factors associated with mortality. Coexisting infections and vitamin D deficiency may prolong the hospitalization.

Keywords: coexisting infections, comorbidity, vitamin D deficiency, COVID-19, cardiovascular diseases

Streszczenie

Wprowadzenie. Celem badań była analiza profilu pacjentów przyjmowanych z powodu infekcji COVID-19 w Oddziale Chorób Wewnętrznych, Autoimmunologicznych i Metabolicznych Uniwersyteckiego Centrum Klinicznego Śląskiego Uniwersytetu Medycznego w Katowicach.

Materiał i metody. Retrospektywna analiza objęła wszystkich kolejnych pacjentów z potwierdzoną infekcją COVID-19 przyjętych do Oddziału Chorób Wewnętrznych w okresie od listopada 2020 do czerwca 2021. Przeanalizowano dane takie jak: wiek, płeć, data przyjęcia do oddziału, długość hospitalizacji, tryb przyjęcia, postawione rozpoznania główne i choroby towarzyszące, tryb wypisu pacjentów i przyczyny śmierci w przypadku hospitalizacji zakończonej zgonem.

Wyniki. Grupa badana liczyła 232 pacjentów (124 (53.4%) mężczyzn) ze zdiagnozowaną infekcją COVID-19. Średni wiek badanych wynosił 66.5±14.7 (24-96) lat. W tej grupie zaobserwowano istotnie statystyczny związek śmiertelności pacjentów ze współistniejącą niewydolnością serca i chorobą niedokrwienną serca oraz liczbą obciążeń sercowo-naczyniowych. Średni czas hospitalizacji wynosił 9.96±6.35 (0-35) dni. Był on istotnie dłuższy wśród pacjentów cierpiących na chorobę nerek i dróg moczowych (11 (6,0-14,0) vs. 9 (5,0-15,0) dni, p=0,022), a szczególnie ze stwierdzoną infekcją dróg moczowych (13,5 (9,0-18,8) vs. 9 (5,0-12,0) dni, p=0.003). Współistniejące zakażenia inne niż infekcja COVID-19 (9 (5,0-12,0) vs. 5 (10,3-23,0) dni, p<0.001) oraz niedobór witaminy D (8 (4,0-12,0) vs. 12 (10,0-17,0) dni, p<0,001) również stanowiły istotny czynnik wydłużający pobyt szpitalny.

Wnioski. Wśród pacjentów hospitalizowanych z powodu infekcji COVID-19, obciążenia sercowo-naczyniowe stanowią istotny czynnik zwiększający śmiertelność pacjentów. Współistniejące zakażenia innego rodzaju oraz niedobór witaminy D mogą natomiast wydłużać hospitalizację.

Słowa kluczowe: współistniejące infekcje, choroba towarzysząca, niedobór witaminy D, COVID-19, choroby sercowo-naczyniowe

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Introduction

COVID-19 (Coronavirus Disease 2019) is an infectious respiratory disease caused by a coronavirus called SARS-CoV-2 (severe acute respiratory syndrome coronavirus-2), which has spread rapidly around the world since December 2019. On 11th March 2020, the World Health Organization (WHO) declared it as a pandemic [1]. Globally, as of 13th January 2023, there have been 661,545,258 confirmed cases of COVID-19, including 6,700,519 deaths, reported to the WHO. Just in Poland, from 3rd January 2020 to 13th January 2023, there were 6,372,901 confirmed cases of COVID-19 with 118,640 reported deaths [2].

Typical symptoms of COVID-19 include fever, cough, headache, shortness of breath, loss of smell and taste, myalgia, or fatigue. In severe cases, patients may develop symptoms of progressive respiratory failure requiring hospitalization and mechanical ventilation. Over time, the virus has been mutating and the symptoms have evolved, but most symptoms remain those from the upper and lower respiratory system [3-5].

Many factors may increase the risk of developing an acute form of the disease, such as pre-existing cardiovascular diseases, diabetes mellitus, chronic kidney diseases, cancer, and respiratory illness, hypertension, obesity [4], lipid metabolism dysregulation [6], and vitamin D deficiency [7].

In Poland, most deaths of COVID-19 patients occurred in patients aged 60-89, regardless of comorbidities. However, in the group of COVID-19 patients with comorbidities, there was no significant difference in the number of deaths, according to the age of the patients (the data published by the Ministry of Health in Poland on November 11, 2021) [8].

