Analysing COVID-19 treatment outcomes in dedicated wards at a large university hospital in northern Poland: a result-based observational study

Damian Krystian Palus, Martyna Ewa Gołbiewska, Olga Piątek, Krzysztof Grudziński, Alan Majeranowski, Radosław Owczuk, Krzysztof Kuziemski, Tomasz Stefaniak

ABSTRACT

Objectives Presenting outcomes of patients hospitalised for COVID-19 should be put in context and comparison with other facilities. However, varied methodology applied in published studies can impede or even hinder a reliable comparison. The aim of this study is to share our experience in pandemic management and highlight previously under-reported factors affecting mortality. We present outcomes of COVID-19 treatment in our facility that will allow for an intercentre comparison. We use simple statistical parameters—case fatality ratio (CFR) and length of stay (LOS).

Setting Large clinical hospital in northern Poland serving over 120 000 patients annually.

Participants Data were collected from patients hospitalised in COVID-19 general and intensive care unit (ICU) isolation wards from November 2020 to June 2021. The sample consisted of 640 patients—250 (39.1 %) were women and 390 (60.9 %) were men, with a median age of 69 (IQR 59–78) years.

Results Values of LOS and CFR were calculated and analysed. Overall CFR for the analysed period was 24.8 %, varying from 15.9 % during second quarter 2021 to 34.1 % during fourth quarter 2020. The CFR was 23.2 % in the general ward and 70.7 % in the ICU. All ICU patients required intubation and mechanical ventilation, and 44 (75.9 %) of them developed acute respiratory distress syndrome. The average LOS was 12.6 (±7.5) days.

Conclusions We highlighted the importance of some of the under-reported factors affecting CFR, LOS and thus, mortality. For further multicentre analysis, we recommend broad analysis of factors affecting mortality in COVID-19 using simple and transparent statistical and clinical parameters.

INTRODUCTION

COVID-19 is an acute respiratory disease caused by SARS-CoV-2. The COVID-19 outbreak started in December 2019 in Wuhan, China, with its aetiological factor identified in January 2020.1 Rapid spreading of the SARS-CoV-2 virus caused a global pandemic, resulting, by the end of 2021, in more than 290 million infections and over 5 million deaths.2 Manifestations of SARS-CoV-2 infection are diverse, ranging from asymptomatic to severe pulmonary failure requiring intensive care. In Poland, the number of infected reached almost six million with over 100 000 deaths by July 2022.2 Poland implemented a variety of measures to manage the COVID-19 pandemic in 2020 and 2021. The first case of COVID-19 in Poland was confirmed on 4 March 2020. In March 2020, the government declared a state of emergency and implemented a nationwide lockdown. Social distancing measures were put in place, and wearing face masks in public was mandatory. These restrictions were gradually lifted in the summer of 2020, but were re-introduced in the fall as the number of cases began to rise again. Poland began the vaccination programme in December 2020, starting with healthcare workers (HCWs) and the elderly. Hospitals across Poland implemented various policies to cope with the pandemic, including creating dedicated COVID-19 wards, increasing the availability of personal protective equipment (PPE) and limiting visitations. The pandemic has put a significant strain on the healthcare system, leading to overcrowding in some hospitals and shortages of medical personnel and equipment.3

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study was set in a large clinical hospital serving over 120 000 patients annually.
⇒ A robust sample of 640 hospitalisations was used.
⇒ All analysed hospitalisations were resolved, that is, ended in either death or discharge.
⇒ This study was conducted at a single centre.
⇒ We relied on accurate recordkeeping and had no control over variables.


⇒ Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-066734).

KK and TS are joint senior authors.

Received 14 August 2022
Accepted 15 May 2023

© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to
Dr Martyna Ewa Gołbiewska; margol@gumed.edu.pl

© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.
As the pandemic continued in 2020 and 2021, an abundance of reports on COVID-19 treatment were being published with the outcomes varying between and within countries, as fatality ratios were calculated using crude methods.

For a meaningful intercentre comparison of outcomes, several statistical parameters and clinical metrics must be applied, such as case fatality ratio (CFR) and length of stay (LOS).

