Long-Term Trends in Intensive Care Unit Hospitalizations in Poland: Study Based on the National Hospital Registry, 2012-2021

Keywords
In-hospital fatality, ICU fatality, nationwide registry, general ICUs, critical care service

Abstract

Introduction
Intensive care unit (ICU) hospitalizations are one of major burdens on the healthcare system, and they may be related to high risk of in-hospital fatality. The aim of the study was to describe long-term trends in ICU hospitalizations and related fatality rates in Poland.

Material and methods
Our study is a population-based study based on 738,579 ICU hospitalization records in 2012-2021.

Results
Based on the hospital registry and data on general population, the mean annual ICU hospitalization incidence was estimated at 1.9 per 1,000 (SD: 0.18) and a significant increase trend in hospitalizations was observed from 1.6 per 1,000 in 2012 to 2.2 per 1,000 in 2021, P<0.005. We observed a significant predominance of male patients (56.6% P<0.001) in the study group when compared to general population. The mean and median age in the study group were 61.6 (SD: 18.2) and 65 years (IQR: 53-74), respectively. The trend in fatal hospitalizations increased significantly from 37.7% in 2012 to 46.5% in 2021, P<0.05. However, the trend in fatal hospitalization rates during the ICU stay increased significantly from 31.2% in 2012 to 42.5% in 2021, P<0.01. The mean length of ICU stays increased from 8.7 in 2012 to 10.1 days in 2021, P<0.001.

Conclusions
The paper presents the recent trends in quantitative and qualitative changes in ICU hospitalizations in Poland. The presented data may be the basis for comparative analyzes in a global context. Reported data may indicate the need to perform adaptive systemic changes to improve health care.

Title: Long-Term Trends in Intensive Care Unit Hospitalizations in Poland: Study Based on the National Hospital Registry, 2012-2021

Short Title: Long-Term Trends in Intensive Care Unit Hospitalizations in Poland

INTRODUCTION Intensive Care Unit (ICU) hospitalizations may be one of major burdens on the healthcare system. Eligibility criteria for ICU treatment are well defined in most cases, but in practice, the number of hospitalizations in ICUs may differ considering such factors as financial resources, human resources, medical resources, organization of the country's health care, and other additional factors. In a study from USA, based on hospital discharge data in the State Inpatient Database for Maryland and Washington States, the proportion of hospitalized patients admitted to an ICU across hospitals ranged from 3 to 55 percent [1]. Hospitalizations in the ICUs concern emergencies associated with a sudden threat to health or life. Respiratory failure was reported to be one of the most common reasons for ICU admissions and hospitalizations [2]. Another study revealed the incidence of sepsis in ICUs at 58 per 100,000 person-years, 41.9% of whom died in hospital [3]. Factors that were important for the prognostic outcome of sepsis in patients hospitalized in ICUs include gender, and selected clinical factors and diseases [4].

High mortality rates were reported to be related to ICU care, being 19.0% in the hospital and 21.7% within 6 months [5]. ICU readmission was associated with an increased severity of illness scores during the same hospitalization in adult patients [6]. Another study based on large data of 77,132 ICU survivors reported that 89% of patients returned home, but after 1 year, 77% of patients were still at home and 17% of them had died [7]. Compared to non-ICU patients, ICU patients showed an increased hospital length of stay and mortality. ICU patients were more frequently readmitted to hospital than controls, and mortality up to 1 year in this group was also higher in ICU patients [8]. Compared with late readmission, early readmission was associated with decreased mortality [9]. Readmission to the ICU during the same

hospitalization may not be a rare problem. In a study from Brazil, out of 5,779 ICU patients, (10%) were readmitted to the ICU during the same hospitalization [10]. A significant proportion of patients hospitalized in ICUs died during hospitalization. Infection at ICU discharge, ICU readmission, age, length of hospital stay, and higher SAPS III values increased the risk of death in ICU survivors [11]. ICU and in-hospital mortality may be reported with considerable heterogeneity. In one study mortality of older patients (≥75 years old) admitted to ICU ranged from 1% to 51%, in-hospital mortality from 10% to 76% [12]. In a study from India, the most common cause of death among elderly patients was found to be sepsis, followed by pneumonia [13]. In another report, end-of-life care expenditures for the older population with cancer were highly concentrated until the last month [14]. Hospitalizations in ICUs involve costs of care during hospitalization and may be related to costs of post-hospital care. Critical care survivors had greater 1-year post-discharge healthcare resource utilization than non-critical inpatients, including 68% of those with longer hospital stays [15]. In a recent study including data on 19,119 older adults aged 65 years or more who had received high-intensity care at least once and died in the intensive care unit in South Korea, the annual cost of high-intensity care at the end of life increased steadily from 2016 to 2019 [16]. In Poland, there are uniform ICU qualification criteria recommended by the Polish Society of Anaesthesiology and Intensive Therapy (PTAiIT). Guidelines for ICU admission in Poland in the form of priorities were first published in 2012 [17], and recently modified [18].

