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Renal impairment in patients admitted due to COVID-19 — the experience of University Hospital No 1 in Bydgoszcz

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ABSTRACT

Introduction: COVID-19 is a prominently respiratory infection, with potential renal complications. Our objective was to describe the incidence of renal impairment and its influence on clinical outcome in patients admitted to University Hospital No 1 in Bydgoszcz due to COVID-19.

Material and methods: In this single-center observational study we retrospectively identified patients with a positive test result for SARS-CoV-2 from either a nasopharyngeal or oropharyngeal swab PCR (n = 988) who were admitted to University Hospital No 1 in Bydgoszcz, Poland since April 1, 2020 to April 30, 2021. Details of the patients' demographics, diagnoses (based on ICD-10 codes), eGFR and clinical outcomes were obtained using a combination of a manual chart review of the electronic medical record from the hospital database.

Results: Median baseline eGFR was 77,4 ml/min (IQR 51,6–93,7 ml/min) and minimal eGFR was 68,7 ml/min (IQR 39,9–90 ml/min), $p < 0,05$. We found significant differences in median baseline and minimal eGFR between patients discharged and deceased (80,8 *vs.* 55,4 ml/min and 73,7 *vs.* 33 ml/min, respectively, $p < 0,001$). Patients who died (12,5 %) were older, with more co-morbidities including CKD and AKI, and presented a significantly lower value of eGFR both at baseline and during hospital stay, as well as, more frequent and extensive deterioration of eGFR. Factors predisposing to in-hospital death were age, atrial fibrillation, heart failure, coronary artery disease, and among them AKI and CKD were strong negative prognostic parameters.

Conclusions: Renal impairment on admission as well as during hospitalization among patients with SARS-CoV-2 infection is a risk factor of negative outcome.

Key words: SARS-CoV-2, kidney injury, pandemic

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Introduction

COVID-19 is a prominently respiratory infection, with potential cardiological, hematological, gastrointestinal, and renal complications. Most COVID-19 infections are not severe, with the spectrum of symptoms ranging from mild to critical. Although the principal features associated with COVID-19 are diffuse alveolar damage and acute respiratory failure, kidney impairment has also often developed, with the frequent onset of acute kidney injury (AKI). In addition, more than 20% of deceased patients were affected by chronic kidney disease (CKD) [1].

The incidence of AKI in patients with COVID-19 varies depending on the study methodology but in patients with severe infection requiring care in the intensive care unit, the rates of acute kidney injury increased significantly from 15% to even 80% [2]. AKI constitutes a negative prognostic factor in COVID-19 patients. It is considered a marker of disease severity [3]. The renal damage observed in COVID-19 patients is the result of complex mechanisms induced directly and indirectly by SARS-CoV-2 [4]. The ability of the virus to bind the ACE-2 receptors in kidneys, hypoxia, persistent hypotension, rhabdomyolysis, over activation of the coagulation cascade and impairment of microcirculation,

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dysfunction of other organs play a role in the predisposition to the development of acute renal damage [5].

However, to date, we do not have sufficient data on the incidence and characteristics of kidney disease associated with SARS-CoV-2 pandemic in our country. The impact of renal failure on COVID-19 patients is not uniform and may be conditioned by the baseline characteristics of patients, the strategy applied for the case detection, the definition of kidney injury, and environmental factors.

Our objective was to describe the incidence of renal impairment and its influence on clinical outcome in patients admitted to University Hospital No 1 in Bydgoszcz due to COVID-19.

Material and methods

In this single-center observational study we retrospectively identified patients with a positive test result for SARS-CoV-2 from either a nasopharyngeal or oropharyngeal swab PCR (n = 988) who were admitted to University Hospital No 1 in Bydgoszcz, Poland. Patients were hospitalized since April 1, 2020 to April 30, 2021. Details of the patients' demographics, diagnoses (based on ICD-10 codes), eGFR and clinical outcomes were obtained using a combination of manual chart review of the electronic medical record from the hospital database (Open Care system). Values of estimated glomerular filtration rate (eGFR) were analyzed for two-time points during hospitalization: the first value that was obtained within 24 hours following admission, and the lowest value occurred during a hospital stay.

The study protocol complies with the declaration of Helsinki and was approved by the local ethics committee of Nicolaus Copernicus University in Torun, Poland.