Patients who developed another infection had a higher risk of prolonged hospitalization and death. The most commonly described co-infections were respiratory, bloodstream, and urinary infections [5]. Moreover, the development of *C. difficile* infection had a significant impact on the more serious condition and poorer prognosis of patients [9].

In 2021, more than 91,000 people died from COVID-19 in Poland. It was the cause of almost one in five deaths that year (the data from the Central Statistical Office in Poland) [10]. In almost all age groups, the mortality rate per 100,000 individuals was twice as high in men as in women. This might have been partly due to the worse health condition of men in Poland, who often neglect preventive examinations and are burdened with numerous untreated diseases [10]. The fact is that men work longer in Poland due to differences in retirement age (for females the age is 60, while for males – 65) [11]. In addition, men more often stay in the labor market after retirement age. In 2019, 81.5 % of those employed in hazardous conditions were men [12]. Considering the previous arguments, it is important to note that men are under occupational exposure factors for longer, which can be associated with health problems.

The highest number (34,865) of hospitalized patients due to COVID-19 in Poland was reported on 8th April 2021 [13]. Due to the sudden development of the pandemic, it was necessary to adapt many hospital wards for patients with COVID-19. This was also the case of the Department of Internal, Autoimmune, and Metabolic Diseases (DIAMD) of the Medical University of Silesia in Katowice, Poland, which became a COVID-19 ward (COVID-19 DIAMD) on 16th November 2020. The most common causes of death before the COVID-19 pandemic in Poland were cardiovascular diseases, cancers, diabetes, and chronic respiratory diseases [14]. In 2020, there was an increase in cardiovascular deaths as compared with the previous few years. More than 174,500 people died from cardiovascular diseases, accounting for 42.6% of all deaths [15]. It is difficult to assess whether this is the beginning of a trend change or just a one-time increase due to the specificities of the pandemic year. Studies on the changes in the profiles of chronic diseases and deaths during the COVID-19 pandemic are emerging [16] but are not yet sufficient to answer that question.

Aim of the work

The objective of this retrospective study was to examine the profile of COVID-19 patients, hospitalized at the Department of Internal, Autoimmune and Metabolic Diseases (DIAMD) of the Medical University of Silesia during its operation as a COVID-19 ward (COVID-19 DIAMD).

Material and methods

A retrospective analysis of medical records of all patients admitted to COVID-19 DIAMD ward from November 2020 to June 2021 was carried out. The study group included 232 patients; in all instances the diagnosis of COVID-19 was confirmed by a PCR test.

The data was collected from the electronic medical records system of the Central Clinical Hospital of the Medical University of Silesia in Katowice, Poland.

Collected data included: gender, age, date of admission, length of hospital stay, the mode of admission, main diagnosis on admission, comorbidities on admission, final main diagnosis and comorbidities, descriptive diagnosis, discharge mode from the hospital, underlying cause of death, secondary cause of death, direct cause of death, and information about the deaths at the Intensive Care Unit (ICU) after transfer from COVID-19 DIAMD ward. Each patient's comorbidities were divided into several categories, defined as: cardiovascular diseases, respiratory diseases, gastrointestinal diseases, endocrine diseases, hyperlipidemia, obesity, prediabetes, diabetes, vitamin D deficiency, kidney and urinary tract diseases, neurological diseases, hematopoietic system diseases, rheumatic diseases, oncological diseases, infectious diseases, past surgeries, acute circulatory-respiratory, and respiratory failure. Within each category, the number of specific diagnoses was provided for each patient, as well as the presence or absence of the diagnosis of hyperlipidemia, obesity, prediabetes, diabetes, vitamin D deficiency (defined as concentration <20 ng) [17], acute circulatory-respiratory, respiratory failure or alcohol use disorder (provided icd-10 criteria of diagnosis) [18]. For example, for the category cardiovascular disease, all diagnoses, including among others hypertension, ischemic heart disease or heart arrythmia, were counted for each patient as it is presented in Table 1.