AIM OF THE STUDY There is limited information on ICU hospitalizations in Poland based on a nationwide database registry [19], [20]. The aim of the study was to describe long-term trends in ICU hospitalizations and related fatality rates in Poland.

MATERIAL AN METHODS Our study is a population-based, retrospective analysis of hospital discharge records of patients hospitalized, and these hospitalizations included a stay or stays in ICUs. Data were obtained from the National Institute of Public Health, National Institute of Hygiene – National Research Institute in Warsaw, and they covered the period from 2012 to 2021. All hospitals in Poland, except psychiatric facilities, are legally required to send discharge data to the Institute. The data are anonymous and include information on hospitalizations, dates of admission and discharge, sex, date of birth, and place of residence. The hospital morbidity database used in this study was previously prepared and cleaned by NIZP - PZH as part of its statutory activities, and no other exclusion criteria were specified in our study . In 11557 hospitalization records (1.6% of all records) inaccuracies or lack of data were noticed when reported the patient's place of residence. In 971 hospitalization records (0.1% of all records) inaccuracies or lack of data were noticed when reported the date of birth or age. These records were not included in the process of identifying whether the reported hospitalization was the first or subsequent one. The inclusion criterion was a stay in the ICU (the department code - 4260) for the entire period or part of the hospitalization. Records were excluded if a patient was hospitalized in the cardiology ICU department (the code - 4106). Other studies also separated cardiovascular and medical ICUs [21], [22]. Information on the study presented in this paper was submitted to the local bioethics committee.

To perform most statistical analyses, Statistica (TIBCO Software Inc, version 13) [23] and WINPEPI [24] were used. For continuous variables means, SD, medians and IQR were computed, respectively. For nominal variables, counts and percentages were analyzed. The data were anonymised but date of birth, place of residence and gender were the basis for estimating annual frequencies of hospitalization. Data from the Statistics Poland (national

census) were used as denominators [25]. To assess trends, linear regression was used. The trend analysis included the numerical values of events as a dependent variable and the size of a specific population in a each year of the study period as an independent variable. In the case of selected variables such as age, length of stay (LOS), a trend analysis in linear regression was performed based on average values calculated for each year in the study period. A two-sided p-value lesser than 0.05 was considered to be statistically significant.

RESULTS

THE STUDY GROUP The study was based on 738,579 hospital discharge records of patients hospitalized including stay in ICUs in Poland in 2012-2021. In the analyzed period, one hospitalization was reported in 87.6% of patients, two separate hospitalizations were found in 8.5% of patients, three hospitalizations were reported in 1.4% of patients. During the study period, one ICU stay during one hospitalization was recorded in 94.5% of cases, and two ICU stays in one hospitalization were observed in 5.2% of hospitalization cases.

AGE AND SEX In the study group, a significant predominance of male patients was observed: 417,987 males (56.6%) and 320,568 females (43,4%), $P<0.001$, as compared to the sex distribution in general Polish population. In 24 hospitalization records sex was not reported as male or female. The mean and median age in the study group was 61.6 years (SD: 18.2) and 65 years (IQR: 53-74 years), respectively. A significantly increasing trend of mean age was observed during the study period from 60.4 (SD: 18.7) years in 2012 to 62.2 (SD: 17.4) years in 2020 and 61.9 (SD: 16.9) years in 2021, R2=0.84, $P<0.001$.

LENGHT OF STAY The mean and median LOS in hospitalization records were 18.17 (SD: 22.6) and 11 (IQR: 5-22) days, respectively. We did not observe significant changes in the LOS trend during hospitalizations in the study period. The mean and median LOS calculated only for ICU stay were 9.42 (SD: 16.6) and 3 (IQR: 1-11) days, respectively. A significantly increasing trend of mean length of ICU stay was observed during the study period from 8.7 days in 2012 to 10.1 days in 2021, R2=0.92, P<0.001. During the study period, the maximum hospital stay ranged from 477 days in 2015 to 771 days in 2012, and the maximum ICU stay during hospitalizations ranged from 447 days in 2015 to 670 days in 2012. The overall percentage of patients stayed in the ICUs for 10 or more days was 27.8%. LOS was not reported in 303 hospitalization records.