**Case fatality ratio**

CFR, which estimates the proportion of deaths from disease to confirmed cases of disease, is calculated using the following equation:

\[
\text{Case Fatality Ratio (CFR, in%) = \frac{\text{Number of deaths from disease}}{\text{Number of confirmed cases of disease}} \times 100}
\]

During an ongoing pandemic, using the equation above can cause an underestimate. It includes cases that are unreported at a given time (ie, neither died nor recovered). To present an accurate outcome, we applied a modified equation as follows:

\[
\text{Case Fatality Ratio (CFR, in%)} = \frac{\text{Number of deaths from disease}}{\text{Number of confirmed cases of disease} + \text{Number of recovered from disease}} \times 100
\]

During the initial stages of the pandemic, the modified equation could rarely be used, as live tracking of new cases and daily reports of treatment were of high priority. With the pace of the pandemic slowing down, a meaningful intercentre comparison of the effectiveness of treatment became possible. In case of the SARS-CoV-2 pandemic, CFR is difficult to measure because numerous undetected infections are excluded from statistics. Mortality is higher among hospitalised patients, with outcomes varying between regions and countries. WHO estimates COVID-19 global mortality to be about 1.1%. In Poland, the CFR value in hospitalised patients was estimated to be 18.4%, in other countries it varied from 0.1% to 25%. CFR varied during each wave of pandemic. Analysis of more than 500,000 patients admitted to 209 hospitals in the USA showed that CFR varied across the year 2020, reaching 10.6% in March, peaking at 19.7% in April, before dropping to 9.3% in November. Similar mortality shifts were observed in other countries, where CFR fluctuated, yet steadily increased with subsequent waves of COVID-19. Fatality ratios were affected by quality of healthcare, access to therapeutic options (as new treatments such as antiviral drugs and convalescent plasma were introduced as a standard of care at separate times), and environmental, financial, and social conditions at any given time. This is supported by evidence of intranational variations of mortality between centres with different standards of care. Additionally, admission criteria for patients with COVID-19 frequently changed during the subsequent waves of the pandemic along with the percentage of critically ill patients, which further affected CFR. Discharge criteria affected mortality too.

Patients often required prolonged hospitalisation after having met the COVID-19 discharge criteria (eg, oxygen saturation ≥94%) due to comorbidity and complications. The pandemic resulted in a financial burden for hospitals, and mental and physical exhaustion of HCWs. In some instances, personnel intentionally delayed discharge to avoid a new admission, as new admissions of unknown stability seemed more cost-effective and less risky.

**Length of stay**

LOS helps to evaluate patient flow, bed occupancy rate and hospital efficiency. Several factors affect in-hospital CFR. Most well documented are demographics (male gender, older age), obesity, comorbidity, complications, type of treatment and biochemical prognostic factors such as inflammatory biomarkers. Furthermore, patients’ treatment limitations (PTL)—‘do not intubate’ (DNI) /‘do not resuscitate’ (DNR) orders that are determined in cooperation with patients and/or their loved ones, and followed by examination by an internal medicine specialist or anesthesiologist—are important predictive factors for mortality. Meta-analysis of published literature is now of limited use, as reports on demographics and treatment are heterogeneous. Parameters that are easy to standardise and enable comparison of group coherency in different centres are: (1) Age, (2) Sex and (3) Initial physical condition (ie, respiratory failure, acute respiratory distress syndrome (ARDS), intubation, mechanical ventilation or other invasive procedures).

To shed some light on differences in mortality outcomes, reports should include analysis of additional factors by region, country or facility, that is, financial, and organisational, gross domestic product (GDP) per capita, therapeutic options available, health system overload, HCWs’ availability, their experience and qualifications, as well as mental burn-out. To this day, these crucial factors have rarely been included in published research.

**Aim of the study**

The aim of this study is to present outcomes of COVID-19 treatment in our facility using simple and repeatable parameters enabling meaningful intercentre comparison. The retrospective design of this study allows us to discuss and understand some of the underexamined factors affecting mortality.

**METHODS**

**Background**

We conducted a retrospective analysis using observational data from the Hospital Episode Statistics data set for a large university hospital in northern Poland—the University Clinical Centre in Gdansk. Patients hospitalised in COVID-19 isolation wards between November 2020 and June 2021 were included. They were hospitalised in separate isolation wards each consisting of 25–75 beds (COVID-S), and in an isolated intensive care unit (ICU) of 4–12 beds (COVID-ICU). The number of beds...
available varied across the pandemic according to the number of new cases and requisitions from administrative authorities.