Table 1. Prevalence of comorbidities reported in COVID-19 patients hospitalized in COVID-19 DIAMD ward in 2020-2021

Categories of comorbidities	Number of patients (and percentage) with diagnoses within category of comorbidities								
	At least 1 diagnosis	Number of diagnoses within category							
		1	2	3	4	5	6	7	8	9
Cardiovascular diseases	185 (79.7)	52 (22.4)	54 (23.3)	31 (13.4)	19 (8.2)	15 (6.5)	9 (3.9)	2 (0.9)	3 (1.3)	0
Respiratory diseases	38 (16.4)	30 (12.9)	8 (3.4)	0	0	0	0	0	0	0
Gastrointestinal disease	104 (44.8)	51 (22.0)	26 (11.2)	10 (4.3)	6 (2.6)	6 (2.6)	3 (4.3)	1 (0.4)	1 (0.4)	1 (0.4)
Endocrine diseases	59 (25.4)	51 (22.0)	8 (3.4)	0	0	0	0	0	0	0
Kidney and urinary tract diseases	80 (34.5)	61 (26.3)	15 (6.5)	3 (1.3)	1 (0.4)	0	0	0	0	0
Hematopoietic diseases	26 (2.2)	23 (9.9)	1 (0.4)	2 (0.9)	0	0	0	0	0	0
Rheumatic diseases	27 (11.6)	26 (11.2)	1 (0.4)	0	0	0	0	0	0	0
Oncological diseases	46 (19.8)	41 (17.7)	2 (0.9)	3 (1.3)	0	0	0	0	0	0

Infectious diseases	28 (12.1)	26 (11.2)	2 (0.9)	0	0	0	0	0	0	0
Neurological diseases	29 (12.5)	25 (10.8)	4 (1.7)	0	0	0	0	0	0	0

All data was anonymized. The statistical analysis was performed with Jamovi 2.2.5 software. The quantitative variables are presented as an arithmetic mean and standard deviation, for normally distributed variables, or a median and the interquartile range (IQR) for variables without normal/skewed distribution. The normality of distribution was assessed with the Shapiro-Wilk test. Qualitative variables are presented as absolute values and percentages. The intergroup differences for the quantitative variables were assessed using the U-Mann-Whitney, t-Student test or the Kruskal-Wallis's test (variables with skewed distribution), respectively. For qualitative variables, a chi square test was used.

Results

The study group comprised 232 patients, including 124 (53.4%) males. The youngest hospitalized patient was 24 years old and the oldest was 96 years old; the mean age was 66.5±14.7. The mean age of men was 66.2 years±15.9 and 66.8±13.3 years for women. The youngest man was 24 years old, and the youngest woman was 37 years old, while the oldest patients were 95 and 96 years old, respectively.

Out of 232 hospitalized COVID-19 patients, only three had no comorbidities. The prevalence of comorbidities reported in COVID-19 patients hospitalized in COVID-19 DIAMD ward in 2020-2021 is presented in Table 1 (Table 1).

Among all categories of comorbidities (Table 1), the most prevalent were cardiovascular diseases; 185 (79,7%) patients had at least one cardiovascular disease and most (23.3%) had 2 cardiovascular diagnoses. The second group of comorbidities were gastrointestinal diseases; 104 (44.8%) patients had at least one diagnosed disease from that category. Kidney and urinary tract diseases were present in 80 (34.5%) patients. Endocrine diseases were diagnosed in 59 (25.4%), oncological diseases in 46 (19.8%), and respiratory diseases in 38 (16.4%) patients. The least prevalent were comorbidities in the categories of hematopoietic diseases (26 patients, 2.2%), rheumatic diseases (27 patients, 11.6%), neurological diseases (29 patients, 12.5%), and infectious diseases other than COVID-19 (28 patients, 12.1%).

Metabolic disorders reported in the study group (Table 2) were hyperlipidemia (53 patients, 22.8%), obesity (44 patients, 19%), and prediabetes (11 patients, 4.7%); out of 63 (27.1%) patients diagnosed with diabetes mellitus – 4 had type 1, 49 type 2, and 10 type 3 diabetes mellitus. Additionally, 63 (27.1%) patients had vitamin D deficiency. Six patients had COVID-19 reinfection, and 33 (14.2%) patients had acute circulatory-respiratory or respiratory failure in the course of COVID-19.

Table 2. Prevalence of specific diagnoses in COVID-19 patients hospitalized in COVID-19 DIAMD ward in 2020-2021

Diagnosis	Number of patients with diagnosis n (%)
Hyperlipidemia	53 (22.8)
Obesity	44 (19.0)
Prediabetes	11 (4.7)
Diabetes mellitus	63 (27.1)
Diabetes mellitus type 1	4
Diabetes mellitus type 2	49
Diabetes mellitus type 3 (steroid diabetes)	10
Vitamin D deficiency	63 (27.1)
Reinfection	6 (2.6)
Acute circulatory-respiratory or respiratory failure	33 (14.2)
Alcohol use disorder	8 (3.4)

The main diagnosis upon discharge from the COVID-19 DIAMD was COVID-19 (217 patients, 93.5%), as presented in Table 3. Further final diagnoses included cardiac arrest in 6 patients (2.6%), myelodysplastic syndrome (2 patients, 0.9%), and individual cases of respiratory failure, acute respiratory failure, unspecified pneumonia, cerebral infarction, gastric varices, hepatorenal syndrome, and vitamin D deficiency.