HOSPITALIZATION RATES AND IN-HOSPITAL FATALITY RATES Based on the study data, annual information on the number of hospitalizations, percentage of male patients, hospitalization rates, hospitalization fatality rates, fatality and fatality rates during the ICU stays are presented in Table 1. Using data from the hospital registry, the mean annual hospitalization incidence was estimated to be 1.9 per 1,000 hospitalizations (SD: 0.18) and the trend was significantly increasing during the study period from 1.6 per 1000 in 2012 to 2.2 per 1000 in 2021, R2=0.69; P<0.005. During the 2012-2021 period, the mean annual rate of fatal hospitalizations, including the ICU stay, accounted for 38.4% (SD: 3.3). The trend in fatal hospitalizations increased significantly from 37.7% in 2012 to 46.5% in 2021, R2=0.44, P<0.05. Similarly, in the years 2012-2021, the mean annual rate of fatal ICU stay accounted for 32.8% (SD: 4.0) The trend in fatal hospitalization rates during the ICU stay increased significantly from 31.2% in 2012 to 42.5% in 2021, R2=0.59, P<0.01. In the years 2012-2021,

the mean annual rate of fatal ICU stay equal or longer than 10 days accounted for 10.3% (SD: 2.0). The trend in these fatal hospitalization rates during the ICU stay increased significantly from 9.1% in 2012 to 15.4% in 2021, R2=0.72, $P<0.005$. Hospitalization incidence rates per 1,000 by age range were presented in Table 2. In 2021, compared to 2012, an increase in the frequency of hospitalizations was observed in most cases, except for patients aged 0-19 and patients over 80 years of age. Fatality rates during ICU stay by age range were presented in Table 2. In 2021, compared to 2012, an increase in the frequency of hospitalizations was observed in most cases, except for patients aged 0-14.

DISCUSSION

TRENDS IN INTENSIVE CARE UNIT HOSPITALIZATIONS Based on the hospital registry, the mean annual hospitalization incidence was estimated to be 1.9 per 1,000 and this rate seems to be relatively low in comparison to data from other countries. In a large study from Denmark, the number of ICU patients per 1000 person-years for the 5-year period was 4.3 patients, and it ranged from 3.7 to 5.1 patients per 1000 person-years in the five regions of Denmark, and from 2.8 to 23.1 patients per 1000 person-years in the 98 municipalities [26]. In a study from Korea based on ICU admissions from August 2009 to September 2014, the ICU admission rate was 744.6 per 100,000 person-years (869.5 per 100,000 person-years in men and 622.0 per 100,000 person-years in women) [27]. Significant predominance of male patients was also observed in our study as presented in Table 1. In another study on 1425 patients, 780 (54.7%) were males [28].

The study presented in this paper showed a statistically significant increasing trend in the frequency of hospitalizations as presented in Table 1. The growing trend in hospitalizations may result both from the organization of health care or the aging of the Polish population [29]. The elderly were the main groups hospitalized in ICUs as reported in Table 2. This may result both from the organization of health care and multi-morbidity among the elderly, which increases with age and increases the health needs of this group of patients. Hospitalization incidence rates per 1,000 by age range were presented in Table 2. In 2021, compared to 2012, an increase in the frequency of hospitalizations was observed in most cases, except for patients aged 0-19 and patients 80 and over 80 years of age. In a study from Texas, United States, which was based on ICU hospitalizations of patients with dementia aged 65 years or older, increasing comorbidity burden, rising severity of illnesses, and increasing use of health care resources were reported [30].

The mean age in our study was relatively high: 61.6 years and the trend of mean age was significantly increasing during the study period. Additionally, as it was shown in Table 1, in each year during the study period, male predominance was observed in the study group and among the total number of deaths, as well as deaths during the stay in the ICU. Data from another study on a large group of 223,129 patients admitted to ICUs in Australia and New Zealand showed a lower mean age of 59.2 years and 41.7% of female patients [31]. Older age and male sex were also reported to be the risk factor for ICU admission and death. In recent meta-analyses on 59 studies when hospitalized with COVID-19, men more often developed severe COVID-19 disease and more often required intensive care admission, ultimately resulting in death more often. Additionally

in this study it was reported that patients aged 70 years and above affected by COVID-19 were more often observed to have ICU admission and dying compared with patients younger than 70 years [32].

In other meta-analyses based on 229 studies comprising over 10 million patients it was reported that men had a higher risk for COVID-19 infection, hospitalization, disease severity, ICU admission and death [33].

In our study, the mean LOS was on a stable level with small fluctuations when analyzing the length of hospitalization stay. However, the mean ICU stay was increasing. The mean LOS seems to be long when compared to data from other countries. In one study on healthcare-associated infections in ICUs, the observed LOS was 11.66 days [34]. In another study on 108,302 ICU patients, the reported LOS was 9 days [8]. Yet another study from Australia and New Zealand showed the ICU LOS of 3.6 days [31]. Another study revealed the median ICU and hospital length of stay of 4 and 13days, respectively [27]. Long ICU stay comes with a significant financial burden. However, premature discharges appear to have a significant impact on mortality in the hospital care of critically ill patients [35].

In our study, the average percentage of patients staying in the ICUs for 10 days or more was 27.8% and it may be relatively high. In another study patients staying in the ICU for 10 days or more accounted for only 5% of all ICU patients. It was also highlighted that these patients' outcomes were markedly worse than the outcomes of patients staying in the ICU for less than 10 days [36]. LOS plays an important role not only in patients' outcomes. It should be highlighted that the economic burden on ICU-acquired pneumonia can mainly be related to an increased length of stay of surgical patients and patients with mid-range severity scores at admission [37].