**Statistical analysis**

We used Airtable software to prepare an anonymised database consisting of patients’ (1) Age, (2) Sex, (3) Comorbidity, (4) LOS and (5) Outcome of hospitalisation. We estimated values of CFR by groups, wards and pandemic waves. We conducted descriptive and inferential statistical analysis using SciPy V.1.8.1, scikit-learn V.1.1.3 and pandas V.1.5.0 library for Python V.3.9, calculating means, medians, SD and IQRs in the sample, and data manipulation along with verifying statistical hypothesis description and correlations. Comparison groups were physically separate at distinct phases of the pandemic and the square variances of their CFRs were between 0.6 and 1.2. Thus, assumption about heterogeneity in variance allowed us to compare the CFRs between periods. We assumed that the power of z-test should be set to standard 0.8 and Cohen’s d not higher than 1.2 (which followed maximum variance for heterogeneity of the samples). For that assumption, our minimal sample size needed in each group is 11 observations (calculated as round of outcome 10.9012). 17

We used the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) cross-sectional checklist when drafting our report. 18

**Inclusion and exclusion criteria for subjects**

**COVID-S inclusion criteria**

1. Oxygen peripheral saturation (SpO2) <95% requiring supplemental oxygen.
2. Dyspnoea, severe cough, syncope, fatigue, diarrhoea with SpO2 ≥95%.
3. Complications of COVID-19 infection requiring hospitalisation with SpO2 ≥95%.
4. Maintaining continuity of medical care in patients who had tested positive for SARS-CoV-2 during hospitalisation in another ward.
5. Patients were ready for discharge from COVID-S ward when:
   1. There was no further need for supplemental oxygen.
   2. Ten days isolation ended, and oxygen therapy could be continued at home or in the pulmonary ward.
   3. Ten days isolation ended, and further medical care could be administered in the designated ward.

**COVID-ICU inclusion criteria**

For patients with confirmed COVID-19 requiring intubation, two out of the three criterions had to be met, including criterion number 3:

1. Aggravation of respiratory failure regardless of non-invasive ventilation methods as a result of
   a. SpO2 and partial pressure remaining persistently low, leading to retention of carbon dioxide and respiratory acidosis, or
   b. Intolerance to ventilation, that is, acute dyspnoea, increased breathing effort, anxiety with poor response to pharmacotherapy.
2. Surgery, injury or cardiopulmonary resuscitation requiring intubation.
3. Patient required intensive care and could benefit from hospitalisation in ICU as determined by an anaesthesiologist according to national guidance. 16

Early phase postmyocardial infarction patients, patients after ischaemic stroke and gastrointestinal haemorrhage, as well as patients requiring dialysis or administration of pressor amines were not admitted to COVID-ICU, unless they required intubation and mechanical ventilation. Instead, they were treated in COVID-S. Advanced metastatic cancer and DNI/DNR order disqualified patients from transfer to ICU.

Patients were ready for discharge from COVID-ICU:

1. After discontinuation of mechanical ventilation, or
2. If further medical care could be continued in COVID-S or pulmonology ward.

**Exclusion criteria**

We excluded subjects with confirmed SARS-CoV-2 infection:

1. Whose LOS, after having met the discharge criteria, was prolonged due to non-medical issues that is, administrative and socioeconomic; or
2. Who were admitted to the COVID-19 ward to undergo medical procedures impossible to conduct in other wards due to public health hazard (ie, radiotherapy, chemotherapy).

We included deaths up to 8 weeks after discharge, when cause-and-effect relationship applied. We analysed only resolved cases, that is those ending in discharge or death.

**Patient and public involvement**

Patients or the public were not involved in our research.

**RESULTS**

Between November 2020 and June 2021, 664 patients were hospitalised in COVID-19 wards in our facility. After applying the exclusion criteria, 640 patients were included in the analysis.

The median age was 69 (IQR 59–78) years. There were 390 (60.9%) men with a median age of 68.5 (IQR 56–76) years and 250 (39.1%) women with a median age of 71 (IQR 60–82) years. The overall CFR was 24.8% (n=159). It was higher in COVID-ICU than in COVID-S: 70.7% (n=41) vs 23.2% (n=144), respectively. The median age of in-hospital deaths was 75 (IQR 68–84) years and 67 (IQR 55–75) years for the discharged. There were 93 deaths among men and 66 among women, corresponding to 58.5% and 41.5% of admissions, respectively (p=0.4657).