Table 3. Main diagnoses of COVID-19 patients at the time of discharge from COVID-19 DIAMD ward

Main diagnosis at discharge	Number of patients with diagnosis n (%)
COVID-19 (virus identified)	217 (93.5)
Cardiac arrest	6 (2.6)
Respiratory failure	1 (0.4)
Unspecified pneumonia	1 (0.4)
Cerebral infarction	1 (0.4)
Gastric varices	1 (0.4)
Myelodysplastic syndrome	2 (0.9)
Hepatorenal syndrome	1 (0.4)
Vitamin D deficiency	1 (0.4)
Acute respiratory failure	1 (0.4)

Median length (days) of hospital stays of COVID-19 patients in the study group with and without comorbidities in specific categories is presented in Table 4.

Table 4. Median length (days) of hospital stays of COVID-19 patients in the study group with and without comorbidities in specific categories

Category of comorbidities	Length of hospital stay, number of days (IQR)		*p*-value	Df	Z
	Without comorbidity	With comorbidity			
Cardiovascular diseases	10 (5.5-11.5)	9.5 (5.0-13.0)	0.428	230	4022
Respiratory diseases	10 (6.0-13.0)	9 (5.0-12.8)	0.726	230	3553
Gastrointestinal diseases	9 (5.50-12.5)	10 (5.0-13.0)	0.396	230	6236
Kidney and urinary tract diseases - **Urinary tract infection** - **Other conditions**	**9 (5.0-12.0)** **9 (5.0-12.0)** 9 (5.75-12.3)	**11 (6.0-14.0)** **13.5 (9.0-18.8)** 10 (5.0-14.0)	**0.022** **0.003** 0.271	230 230 230	**4969** **1430** **5064**
Hematopoietic diseases	10 (6.0-13.0)	8 (5.0-13.0)	0.821	230	2605
Rheumatic diseases	10 (5.0-13.0)	8 (5.5-10.5)	0.164	230	2311
Oncological diseases	10 (6.0-13.0)	8 (5.0-14.0)	0.906	230	4230
Infectious diseases other than COVID-19	**9 (5.0-12.0)**	**13.5 (10.3-23.0)**	**<0.001**	230	**1632**
Neurological diseases	9 (5.0-13.0)	11 (8.0-15.0)	0.055	230	2294
Hyperlipidemia	9 (5.50-13.0)	10 (5.0-14.0)	0.301	230	4300
Obesity	9 (5.0-13.0)	10 (6.0-13.3)	0.356	230	3766
Prediabetes	10 (5.0-13.0)	9 (6.5-12.5)	0.823	230	1167
Diabetes mellitus	9 (5.0-12.0)	11 (5.5-14.0)	0.136	230	4646
Vitamin D deficiency	**8 (4.0-12.0)**	**12 (10.0-17.0)**	**<0.001**	230	**3261**
COVID-19 reinfection	10 (6.0-13.0)	3 (2.25-9.0)	0.061	230	374
Alcohol use disorder	10 (5.0-13.0)	8 (6.0-10.8)	0.695	230	823
Any comorbid disease	10 (4.5-10.0)	10 (5.25-13.0)	0.652	230	1016

Notes: IQR – interquartile range, Df-degrees of freedom, Z – value of U-Mann-Whitney statistic; **bold font** – statistically significant results; non-parametric data was calculated with the U-Mann-Whitney test.

The average length of hospital stay was 9.96±6.35 days, with the shortest hospitalization of less than one day and the longest of 35 days. The mean hospital length of stay was 9.76±6.26 days for women and 10.12±6.46 days for men, with the shortest hospitalization lasting one day for both sexes, and the longest 33 days for women and 35 days for men. There was no statistically significant difference in the time of hospital stay between women and men.