In our study, during one hospitalization, one stay in the ICU was recorded in 94.5% of cases, and this may be related to the long ICU stay observed in our study. In the analyzed 10-year period of the study, not more than one hospitalization with ICU stay was found in 87.6% of patients, which can be considered a satisfactory result. It was reported that readmission to the ICU was associated with poor clinical outcomes, increased length of ICU and hospital stay, and increased costs. In one study based on data of 5,779 patients admitted to the ICU, 10% of patients were readmitted to the ICU during the same hospitalization [10]. In another study, in a year after the ICU care, 10% were readmitted to the ICU [5].

TRENDS IN IN-HOSPITAL AND ICU MORTALITY The study revealed a relatively high percentage of fatality for all hospitalizations and ICU stays, with predominance of male patients as reported in Table 1. In another study, hospital mortality among patients admitted to ICUs accounted for 19.0% [5]. In this study, women showed a significantly higher hospital mortality than men, which is opposite to the results obtained in our study. Furthermore, the mean and median ICU length of stay in this study were relatively low in comparison to our study and they accounted for 3.96 and 2.33 days, respectively. In a study from Korea, the overall in-hospital mortality was 13.8%. Among all Koreans, the ICU mortality rate was 102.9 per 100,000 person-years (122.5 per 100,000 person-years in men and 83.8 per 100,000 person years in women) [27]. In a recent study based on data of 500,124 patients admitted to ICUs, 420,187 (84%) persons survived to hospital discharge [38]. In another study, the overall mortality rate was reported to be 37.6%, and it was associated with the age of over 75 years, transfer from a medical ward, a communicable disease, and cardiovascular disease [28]. In yet another study, mortality among ICU patients was reported to be 18.5% [8].

Trends in fatal hospitalizations and fatal hospitalizations during ICU stay was significantly increased in the study period with more marked increase in 2020 and 2021 which may be related to the COVID-19 pandemic. In a recent meta-analysis, almost half of patients with COVID-19 receiving invasive mechanical ventilation died according to the reported case fatality rates (CFR), but the authors of the study reported that variable CFR reporting methods resulted in a wide range of CFRs across studies [39]. In another systematic review and meta-analysis, the pooled CFR of COVID 19 in hospitalized patients was 13.0% and the pooled CFR in patients admitted to ICUs was 37.0% [40]. Additionally, it may be supposed that many patients with COVID-19 required care in the ICU after the COVID-19 pandemic outbreak in Poland. In the retrospective cohort study of critically ill patients admitted to ICUs in Lombardy, Italy, with laboratory-confirmed COVID-19, the mortality rate and absolute mortality were high [41]. A precise explanation of the increase in mortality in the study group in Poland in 2020-2021 may require further focused research including commorbidities analyzes.

Table 2 and Table 3 showed hospitalization fatality rates and ICU fatality rates increased with age, with the highest fatality observed in the elderly. In comparison, the mean annual number of hospitalizations involving an ICU admission in a study covering hospitalizations of patients aged ≥65 years in New York City hospitals in 2000-2014decreased from 57,938 during 2000-2002 to 45,785 during 2012-2014. The proportion of hospitalizations involving an ICU admission in which in-hospital death occurred decreased from 15.9% during 2000-2002 to 14.5% during 2012-2014 [42]. In a study analyzing the outcomes of the very elderly patients (85 years old or older), the mortality rate was 81.7% and the rate of survival in intensive care units was low [43].

It is worth mentioning that in our study ICU fatality rates among children aged 0-14 years were observed to decrease in 2021 in comparison to 2012, as presented in Table 3. In a study from Korea, the overall mortality of critically ill children was 4.4% with a significant decrease in mortality from 5.5% in 2012 to 4.1% in 2018 (*P* for trend < 0.001), however, neonates and neonatal ICU admissions were excluded in the abovementioned study [44].

Despite the fact that overall ICU fatality rates were reported to be high, mortality rate in the subgroups of ICU patients with LOS ≥10 days was noticeably lower in comparison to total ICU stay fatality rates as reported in Table 1. This suggests that the initial condition of patients admitted to ICUs may be responsible for the high mortality rate among ICU patients.

ADVANTAGES AND LIMITATIONS OF THE STUDY The study used data from the national hospital morbidity register, which was not analyzed in relation to the reliability and consistency of the reported data. However, the legal obligation to report hospitalization data to the register, as well as legal regulations on data processing in relation to official statistics, may suggest high reliability and consistency of the data used. A comparison of our results with other studies and other health systems in the world is very difficult. Differences may result from many factors, such as healthcare organization, financing methods, admission criteria, training of doctors and nurses, cultural and ethical differences.