Intrahospital general CFR decreased across the first and second quarters of 2021, reaching 15.9% in the second quarter of 2021. A similar decrease was observed
within COVID-S and COVID-ICU populations as shown in table 1. Among those hospitalised in COVID-ICU, 75.9% developed ARDS. All (100%, n=58) of the subjects admitted to COVID-ICU required intubation and mechanical ventilation.

Average LOS was 12.6 (± 7.5 SD) days, 11.5 (± 7.3) days in the COVID-S ward and 8.2 (± 6.4) days in the COVID-ICU ward. The full distribution of quantitative variables is summarised in online supplemental table 1.

We compared three quarters of 2020 and 2021, since the minimal probe for the third quarter of 2020 was not obtained. We used z-test deaths’ proportion comparison, since the probes were greater than 30 and the proportion of squares of SD within the quarters was between 0.6 and 1.2, which is appropriate for heterogeneity of independent samples (see online supplemental table 2). Proportions of deaths for the first quarter of 2021 (1Q21) and 2Q21 were not statistically different. Proportions of deaths for 1Q21 and 4Q20 for 2Q21 and 4Q20 were statistically different. The same comparisons were calculated for proportions of deaths for COVID-S (see online supplemental table 3) and COVID-ICU (see online supplemental table 4). Proportions of CFR between wards within periods as seen in online supplemental table 5 indicates that CFR values for COVID-ICU wards differed, compared with CFR for COVID-S and in total.

Values of CFR in COVID-S and COVID-ICU compared with periods indicated only one difference in CFR in the COVID-S ward, that is, between 1Q21 and 2Q21. Also, CFR of 1Q21 differed compared with whole analysed periods as shown in online supplemental table 6. CFR between all periods in the COVID-ICU ward showed no difference (see online supplemental table 7).

**DISCUSSION**

**Mortality**

Perception of the COVID-19 pandemic is shaped by fatality rate presented as the number of deaths. This crude measure can hardly be used to assess the severity of an epidemic, nor to compare its size and outcomes in an intercentre analysis. In this study, CFR in COVID-19 dedicated wards in the University Clinical Centre in Gdansk, Poland was estimated to be 24.8%. In-hospital mortality reported in Poland ranged from 1.38% to 34.9%, depending on the publishing author (see table 2).

Inconsistency between the reported outcomes arises from factors such as the phase of the pandemic, standard of care at the time, sample size, and demographics. Differences in methods and data sources used by researchers also affect these estimations. Published reports on in-hospital mortality based on electronic health records (EHRs), unlike statistical registries, correspond with our outcomes, with mortality ranging from 18.8% to 34.9%.

Published reports based on large administrative registries show general CFR ranging from 15.8% in the USA, 18.4% in Poland and 23.3% in the Republic of South Africa, to 26.6% in the UK. Meta-analysis evaluating

Table 1 Case fatality ratio (CFR) in patients with COVID-19 by wards across the pandemic

<table>
<thead>
<tr>
<th>Pandemic phase</th>
<th>All COVID CFR (deaths/cases, n)</th>
<th>COVID-S CFR (deaths/cases, n)</th>
<th>COVID-ICU CFR (deaths/cases, n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020-Q4 to 2021-Q3</td>
<td>24.8% (159/640)</td>
<td>23.2% (144/620)</td>
<td>70.7% (41/58)</td>
</tr>
<tr>
<td>2021-Q3</td>
<td>28.6% (2/7)</td>
<td>33.3% (2/6)</td>
<td>50% (1/2)</td>
</tr>
<tr>
<td>2021-Q1</td>
<td>21.9% (61/278)</td>
<td>19.4% (52/268)</td>
<td>72.7% (16/22)</td>
</tr>
<tr>
<td>2021-Q2</td>
<td>15.9% (22/138)</td>
<td>14.9% (20/134)</td>
<td>58.3% (7/12)</td>
</tr>
<tr>
<td>2020-Q4</td>
<td>34.1% (74/217)</td>
<td>33.0% (70/212)</td>
<td>77.3% (17/22)</td>
</tr>
</tbody>
</table>

n, number of patients.

Table 2 In-hospital mortality reports for the Polish population of SARS-CoV-2-positive patients. Primary sources include institutional databases and electronic health records (EHRs). Secondary data are collected from original sources—administrative databases and statistical registries.