The length of the hospital stay was significantly longer among patients diagnosed with several comorbidities (Table 4), such as kidney and urinary tract diseases (11 (IQR: 6.0-14.0) vs. 9 (IQR: 5.0-15.0) days, p=0.022), including urinary tract infections when compared with patients without this diagnosis (13.5 (IQR: 9.0-18.8) vs. 9 (IQR: 5.0-12.0) days, p=0.003). Infectious diseases, other than COVID-19, including *C. difficile* infection, bacteremia or sepsis (*E. faecalis, P. mirabilis, P. aeuruginosa*), *Candida albicans* organ fungal infections and infected wounds, were associated with extended hospitalization, on average, from 9 (IQR: 5.0-12.0) days to 13.5 (IQR: 10.3-23.0) days, p<0.001). Vitamin D deficiency was associated with a statistically significantly (p<0.001) longer average stay in the COVID-19 DIAMD ward (12 (IQR: 10.0-17.0) days), as compared to patients with a normal vitamin D concentration (8 (IQR: 4.0-12.0) days). Hospitalization of patients with neurological diseases was longer, at the border of statistical significance, as compared with the patient without such diagnoses (11 days (IQR: 8.0-15.0) vs. 9 days (IQR: 5.0-13.0), p=0.055). The associations between comorbidities, such as cardiovascular diseases, respiratory diseases, gastrointestinal diseases, hematopoietic system diseases, rheumatic diseases, oncological diseases, and the length of hospital stay were not statistically significant. There was also no association in relation to hyperlipidemia, obesity, prediabetes, diabetes, alcohol use disorder, and COVID-19 reinfection.

The mode of discharge of COVID-19 patients from COVID-19 DIAMD ward in 2020-2021 is presented in Table 5.

Table 5. Mode of discharge of COVID-19 patients from COVID-19 DIAMD ward in 2020-2021

Mode of discharge	Number of patients, n (%)
Transfer to another COVID-19 ward	20 (8.62)
Transfer to another non-COVID-19 ward	12 (5.17)
Referral for outpatient treatment	141 (60.78)
Referral to stationary care facility	5 (2.16)
Transfer to ICU	19 (8.19)
Death	35 (15.09)

Notes: *Among 19 patients transferred to the ICU, 15 patients died. They were included in the death statistics.

Out of 232 patients in the study group, 141 (60.78%) were referred to outpatient treatment and five (2.16%) to stationary care facilities. Nineteen patients (8.19%) were transferred to intensive care units (ICU), 20 (8.62%) patients were transferred to other COVID-19 units, and 12 (5.17%) to other non-COVID-19 wards. Thirty-five (15.09%) patients hospitalized in COVID-19 DIAMD ward died, including 15 in the ICU.

Factors associated with mode of discharge of COVID-19 patients were different length of hospitalization, age of patients, number of comorbidities, and number of diagnosed cardiovascular diseases. Patients discharged to outpatient treatment were hospitalized for longer (10 (IQR: 7.0-14.0) vs. 6 (IQR: 3.0-12) days, $p<0.001$) than the ones who died. This group of patients were younger 64 (IQR: 53.8-73.0) vs. 78 (IQR: 72.0-82.5) years, $p<0.001$) and had fewer cardiovascular diseases (1.5 (0.75-2.0) vs. 3 (2.0-4.0), $p<0.001$). All significant factors are shown in Table 6.

Table 6. Statistically significant factors associated with different modes of discharge from COVID-19 DIAMD ward

Factor	Mode of discharge						*p*-value	Df	X^2
	Outpatient treatment	Stationary care facility	Non COVID-19 ward	COVID-19 ward	ICU	Death			
Length of hospital stay, days (IQR)	10 (7.0-14.0)	17 (14.0-20.0)	10.5 (9.0-15.0)	4.5 (3.0-6.5)	3 (1.0-3.0)	6 (3.0-12)	**<0.001**	**5**	**46.6**
In post-hoc analysis, statistically significant pairwise comparisons: - outpatient treatment vs COVID-19 ward ($p<0.001$) - COVID-19 ward vs non-COVID-19 ward ($p=0.015$) - COVID-19 ward vs stationary care facility ($p=0.029$) - outpatient treatment vs death ($p=0.008$) - outpatient treatment vs ICU ($p<0.001$) - non-COVID-19 ward vs ICU ($p=0.014$) - COVID-19 ward vs stationary care facility ($p=0.018$)									
Age of patients, years (IQR)	64 (53.8-73.0)	81 (80.0-83.0)	73.5 (56.8-80.5)	74 (66.5-78.5)	65 (61.0-70.5)	78 (72.0-82.5)	**<0.001**	**5**	**40.2**
In post-hoc analysis, statistically significant pairwise comparisons: - outpatient treatment vs death ($p<0.001$) - outpatient treatment vs stationary care facility ($p=0.034$) - death vs ICU ($p<0.001$) - ICU vs stationary care facility ($p=0.015$)									