CONCLUSIONS The paper presents the latest trends in quantitative and qualitative changes in hospitalizations in non-cardiac ICUs. Among the observed trends, the growing trend of ICU hospitalizations and the trend of hospital deaths in ICUs should be given special attention. The presented data may be an important source for further analysis of changes in ICU hospitalization, and a basis for comparative analyzes in a global context. Furthermore, they may indicate the need to perform adaptive systemic changes to improve health care in Poland.

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CONTRIBUTION STATEMENT All authors conceived the idea for the study. All authors contributed to the design of the research. Paweł Goryński was involved in data collection. Krzysztof Kanecki, Piotr Tyszko, Paweł Goryński, Michał Rząd processed and analyzed the data. Krzysztof Kanecki, Katarzyna Lewtak edited the manuscript. All authors made a critical analysis of the article. All authors approved the final version of the manuscript.

REFERENCES

1. Seymour CW, Iwashyna TJ, Ehlenbach WJ, Wunsch H, Cooke CR. Hospital-level variation in the use of intensive care. Health Serv Res 2012; 47: 2060–2080.

2. Villgran VD, Lyons C, Nasrullah A, Clarisse Abalos C, Bihler E, Alhajhusain A. Acute Respiratory Failure. Crit Care Nurs Q 2022; 45: 233–247.

3. Fleischmann-Struzek C, Mellhammar L, Rose N, Cassini A, Rudd KE, Schlattmann P, et al. Incidence and mortality of hospital- and ICU-treated sepsis: results from an updated and expanded systematic review and meta-analysis. Intensive Care Med 2020; 46: 1552–1562.

4. Chen C, Wu X, Zhang W, Pu Y, Xu X, Sun Y, et al. Predictive value of risk factors for prognosis of patients with sepsis in intensive care unit. Medicine (Baltimore). 2023; 102: e33881.

5. Garland A, Olafson K, Ramsey CD, Yogendran M, Fransoo R. A population-based observational study of intensive care unit-related outcomes. With emphasis on post-hospital outcomes. Ann Am Thorac Soc 2015; 12: 202–208.

6. Wong EG, Parker AM, Leung DG, Brigham EP, Arbaje AI. Association of severity of illness and intensive care unit readmission: A systematic review. Heart Lung 2016; 45: 3-9.e2.

7. Martin GL, Atramont A, Mazars M, Tajahmady A, Agamaliyev E, Singer M, et al. Days Spent at Home and Mortality After Critical Illness: A Cluster Analysis Using Nationwide Data. Chest 2023; 163: 826–842.

8. de Lima VCBF, Bierrenbach AL, Alencar GP, Andrade AL, Azevedo LCP. Increased risk of death and readmission after hospital discharge of critically ill patients in a developing country: a retrospective multicenter cohort study. Intensive Care Med 2018; 44: 1090–1096.

9. Mady AF, Al-Odat MA, Alshaya R, Hussien S, Aletreby A, Hamido HM, et al. Mortality Rates in Early versus Late Intensive Care Unit Readmission. Saudi J Med Med Sci 2023; 11: 143–149.

10. Ponzoni CR, Corrêa TD, Filho RR, Serpa Neto A, Assunção MSC, Pardini A, et al. Readmission to the Intensive Care Unit: Incidence, Risk Factors, Resource Use, and Outcomes. A Retrospective Cohort Study. Ann Am Thorac Soc 2017; 14: 1312–1319.

11. E Silva LGA, de Maio Carrilho CMD, Talizin TB, Cardoso LTQ, Lavado EL, Grion CMC. Risk factors for hospital mortality in intensive care unit survivors: a retrospective cohort study. Acute Crit Care 2023; 38: 68–75.

12. Vallet H, Schwarz GL, Flaatten H, de Lange DW, Guidet B, Dechartres A. Mortality of Older Patients Admitted to an ICU: A Systematic Review. Crit Care Med 2021; 49: 324–334.

13. Prabhudev P, Ramamoorthi K, Acharya RV. A Clinical and Demographic Profile of Elderly (>65 Years) in the Medical Intensive Care Units of a Tertiary Care Center. Indian J Crit Care Med 2023; 27: 166–175.

14. Jo M, Lee Y, Kim T. Medical care costs at the end of life among older adults with cancer: a national health insurance data-based cohort study. BMC Palliat Care 2023; 22: 76.

15. Alsallakh M, Tan L, Pugh R, Akbari A, Bailey R, Griffiths R, et al. Patterns of Healthcare Resource Utilisation of Critical Care Survivors between 2006 and 2017 in Wales: A Population-Based Study. J Clin Med 2023; 12: 872.

16. Lee Y, Jo M, Kim T, Yun K. Analysis of high-intensity care in intensive care units and its cost at the end of life among older people in South Korea between 2016 and 2019: a cross-sectional study of the health insurance review and assessment service national patient sample database. BMJ Open 2021; 11: e049711.