<table>
<thead>
<tr>
<th>Author(s) and year</th>
<th>Sample (n)</th>
<th>Mortality (%)</th>
<th>Phase of the pandemic (Waves I–III)</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gujski34</td>
<td>1557</td>
<td>1.38%</td>
<td>March 2020 (I)</td>
<td>Primary</td>
</tr>
<tr>
<td>Kanecki20</td>
<td>8252</td>
<td>13%</td>
<td>February to September 2020 (I)</td>
<td>Primary</td>
</tr>
<tr>
<td>Gogolewski38</td>
<td>28 769</td>
<td>16.9%</td>
<td>March to September 2020 (I–I)</td>
<td>Primary</td>
</tr>
<tr>
<td>Gujski6</td>
<td>116 539</td>
<td>18.4%</td>
<td>March to December 2020 (I–II)</td>
<td>Primary</td>
</tr>
<tr>
<td>Flisiak36</td>
<td>5199</td>
<td>9.2%</td>
<td>March 2020 to June 2021 (I–III)</td>
<td>Primary</td>
</tr>
<tr>
<td>Kowalska35</td>
<td>2830</td>
<td>11.5%</td>
<td>March to June 2020 (I)</td>
<td>Primary</td>
</tr>
<tr>
<td>Nowak37</td>
<td>169</td>
<td>26.3%</td>
<td>March to April 2020 (I)</td>
<td>Secondary</td>
</tr>
<tr>
<td>Obremska19</td>
<td>129</td>
<td>34.9%</td>
<td>March to July 2020 (I)</td>
<td>Secondary</td>
</tr>
<tr>
<td></td>
<td>497</td>
<td>29%</td>
<td>October to December 2020 (II)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>239</td>
<td>18.8%</td>
<td>June to August 2020 (I)</td>
<td></td>
</tr>
</tbody>
</table>
33 observational studies with a total sample of 13 398 patients, with 45% of Chinese nationality, showed general mortality of 17.1%, with 11.5% in general COVID wards and 40.5% in ICUs.21 Globally, CFR fluctuated across subsequent waves of the pandemic. In March 2020, CFR in the UK was estimated to be 34%, before declining to 12% by September 2020, following a reduction in the number of new COVID-19 cases.22 In the Republic of South Africa, the general CFR was estimated to be 23%, with peaks of 21.8% and 29.3% during the first and second waves, respectively.7

Our outcomes show a similar declining trend across the pandemic with a CFR of 33.8% in the second wave (November–December 2020) and 19.9% in the third wave (January–May 2021). Unlike in many published reports, we did not observe increased mortality during the third wave of the pandemic, when the Polish healthcare system was most overwhelmed. A steadily declining CFR trend throughout the waves was observed among patients with COVID-19 hospitalised in our facility.

In Poland, mortality in the COVID-19 patient population varied significantly between general wards and ICUs. In the Polish population, 4.9% of all SARS-CoV-2-positive patients required intensive care,6 while in our facility 9% of patients with COVID-19 were admitted to COVID-ICU. From March 2020 to May 2021 the general CFR was estimated to be 24.8% in COVID-S and over 70% in ICU. In the second wave CFR was 33.8% and 78.3% in COVID-S and ICU, respectively, while in the third 19.5% and 65.7%. Estimated CFR for COVID-S wards in the UCC correspond with published reports, however, CFR for our ICU is significantly higher.

Mortality indicators for ICUs vary locally, by region and by country. A French study on mortality during the early phase of the pandemic showed a CFR of 31.3% in the ICU.23 Research based on the Belgian administrative registry from the first wave (March–August 2020) showed a CFR of 36.1%.24 Similarly, Italian researchers reported a CFR of 26% in ICUs, however 58% of the hospitalisations were of unknown outcome.25 A New York study of 257 ICU patients reported a CFR of 39%, although non-resolved cases were included. Moreover, only 79% of patients required mechanical ventilation, indicating a less restrictive admission criteria than in Poland, or a distinct work organisation in COVID-19 wards.25 British cohort studies reported a CFR of 31% in COVID-19 ICUs,27 while broadscale analysis of French ICUs during the first wave of the pandemic revealed mortality ranging from 17.6% to 33.5%, depending on the region. In France, at that time, only 68.1% of COVID-ICU patients required mechanical ventilation.28 Sharma et al reported mortality in the ICU to be over 54% in general, 70.9% among intubated and 22% among those who did not require intubation.28 Therefore, characteristics of admission criteria and the percentage of ICU patients requiring intubation is a crucial factor affecting mortality. In one study, with a total sample size of 14 513 patients with COVID-19, only 68% required mechanical ventilation in the ICU.27 Admission criteria were far less restrictive than in our facility. In our sample, 100% of COVID-ICU patients required invasive mechanical ventilation, as it was synonymous to meeting admission criteria.