The normality of the distribution was verified using Shapiro-Wilk test. Continuous variables are presented as median and interquartile range (IQR) or mean ± standard deviation (SD), categorical variables as absolute frequencies and percentages. The comparison between two variables was performed with Mann Whitney U test or appropriate t-Student test according to the distribution. For comparison of more than two variables, Kruskal-Wallis test or ANOVA was used regarding the normality of data distribution. Analyses of correlations were performed using the Pearson or Spearman test as required. Cox regression models were used to determine factors predisposing to in-hospital death. The two-sided p value < 0.05 was considered significant. STATISTICA version 13.1 was used to perform the analyses.

Results

Baseline characteristics of the group is presented in Table 1. When compared to discharged patients the patients who died were significantly older (76 ± 11 years *vs.* 68 ± 16 years; p < 0,001), they were more severely ill regarding co-morbidities (atrial fibrillation: 17% *vs.* 10%, p < 0,03; heart failure: 24% *vs.* 7,8%, p < 0,0001; coronary artery disease: 10% *vs.* 4,9%, p < 0,02; myocardial infarction: 7,6% *vs.* 2,7%, p < 0,007) and they more frequently manifested CKD (11% *vs.* 4%, p < 0,001) or AKI (17% *vs.* 2%, p < 0,001).

Median baseline eGFR was 77.4 ml/min (IQR 51.6–93.7 ml/min) and minimal eGFR was 68.7 ml/min (IQR 39.9–90 ml/min), p < 0.05. We found significant differences in median baseline and minimal eGFR between patients discharged and deceased (Fig. 1). Patients who died presented significantly lower value of eGFR both at baseline and during hospital stay as well

Table 1. Baseline characteristics of the group

Parameter	n = 988
Age, years [SD]	68.3 [15]
Sex, male	54.4 %
Co-morbidities (%)	
Diabetes	13
Hypertension	22
Atrial fibrillation	11
Heart failure	11
CKD	5
AKI	4
Lenght of hospital stay (days)	11 (IQR 5–16)
Outcome	
Discharge	87.5% (n = 864)
Death	12.5 % (n = 124)

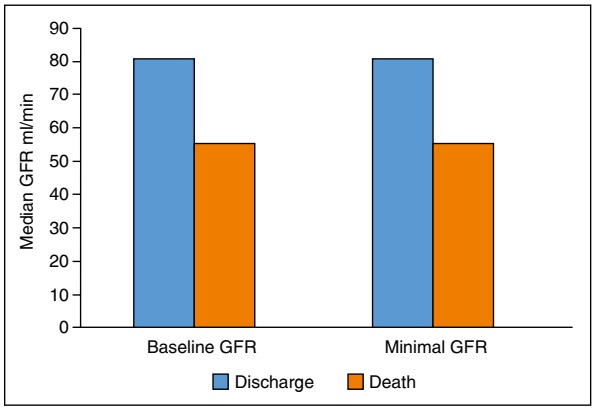

Figure 1. Differences in baseline and minimal median eGFR between the groups: discharged and deceased (p < 0,001)

Table 2. Differences and changes in eGFR between the groups: discharged and deceased

	Discharge (n = 864)	Death (n = 124)	P-value
Baseline eGFR < median [n; %]	n = 414; 81.2%	n = 96; 18.8%	p < 0.0001*
Baseline eGFR ≥ median [n; %]	n = 450; 94.1%	n = 28; 5.9%	
Stable eGFR [n; %]	n = 471; 92.2%	n = 40; 7.8%	p < 0.0001*
Deterioraton of eGFR [n; %]	n = 393; 82.4%	n = 84; 17.9%	
Deterioration of eGFR [mean eGFR (ml/min/m2) ± SD]	5.24 ± 11.4	14.76 ± 19.4	p < 0.0001

*chi^2 test

Table 3. Univariate logistic regression analysis — factors predisposing to in-hospital death

Parameter	OR	–95% CI	+95% CI	P-value
Age	1,053	1.036	1.070	< 0.0001
BMI	1,050	1.009	1.093	0.017
Atrial fibrillation	1,774	1.070	2.940	0.026
Heart failure	3,807	2.390	6.064	< 0.0001
Coronary artery disease	2,19	1.14	4.19	0.017
CKD	3,001	1,601	5.625	0.0006
AKI	9,083	4.802	17.179	< 0.0001

as more frequent and extensive deterioration of eGFR (Tab. 2). Factors predisposing to in-hospital death are presented in Table 3 and Table 4. AKI and CKD were the strongest negative prognostic parameters in the studied population.