Factor	Mode of discharge						*p*-value	Df	X^2
	Outpatient treatment	Stationary care facility	Non COVID-19 ward	COVID-19 ward	ICU	Death			
Number of comorbidities, n (IQR)	5 (3.0-7.0)	8 (4.0-8.0)	5 (3.0-7.0)	9 (7.75-10.3)	4 (2.5-5.5)	8 (4.0-8.0) 7 (5.0-9.0)	**<0.001**	**5**	**25.1**
In post-hoc analysis, statistically significant pairwise comparisons: - COVID-19 ward vs outpatient treatment (p<0.001) - COVID-19 ward vs ICU (p<0.003)									
Number of Cardiovascular diseases, n (IQR)	1.5 (0.75-2.0)	2 (2.0-3.0)	2 (2.0-3.0)	3 (2.0-5.0)	1 (1.0-2.0)	3 (2.0-4.0)	**<0.001**	**5**	**26.6**
In post-hoc analysis, statistically significant pairwise comparisons: - COVID-19 ward vs outpatient treatment (p=0.002) - COVID-19 ward vs ICU (p=0.015) - outpatient treatment vs death (p=0.003) - death vs ICU (p=0.035)									

Notes: ICU – intensive care unit, IQR – interquartile range, Df – degrees of freedom, X^2 – value of Kruskal Wallis statistic; non-parametric data was calculated with the Kruskal Wallis test with post-hoc analysis for p<0.05.

From the total of 232 patients admitted to COVID-19 DIAMD ward, 35 people died, including 20 patients in COVID-19 DIAMD ward and 15 patients in the ICU at the same hospital.

The underlying causes of death in the study group included COVID-19 (32 patients, 91.4%), sepsis (2 patients, 5.7%), and pulmonary edema (1 patient, 2.9%). Among secondary causes of death were respiratory failure (14 patients, 42.4%), acute respiratory failure (11 patients, 33.3%), heart failure (2 patients, 6.1%), COVID-19 (2, 6.1%), unspecified pneumonia, sepsis, stroke, and pneumonia caused by another virus. Direct causes of death in patients with COVID-19 were acute respiratory failure (4 patients, 11.4%) and cardiac arrest (31 patients, 88.6%). All data is presented in Table 7.

Table 7. Underlying, secondary, and direct causes of death in COVID-19 patients hospitalized in COVID-19 DIAMD ward

Causes of death					
Underlying	**n (%)**	**Secondary***	**n (%)**	**Direct**	**n (%)**
COVID-19, identified virus	32 (91.4)	Respiratory failure, undefined	14 (42.4)	Cardiac arrest, unspecified	31(88.6)
Sepsis	2 (5.7)	Acute respiratory failure	11 (33.3)	Acute respiratory failure	4 (11.4)
Pulmonary edema	1 (2.9)	Heart failure, undefined	2 (6.1)	-	-
-	-	Unspecified pneumonia	2 (6.1)		
		COVID-19, virus identified	2 (6.1)		
		Sepsis, undefined	1 (3.0)		
		Pneumonia caused by another virus	1 (3.0)		
		Stroke, not specified as hemorrhagic or infarct	1 (3.0)		

Notes: *In the case of two patients, it was not possible to determine the proper cause of death (for secondary CoD).

Factors that were statistically significantly associated with mortality of patients with COVID-19 hospitalized at the COVID-19 DIAMD ward (Table 8) included higher age (76 vs 67 years) and the number of cardiovascular comorbidities.

Table 8. Factors associated with mortality of patients with COVID-19 hospitalized in COVID-19 Internal Medicine ward

Factors	Alive n (IQR)	Death n (IQR)	*p*-value	Df	Z
Age of patients, years	67 (55-76)	76 (64.5-80.5)	<0.001	230	3159
Length of hospital stay, days	10 (6.0-13.0)	6 (2.5-11.5)	<0.001	230	2886
Number of cardiovascular comorbidities, n	2 (1.0-3.0)	3 (1.0-4.0)	0.022	230	3603

Notes: IQR – interquartile range, Df – degrees of freedom, Z – value of U-Mann-Whitney statistic; nonparametric data was calculated with a U-Mann-Whitney test.