17. Guidelines of the Polish Society of Anaesthesiology and Intensive Care specifying the qualification rules and criteria for admitting patients to the Departments of Anaesthesiology and Intensive Care - February 2012 [Article in Polish]. https://anestezjologia.org.pl/sites/scm/files/2022-02/priorytety_2.pdf Accessed on 03 September 2023.

18. PTAiIT guidelines specifying the qualification rules and criteria for admitting patients to the Departments of Anaesthesiology and Intensive Care [Article in Polish].

https://www.anestezjologia.org.pl/artykul/wytyczne-okreslajace-zasady-kwalifikacji-oraz-kryteria-przyjecia-chorych-do-oddzialow Accessed on 3 September 2023.

19. Weigl W, Adamski J, Goryński P, Kański A, Hultström M. ICU mortality and variables associated with ICU survival in Poland: A nationwide database study. Eur J Anaesthesiol 2018; 35: 949–954.

20. Weigl W, Adamski J, Goryński P, Kański A, Hultström M. Mortality rate is higher in Polish intensive care units than in other European countries. Intensive Care Med. 2017; 43: 1430–1432.

21. Bohula EA, Katz JN, van Diepen S, Alviar CL, Baird-Zars VM, Park JG, et al. Demographics, Care Patterns, and Outcomes of Patients Admitted to Cardiac Intensive Care Units: The Critical Care Cardiology Trials Network Prospective North American Multicenter Registry of Cardiac Critical Illness. JAMA Cardiol 2019; 4: 928–935.

22. Goldfarb M, van Diepen S, Liszkowski M, Jentzer JC, Pedraza I, Cercek B. Noncardiovascular Disease and Critical Care Delivery in a Contemporary Cardiac and Medical Intensive Care Unit. J Intensive Care Med 2019; 34: 537–543.

23. TIBCO Software Inc. Statistica (Data Analysis Software System), Version 13. http://statistica.io. 2017.

24. Abramson JH WINPEPI Updated: Computer Programs for Epidemiologists, and Their Teaching Potential. Epidemiol Persp. 2011; 8: 1.

25. Statistics Poland. https://stat.gov.pl; [Accessed on 04 February 2023].

26. Vestergaard AHS, Christiansen CF, Nielsen H, Christensen S, Johnsen SP. Geographical variation in use of intensive care: a nationwide study. Intensive Care Med 2015; 41: 1895–1902.

27. Park J, Jeon K, Chung CR, Yang JH, Cho YH, Cho J, et al. A nationwide analysis of intensive care unit admissions, 2009-2014 - The Korean ICU National Data (KIND) study. J Crit Care 2018; 44: 24–30.

28. Sadiq AM, Kilonzo KG. Pattern of diseases and clinical outcomes in medical intensive care unit at a tertiary hospital in northeastern Tanzania: A three-year retrospective study. PLoS One 2023; 18: e0282269.

29. National Population and Housing Census 2021 Population ageing in Poland in the light of the results of the 2021 Census. Statistics Poland. Warsaw 2023. Page 14. https://stat.gov.pl/download/gfx/portalinformacyjny/pl/defaultaktualnosci/6536/3/1/1/starzenie_sie_ludnosci_polski_nsp_2021.pdf. Accessed on 28 January 2024.

30. Oud L. Intensive Care Unit (ICU) - Managed Elderly Hospitalizations with Dementia in Texas, 2001-2010: A Population-Level Analysis. Med Sci Monit 2016; 22: 3849–3859.

31. Moran JL, Bristow P, Solomon PJ, George C, Hart GK, Australian and New Zealand Intensive Care Society Database Management Committee (ADMC). Mortality and length-of-stay outcomes, 1993-2003, in the binational Australian and New Zealand intensive care adult patient database. Crit Care Med 2008; 36: 46–61.

32. Pijls BG, Jolani S, Atherley A, Derckx RT, Dijkstra JIR, Franssen GHL, et al. Demographic risk factors for COVID-19 infection, severity, ICU admission and death: a meta-analysis of 59 studies. BMJ Open 2021; 11: e044640.

33. Pijls BG, Jolani S, Atherley A, Dijkstra JIR, Franssen GHL, Hendriks S, et al. Temporal trends of sex differences for COVID-19 infection, hospitalisation, severe disease, intensive care unit (ICU) admission and death: a meta-analysis of 229 studies covering over 10M patients. F1000Res 2022; 11: 5.

34. Gunasekaran S, Mahadevaiah S. Healthcare-associated Infection in Intensive Care Units: Overall Analysis of Patient Criticality by Acute Physiology and Chronic Health Evaluation IV Scoring and Pathogenic Characteristics. Indian J Crit Care Med 2020; 24: 252–257.

35. Rodríguez-Carvajal M, Mora D, Doblas A, García M, Domínguez P, Tristancho A, et al. [Impact of the premature discharge on hospital mortality after a stay in an intensive care unit]. Med Intensiva [Article in Spanish] 2011; 35: 143–149.