Table 4. Multivariate logistic regression analysis — factors predisposing to in-hospital death

Parameter	OR	–95% CI	+95% CI	P-value
Age	1.046	1.022	1.071	0.0002
Heart failure	2.388	1.163	4.904	0.0177
AKI	11.370	4.402	29.366	< 0.0001

Discussion

Our study examined the incidence and manifestation of renal impairment during SARS-CoV-2 infection in a cohort of patients hospitalized in a big academic medical center in Poland. Both CKD and AKI were shown to be very strong risk factors of a worse prognosis and higher mortality in patients admitted with SARS-CoV-2 infection. The incidence of in-hospital death in patients with renal impairment at baseline and during hospitalization was found to be significantly higher than in those patients who enter the hospital with higher baseline GFR and with relatively stable levels of GFR during hospital stay. Moreover, patients who died were older (mean age was 76 years) and were more severely ill compared with discharged patients (median age was 68 years).

COVID-19 infection is frequently severe among patients of advanced age and other medical comorbidities. Males, compared with females, suffer a disproportionately higher number of deaths according to data from cohorts of patients in China, Italy, and the United States [6, 7]. Comorbidities that have been associated with illness severity and mortality include the following ones diabetes mellitus, cardiovascular disease, hypertension, chronic lung disease, cancer, chronic kidney disease, immunocompromising conditions, severe obesity (body mass index ≥ 40), and liver disease [6]. Our observations are consistent with other reports [8], although we found that the presence of AKI or CKD is a very strongnegative prognostic factor in our COVID-19 population.

The incidence of AKI was reported in 3–15% of patients with COVID-19; however, in patients with severe infection requiring intensive care, the rates of AKI were higher up to 15–80% [2, 9]. In other reports, the incidence of AKI ranges from 0.5–7.5% [6, 7]. However, the real incidence of AKI remains uncertain because of a lack of a clear definition of AKI and using different diagnostic methods in numerous studies. Serum creatinine levels and daily urine output are standard assessments of renal damage, but these parameters might be not sufficient for the diagnosis of AKI. Findings from different cohorts of hospitalized patients

showed that 26–63% of patients presented proteinuria at admission or developed proteinuria during their stay in hospital, proteinuria being considered the most recognized sign of kidney damage [3]. A higher incidence of proteinuria and hematuria was reported in patients with severe or critically ill COVID-19 pneumonia [7]. Another possible explanation of the high prevalence of kidney involvement at hospital admission is that some of the COVID-19 patients may already have had a history of CKD.

CKD was present in more than 20% of the deceased patients due to COVID-19 [1]. The significant association of CKD with severe COVID-19 infection was observed in the meta-analysis by Lippi [10] who has confirmed that CKD is associated with an enhanced risk of COVID-19 infection. This can be explained by the pro-inflammatory state and by the alterations of the innate and adaptive immune response associated with CKD, a profile increasing susceptibility to all infections [11]. It has been shown that a large part of COVID-19 patients suffers from other comorbidities and most of these patients are also elderly and males [12, 13]. Among these comorbidities, the presence of chronic kidney disease is an independent risk factor of poor prognosis, similarly to our findings. On the other hand, nephropathic patients are mainly affected by comorbidities, like hypertension and cardiovascular disease or diabetes, also considered as risk factors for COVID 19 infection and poor clinical outcome of SARS-CoV-2 infection [13].

Our study is limited mainly by single-center setting and retrospective observational character, also relatively small sample size. Importantly, we adopted diagnoses of comorbidities from medical records based on ICD-10 codes. Although our study is not representative for all COVID-19 patients in Poland, we assume that it is sufficient enough to generate important queries regarding the management of kidney complications and kidney-related prognosis of infected individuals.

Conclusions

In conclusion, renal impairment on admission as well as during hospitalization among patients with SARS-CoV-2 infection is a risk factor of negative prognosis. Therefore, we believe that careful monitoring of renal function, as well as, individualized fluid management is critical for kidney injury prevention, especially in patients with more serious infection and with more comorbidities.

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