The proportion of patients meeting admission criteria for COVID-ICU is another significant indicator affecting mortality in patients with COVID-19. In the published research we found values of 14% in Belgium,51 10% in Brittany and up to 42% in the Paris region in France.27 In our facility 9% of patients with COVID-19 were eligible for ICU admission—more than in Poland on average. Outcomes presented in British papers link higher ICU admission to lower mortality.31 With limited capacity in ICUs in Poland, a smaller proportion of patients with COVID-19 were transferred to the ICU. In our hospital, limited COVID-ICU bed capacity demanded restrictive admission criteria, which could lead to higher in-hospital mortality. Patients eligible for admission to ICU were initially in a critical condition.

ARDS in COVID-19

Diagnosis of ARDS is a significant factor predicting death in patients with COVID-19 in ICUs. Mortality associated with COVID-19-related ARDS reaches 68%, compared with 42% in ARDS of different aetiology. Older age is associated with higher mortality in patients with COVID-19 who developed ARDS, reaching 85% in populations over 70 years old.29 We have established ARDS diagnosis in 75.9% of patients with COVID-19 in the COVID-ICU. High prevalence of ARDS was due to the advanced stage of the disease at the moment of qualification to ICU, and was also associated with higher mortality in this population. In one retrospective study analysing over 4000 patients with COVID-19, the authors found that among 31.5% of patients who developed ARDS, 59.3% died. Overall mortality was 28%, of which 42.4% died in the ICU or high-dependency unit. Of those who required mechanical ventilation, 45.7% died. Mortality in patients requiring vasopressor agents was 51.7%, in patients requiring haemodialysis 67.2%, and in those requiring non-invasive ventilation 45.8%.29 In our facility, 75.9% of intubated and ventilated patients developed COVID-19-related ARDS, leading to high mortality in ICU. As management and demography of ICUs and high-dependency care units vary by country, intercentre comparison of treatment outcomes is difficult. Methods applied by researchers, as shown in a cited study that merges outcomes from ICUs and high-dependency units together, can further distort the comparison.30

LOS versus mortality in COVID-19

In-hospital mortality measures depend on discharge criteria and length of hospitalisation. A delayed discharge of patient deemed medically fit to leave hospital leads to bed-blocking. In estimates of in-hospital CFR, prolonged hospitalisations reduce denominator value of number of hospitalised cases, affecting numerator describing death prevalence, causing an underestimate. Increase
in numerator value results from an intensive turnover of patients in acute stage of COVID-19 with unpredictable course of a disease.

From November 2020 to June 2021, LOS of over 14 days occurred in 32.2% of patients with COVID-19 in our facility, and 12.5% of hospitalisations lasted over 21 days (excluding deaths). It suggests high patient turnover—a desired response to an overwhelmed healthcare system and demand for healthcare. In Poland, the average LOS during the first and second waves of COVID-19 was 8.8±9.4 days.6 Another Polish analysis determined a mean LOS to be 11.9±8.9 days, and reported a decreasing trend (13.0±10.5 days in the beginning and 11.1±7.5 days during the later stages of the pandemic).31 In our facility, average LOS was 13.1±7.1 days. Heterogeneity of these values implies a necessity to use non-parametrical tests to describe the phenomenon.

**Other factors affecting mortality in COVID-19**

Reports on COVID-19 treatments in Central and Eastern Europe (CEE) are scarcely presented in published studies. Despite social and economic progress over the last decades, CEE healthcare systems still lack innovation and funds compared with western Europe. COVID-19 treatment outcomes differ not only by phase of pandemic and by country, but also locally by region. Analysis of statistical data provided by European countries during the first wave of the pandemic proved a link between high cause-specific mortality rate associated with cancer, cardiovascular and respiratory diseases, and increased CFR of COVID-19. CFR was positively associated with population size, the share of the population over 70, GDP per capita, health expenditure and, surprisingly, level of democracy. A negative association was found between CFR and number of hospital beds. Other factors increasing CFR were prevalence of smoking and air pollution.16 This study used primary data, and the results imply a disproportion in the quality of gathering and reporting data between developed and developing countries. Other researchers emphasise PTL as a commonly ignored group of factors affecting death risk in COVID-19.15