36. Iwashyna TJ, Hodgson CL, Pilcher D, Bailey M, van Lint A, Chavan S, et al. Timing of onset and burden of persistent critical illness in Australia and New Zealand: a retrospective, population-based, observational study. Lancet Respir Med 2016; 4: 566–573.

37. Ferrer M, Torres A. Epidemiology of ICU-acquired pneumonia. Curr Opin Crit Care 2018; 24: 325–331.

38. Hill AD, Fowler RA, Pinto R, Herridge MS, Cuthbertson BH, Scales DC. Long-term outcomes and healthcare utilization following critical illness--a population-based study. Crit Care 2016; 20: 76.

39. Lim ZJ, Subramaniam A, Ponnapa Reddy M, Blecher G, Kadam U, Afroz A, et al. Case Fatality Rates for Patients with COVID-19 Requiring Invasive Mechanical Ventilation. A Meta-analysis. Am J Respir Crit Care Med 2021; 203: 54–66.

40. Alimohamadi Y, Tola HH, Abbasi-Ghahramanloo A, Janani M, Sepandi M. Case fatality rate of COVID-19: a systematic review and meta-analysis. J Prev Med Hyg 2021; 62: E311–E320.

41. Grasselli G, Greco M, Zanella A, Albano G, Antonelli M, Bellani G, et al. Risk Factors Associated With Mortality Among Patients With COVID-19 in Intensive Care Units in Lombardy, Italy. JAMA Intern Med 2020; 180: 1345–1355.

42. Illescas AH, Kache PA, Whittemore K, Lucero DE, Quinn C, Daskalakis D, et al. Hospitalizations Involving an Intensive Care Unit Admission Among Patients Aged 65 Years and Older Within New York City Hospitals During 2000-2014. Med Care 2020; 58: 74–82.

43. Miniksar ÖH, Özdemir M. Clinical Features and Outcomes of Very Elderly Patients Admitted to the Intensive Care Unit: A Retrospective and Observational Study. Indian J Crit Care Med 2021; 25: 629–634.

44. Choi J, Park E, Choi AY, Son MH, Cho J. Incidence and Mortality Trends in Critically Ill Children: A Korean Population-Based Study. J Korean Med Sci 2023; 38: e178.

TABLE LEGEND

1. Table 1. Hospitalizations and fatality rates
2. Table 2. Hospitalization incidence rate per 1000 by age range, 2012-2021
3. Table 3. ICU fatality rate (percentage) by age range, 2012-2021

Long-Term Trends in Intensive Care Unit Hospitalizations in Poland: Study Based on the National Hospital Registry, 2012-2021

Aim of study:

The aim of the study was to describe long-term trends in ICU hospitalizations and related fatality rates in Poland.

NATIONWIDE GENERAL HOSPITAL MORBIDITY STUDY

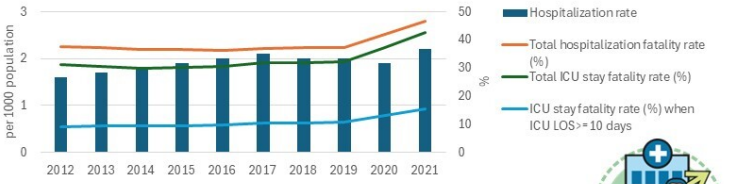
Methods:

Our study is a population-based, retrospective analysis of hospital discharge records of patients hospitalized, and these hospitalizations included a stay or stays in ICUs. Data were obtained from the Nationwide General Hospital Morbidity Study conducted by the National Institute of Public Health in Poland (2012-2021).

738,579 HOSPITALIZATION RECORDS
2012-2021

Results:

- the mean annual ICU hospitalization incidence was estimated at 1.9 per 1,000 (SD: 0.18) and a significant increase trend in hospitalizations was observed from 1.6 per 1,000 in 2012 to 2.2 per 1,000 in 2021, *P*<0.005.
- We observed a significant predominance of male patients (56.6%, *P*<0.001) in the study group when compared to general population. The mean and median age in the study group were 61.6 (SD: 18.2) and 65 years (IQR: 53-74), respectively.
- The trend in fatal hospitalizations increased significantly from 37.7% in 2012 to 46.5% in 2021, P<0.05. However, the trend in fatal hospitalization rates during the ICU stay increased significantly from 31.2% in 2012 to 42.5% in 2021, *P*<0.01.
- The mean length of ICU stays (LOS) increased from 8.7 in 2012 to 10.1 days in 2021, *P*<0.001.



Conclusions:

The paper presents the recent trends in quantitative and qualitative changes in ICU hospitalizations in Poland. The presented data may be the basis for comparative analyzes in a global context and may indicate the need to perform adaptive systemic changes to improve health care.