More specifically (Table 9), chronic heart insufficiency and ischemic heart disease were statistically significantly associated with patients' mortality. Other cardiovascular diseases included atherosclerosis, hypertension, condition after acute coronary syndrome, valvular disease, arrythmias, cardiomyopathy, aortic aneurysm, venous thromboembolism, acute aortic syndromes, acute coronary syndromes, and cerebrovascular trauma, but an association with mortality was not observed. Patients who died were hospitalized for fewer days than those who survived (6 vs 10 days).

Table 9. Cardiovascular diseases associated with mortality of patients hospitalized in COVID-19 DIAMD ward

Cardiovascular disease	Alive	Dead	*p*-value	Df	X^2
Chronic heart failure			<0.001	1	10.9
No, n (%)	157 (82.6)	33 (17.4)			
Yes, n (%)	25 (59.5)	17 (40.5)			
Chronic coronary heart disease			<0.001	1	10.9
No, n (%)	157 (82.6)	33 (17.4)			
Yes, n (%)	25 (59.5)	17 (40.5)			

Notes: Df – degrees of freedom, X^2 – value of chi-squared test statistic; data was calculated using a Chi-squared test.

Discussion

This retrospective study examined the profile of COVID-19 patients hospitalized in the DIAMD, Medical University of Silesia in Katowice, Poland, which became a COVID-19 DIAMD ward and identified several risk factors for death and prolonged hospitalization.

In the group of patients with vitamin D deficiency, urinary tract infections, and infectious disease other than COVID-19, these diagnoses were associated statistically significantly with prolonged hospitalization. Neurological diseases were at the border of statistical significance as a factor prolonging the hospitalization. The length of the hospital stay was not significantly longer among patients diagnosed with cardiovascular disease, respiratory disease, gastrointestinal disease, hematopoietic disease, rheumatic disease, oncological disease, hyperlipidemia, obesity, prediabetes, diabetes, alcohol use disorder, and COVID-19 reinfection.

There have been several meta-analyses on the relationship between COVID-19 and vitamin D [7,19]; however, the results remain inconclusive. A meta-analysis by Kaya at al. of 21 studies found that vitamin D deficiency might increase the risk of COVID-19 infection and disease severity; however, low vitamin D levels had no effect on COVID-19 patient mortality [7]. A meta-analysis conducted by researchers at the American University of Beirut (Bassatne et al.), based on 31 studies, found no statistically significant association between low serum 25(OH)D levels and COVID-19-related health outcomes [19]. In our study, vitamin D deficiency was statistically significantly associated with extended/longer hospital stay at the COVID-19 DIAMD ward from eight (4.0-12.0) to twelve (10.0-17.0) days (p<0.001). This observation is worth noting, as in Poland, a considerable proportion of the population is deficient in vitamin D. A study, involving a total of 5,775 adults from 22 Polish cities found that 89.9% had 25(OH)D levels below 30 ng/ml [17]. Thus, our findings might be considered as an argument to promote vitamin D supplementation in the Polish population.

Our study shows that another crucial factor contributing to longer hospitalization was the development of infections other than COVID-19. For example, the diagnosis of a urinary tract infection, reported in 18 patients, was statistically significantly associated with longer hospitalization, on average 13.5 as compared to 9 days (p=0.003). Studies indicate that catheterized patients, hospitalized for a long time, are at a higher risk of developing urinary tract infections, while highlighting the importance of frequent change of the urinary catheter, to prevent the development of infection [20]. In a prospective observational study, Jalandra et al. showed that COVID-19 patients with co-infections had a higher mortality rate. 14% of patients had co-infections, out of which urinary tract infection was found in 9%. In addition, urinary co-infection emerged as an independent risk factor for mortality [5].

Another example of infections other than COVID-19, which were diagnosed in the study group, were *C. difficile* infection, bacteremia or sepsis (*E. faecalis, P. mirabilis, P. aeuruginosa*), *Candida albicans* organ fungal infections, and infected wounds. Other studies reported similar co-morbidities and their impact on hospitalization time and course. One of them, by Maslennikov et al., indicates that *C. difficile* infection worsens the course and prognosis of COVID-19 [9]. Another study showed that *S. aureus* bacteremia is associated with high mortality rates in hospitalized COVID-19 patients. The study also showed that patients with bacterial or fungal co-infection had a higher mortality and were hospitalized longer. The length of stay in the intensive care unit (13.8 vs. 6.7 days, p<0.001) and the length of hospital stay (18.6 vs. 11.8 days, p<0.001) were longer in the co-infection group [21].