Another aspect playing a key role in providing high quality of care is the mental condition of HCWs. Prevalence of burn-out among HCWs in the COVID era was broadly discussed in recent publications.32 In the early phase of the pandemic, HCWs faced unprecedented mental and physical challenges, caused by exceptionally high mortality among patients, pathogen exposure and risk of infection, the ever-changing protocols of care and shortage of PPE. Introduction of the national vaccination programme in Poland in December 2020 led to a slow and steady drop in the number of new cases on one hand, but at the same time caused an influx of unvaccinated patients with unpredictable course of disease, straining the already exhausted HCWs. Many of the HCWs were interns and resident doctors, more prone to burn-out than their older colleagues.33 In our facility, compensatory measures were introduced by re-distribution of staff and equipment, frequent shift and personnel changes, and adequate compensation for HCWs.

Lastly, socioeconomic status and social support related factors affected patients with COVID-19 during and after hospitalisation. In our experience, families of patients discharged home from COVID wards were reluctant to cooperate due to fear of infection, however their attitude changed when the patient was transferred to a non-COVID ward even for 24 hours before discharge.

Published reports worldwide rarely show the big picture and sum up the simplest outcomes of COVID-19 treatments. These basic measures are imperative in a comprehensive and thorough assessment of COVID-19 wards worldwide in both the clinical and organisational contexts. Broad analysis of causes of public health failures is strictly related to treatment outcomes in each facility, region or country and is more than just dissimilarity between patient characteristics, organisation and infrastructure.

**Limitations of the study**

This is a single-centre, retrospective, observational study, which aims to provide insight into the transparent evaluation of outcomes of the treatment of COVID-19 at the hospital level. Our sample was robust, however ethnically homogenous. We relied on accurate recordkeeping when using EHRs and had no control over variables. The discrepancies of the definition of ‘intensive’ COVID-19 treatment and presentation of the ICU group are significant among authors and diminish generalisation of the study results.

**CONCLUSION**

In our study CFR and LOS were influenced by previously under-reported factors, such as admission criteria for ICU, patient treatment limitations, mental condition of HCWs and the double-edged effect of the national vaccination programme. Therefore, we highlighted an issue with previously reported intercentre analyses. We conclude that our interventions aiming to reduce burn-out of HCWs influenced mortality and should be considered as a meaningful intervention to increase resilience of our institution for future healthcare crises. We recommend using simple statistical parameters and broad analysis of factors affecting mortality in COVID-19 for meaningful intercentre comparisons.

**Author affiliations**

1Faculty of Medicine, Department of Hypertension and Diabetology, Medical University of Gdansk, Gdansk, Poland
2Faculty of Medicine, Department of Psychiatry, Medical University of Gdansk, Gdansk, Poland
3Faculty of Medicine, Department of Pulmonology and Allergology, Medical University of Gdansk, Gdansk, Poland
4Faculty of Medicine, Department of Gynecology, Obstetrics and Neonatology, Medical University of Gdansk, Gdansk, Poland
5Independent researcher, Gdansk, Poland
6Department of Hematology and Transplantology, Faculty of Medicine, Medical University of Gdansk, Gdansk, Poland
Contributors DKP collected the data, designed methodology, wrote the initial draft and revised the manuscript. DKP is responsible for the overall content as guarantor. MEG collected and analysed the data; verified, revised, and translated the manuscript. KG performed statistical analysis. OP collected and analysed the data. AM provided commentary for the paper. RO provided commentary and revised the paper. KK initiated, managed, and supervised the project and revised the paper. TS initiated, planned, and supervised the project, drafted, and revised the paper, and monitored data collection. All authors reviewed the manuscript and accepted its final version for submission.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study was approved by the Independent Bioethics Committee for Scientific Research at Medical University of Gdansk (Ref. No NKBBN/327/2022).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been vetted by any other organization. The content is therefore provided on a ‘not for profit’ basis only, and BMJ and any other organisations no longer have any further rights to use or control copyright of any kind in the work.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID iD Martyna Ewa Gołąbiewska http://orcid.org/0000-0003-3820-487X

REFERENCES