Table 1. Hospitalizations and fatality rates

YEAR	Total hospitalizations (males %)	Hospitalization rate per 1000 population	Total fatal hospitalizations (males %)	Total hospitalization fatality rate (%)	ICU stay fatal hospitalizations (males %)	Total ICU stay fatality rate (%)	ICU stay fatality rate (%) when ICU LOS>=10 days
2012	62233 (56.0)	1.6	23470 (58.4)	37.7	19397 (58.5)	31.2	9.1
2013	66844 (55.4)	1.7	24798 (57.0)	37.1	20439 (57.2)	30.6	9.4
2014	69056 (55.8)	1.8	25172 (57.8)	36.5	20582 (57.9)	29.8	9.3
2015	72485 (55.8)	1.9	26386 (57.8)	36.4	21901 (57.8)	30.2	9.5
2016	77259 (56.2)	2.0	27865 (58.2)	36.1	23585 (58.1)	30.5	9.7
2017	78994 (56.3)	2.1	29228 (57.6)	37.0	25015 (57.6)	31.7	10.4
2018	77634 (57.0)	2.0	28953 (58.8)	37.3	24849 (58.6)	32.0	10.3
2019	77673 (56.8)	2.0	28932 (58.9)	37.2	25055 (58.7)	32.3	10.8
2020	71928 (58.7)	1.9	30043 (61.3)	41.8	26824 (61.3)	37.3	13.1
2021	84473 (57.6)	2.2	39284 (60.0)	46.5	35868 (60.0)	42.5	15.4

Table 2. Hospitalization incidence rate per 1000 by age range, 2012-2021

AGE RANGE (YEARS)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0-4	0.3	0.3	0.3	0.4	0.5	0.5	0.4	0.4	0.3	0.3
5-9	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1
10-14	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
15-19	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.2	0.3
20-24	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.6
25-29	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.8
30-34	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.9	0.9	1.0
35-39	0.8	0.7	0.8	0.8	0.9	0.9	0.9	0.9	0.8	1.0
40-44	0.8	0.8	0.8	0.9	0.9	0.9	1.0	0.9	0.8	1.0
45-49	1.1	1.1	1.0	1.2	1.3	1.3	1.2	1.2	1.1	1.4
50-54	1.5	1.5	1.5	1.6	1.7	1.6	1.7	1.7	1.6	2.0
55-59	2.2	2.3	2.3	2.4	2.5	2.5	2.4	2.4	2.3	2.7
60-64	3.2	3.4	3.4	3.5	3.7	3.6	3.6	3.6	3.3	4.0
65-69	4.4	4.8	4.8	5.0	5.3	5.2	5.0	5.0	4.6	5.7
70-74	4.9	5.5	5.7	6.0	6.6	6.9	6.5	6.3	6.0	7.0
75-79	5.8	6.3	6.6	6.8	7.2	7.2	7.1	7.0	6.4	7.8
80-85	6.4	6.6	7.0	7.1	7.5	7.5	7.0	6.9	6.2	6.4
85+	6.4	6.8	7.1	7.1	7.2	7.5	6.9	6.5	5.3	5.0

Table 3. ICU fatality rate (percentage) by age range, 2012-2021

AGE RANGE (YEARS)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0-4	10.9	8.6	10.5	10.6	9.3	8.8	8.8	8.3	8.2	7.6
5-9	10.6	11.0	11.8	5.5	5.9	8.0	9.7	10.9	6.3	7.1
10-14	6.3	4.8	6.7	5.2	6.1	6.2	10.0	5.4	5.5	5.7
15-19	11.3	12.3	12.5	11.3	9.5	11.7	12.4	11.0	13.1	14.4
20-24	15.4	15.0	14.0	14.9	11.6	12.9	13.0	11.5	13.7	16.7
25-29	11.3	12.0	11.2	10.8	13.0	11.4	12.8	12.8	12.1	13.5
30-34	14.0	13.2	11.8	10.6	11.7	12.5	13.3	14.1	14.6	16.3
35-39	22.0	19.2	20.9	18.9	19.6	18.6	19.8	20.1	23.8	24.9
40-44	31.8	29.1	29.6	26.8	26.8	27.8	28.4	28.1	28.9	34.2
45-49	32.1	32.5	32.3	32.0	31.9	31.8	33.0	32.5	34.8	39.2
50-54	34.4	32.9	31.3	31.5	32.3	32.6	33.0	34.5	37.5	41.5
55-59	33.9	32.5	31.1	31.4	31.9	32.8	32.6	33.7	38.6	43.7
60-64	34.9	34.4	32.9	33.3	33.5	33.7	34.7	34.2	39.7	46.1
65-69	37.2	37.6	36.1	35.0	33.8	36.2	36.0	36.3	42.1	49.8
70-74	42.9	40.9	39.3	41.0	38.4	39.2	39.8	39.9	46.4	52.5
75-79	48.0	47.7	47.0	46.2	45.5	45.8	46.9	45.0	52.3	58.6
80-85	58.3	56.2	56.0	57.1	56.1	56.9	57.6	55.0	61.0	63.6
85+	66.6	66.5	65.0	66.6	66.2	67.0	66.5	67.9	68.4	70.0