The median lengths of hospitalization differed between groups of patients depending on their mode of discharge. Patients who were discharged to stationary care facilities, non-COVID wards, and those discharged to outpatient treatment were hospitalized for a longer time than those transferred to the ICU or those who died. This difference could have been caused by the difference in the severity of the patients upon admission and the progress of COVID-19.

In 2020, the average length of patient's hospitalization in Poland was 6.8 days, ranked among the top ten countries with the longest hospitalization among the 34 analyzed countries [22]. A study by Tucker outlined that older patients, those who had additional medical conditions, or were put on mechanical ventilation had higher hospitalization costs, longer stays in the hospital, and an increased risk of death [23]. A shorter stay would reduce the cost per discharge.

Among 232 patients, 20 died in COVID-19 DIAMD ward, and 15 died in the ICU at the same hospital, resulting in a mortality rate of 15%. In a study by Kowalska et al., which covered data from all hospitals in Silesia from March to June 2020, the estimated in-hospital mortality rate for COVID-19 was 11.5% [24]. With reference to other publications, this number seems to be higher. However, this might have been because the hospitalized individuals in COVID-19 DIAMD were older than in many other studies. The mean age for men was 66.2±15.9 years and 66.8±13.3 years for women, while in other Polish study, the mean age for men was 57.4±18.7 years and for women 58.6±20.2 years for women [24]. In our study, nineteen patients (8.19%) were transferred to the ICU, and we can compare this number to the cohort by Nowak et al., in which 16% of patients were eventually admitted to the ICU [25]. The contribution of comorbidities is also important. In this study, out of 232 patients, only three had no comorbidities, while in the systematic review and meta-analysis, of respectively 33 and 22 studies by Morgan Spencer Gold et al., 59.2% of patients had no significant comorbidities [26]. In our study group, the most common comorbidities were cardiovascular diseases (79.7%) and gastrointestinal diseases (44.8%). In addition, many COVID-19 patients with severe comorbidities and/or in severe clinical condition were referred or transferred to COVID-19 DIAMD because of the facilities available in the multidisciplinary university hospital. The difference in available facilities, and thus potentially in the profile of hospitalized patients, was especially significant when compared to temporary COVID-19 hospitals. The establishment of temporary hospitals was based on the concept of treating COVID-19 patients whose condition would not require advanced treatment of coexisting diseases, while reducing the burden on normal hospitals during the pandemic [27]. A Polish study by Kanecki et al, including data on 8,840 patients, from February to September 2020, showed a mortality rate of 11.5%. In this study group, the mean age for men was 55.4±20.4 years and 59.5±21.7 years for women [28]. Another Polish study of 169 patients showed that 78.3% had comorbidities [25].

Chronic heart failure and ischemic heart disease were diagnoses which were statistically significantly associated with patient mortality. The Polish study by Kowalska et al. similarly found that the increased risk of death in COVID-19 patients is associated with the presence of chronic cardiovascular disease [24]. A study of 3,080 patients in Spain found that those with a previous history of chronic heart failure were more prone to the development of acute heart failure and had higher levels of NT-proBNP (N-terminal pro brain natriuretic peptide) during COVID-19 infection. In addition, COVID-19 patients with previous chronic heart failure had higher mortality rates [29].

Our study has some limitations. Due to the retrospective design of the study and obtaining the data from an electronic medical records system, some data recorded in the paper files of the patients may be missing. This could, in consequence, lead to the numbers being underestimated. Second, the statistical analysis and interpretation of our findings might be limited by the sample size. Third, the analyzed time period was relatively short (from November 2020 to June 2021); however, that was a result of how long DIAMD functioned as COVID-19 DIAMD.

We plan to continue our study by focusing on the evolution of the profile of COVID-19 patients over the 8-month time period when COVID-19 DIAMD functioned.

Conclusions

In conclusion, vitamin D deficiency, urinary tract infections, and infectious diseases other than COVID-19 were diagnoses which were statistically significantly associated with prolonged hospitalization of patients with COVID-19. The estimated mortality rate for patients with COVID-19 was 15%. The higher mortality rate in comparison to other studies might have been due to the high number of comorbidities in patients, which occurred in almost 99% of people and those in older age. Statistically significant factors that interplayed with patient mortality were chronic heart failure and ischemic heart disease.

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