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PRACA ORYGINALNA
ORIGINAL PAPER

Characteristics of diabetic patients based on the Silesian Intensive Care Unit Registry

Charakterystyka pacjentów z cukrzycą na podstawie Śląskiego Rejestru Oddziałów Intensywnej Terapii

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ABSTRACT

INTRODUCTION: Diabetes mellitus (DM), a chronic condition, contributes to heightened hospitalizations, disability, and early mortality due to related complications. This study aimed to explore the incidence, clinical traits, and prognostic implications of DM in patients treated in Silesian intensive care units (ICUs).
MATERIAL AND METHODS: The paper is a retrospective, multicenter study containing patient data from the Silesian Intensive Care Unit Registry. Patients were treated in multi-profile ICUs in the Silesian Voivodeship. The registry collected clinical data of patients before admission to the ICU during hospitalization, as well as the results of ongoing treatment. To determine the effect of diabetes on the variables analyzed (51 variables), patients were divided into two groups: patients with a history of DM (regardless of its type) and patients without DM. Intergroup differences were compared for quantitative variables using parametric (Student's t-test) or non-parametric (Mann–Whitney U) tests, depending on the type of distribution.
RESULTS: The study population of 25,456 included 6,393 patients (25.1%) with DM. DM patients were typically older (71 vs. 64 years, $p = 0.001$) and predominately female (49% vs. 39%, $p < 0.001$). Statistically significant comorbidities amongst DM patients included coronary artery disease (OR = 2.96), hypertension (OR = 3.62), chronic renal failure (OR = 4.29; requiring dialysis, OR = 2.98), and morbid obesity (OR = 4.01), all with $p < 0.001$. Primary reasons for ICU admission in DM patients were notably multiple organ failure (OR = 1.18), shock (OR = 1.20), and infection/sepsis (OR = 1.35/1.16), each with $p < 0.001$. An elevated risk of ICU death by 24% was observed in DM patients ($p < 0.001$).
CONCLUSIONS: These findings underscore the substantial influence of DM on the clinical presentation and therapeutic outcome in critically ill patients, regardless of its role as a comorbidity rather than a primary admission cause.

KEYWORDS

diabetes mellitus, intensive care, infections, perioperative care, cardiovascular complications

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STRESZCZENIE

WSTĘP: Cukrzyca (*diabetes mellitus* – DM) jest chorobą przewlekłą, której powikłania są przyczyną dodatkowych hospitalizacji, inwalidztwa i przedwczesnych zgonów. Celem pracy była ocena częstości występowania, cech klinicznych i rokowania pacjentów z DM leczonych w śląskich oddziałach intensywnej terapii (*intensive care units* – ICUs).

MATERIAŁ I METODY: Praca jest retrospektywnym, wieloośrodkowym badaniem wykorzystującym dane pacjentów ze Śląskiego Rejestru Oddziałów Intensywnej Terapii. Pacjenci byli leczeni w wieloprofilowych ICUs na terenie województwa śląskiego. Rejestr gromadził dane kliniczne pacjentów przed przyjęciem na ICU, w trakcie hospitalizacji, a także wyniki prowadzonego leczenia. Aby określić wpływ cukrzycy na analizowane zmienne (51 zmiennych), pacjentów podzielono na dwie grupy: pacjenci z DM w wywiadzie (niezależnie od jej typu) i pacjenci bez DM. Różnice międzygrupowe porównywano w przypadku zmiennych ilościowych za pomocą testów parametrycznych (test t-Studenta) lub nieparametrycznych (test U Manna–Whitneya), zależnie od typu rozkładu.

WYNIKI: Spośród 25 456 chorych DM występowała u 6393 (25,1%). Pacjenci z DM byli starsi (71 vs. 64 lata, $p = 0,001$), częściej były to kobiety (49% vs. 39%, $p < 0,001$). U pacjentów z DM znamiennie częściej występowały ($p < 0,001$): choroba wieńcowa (OR = 2,96), nadciśnienie tętnicze (OR = 3,62), przewlekła niewydolność nerek (OR = 4,29; z koniecznością dializoterapii, OR = 2,98) oraz otyłość olbrzymia (OR = 4,01). Wśród pierwotnych przyczyn przyjęcia na ICU istotnie częstsze były ($p < 0,001$): niewydolność wielonarządowa (OR = 1,18), wstrząs (OR = 1,20) oraz infekcja/sepsa (OR = 1,35/1,16). U pacjentów z DM stwierdzono zwiększone o 24% ryzyko zgonu na ICU ($p < 0,001$).

WNIOSKI: Wyniki podkreślają istotny wpływ DM na stan kliniczny i efekt leczenia krytycznie chorych, nawet jeżeli pozostaje ona chorobą współistniejącą, a nie głównym powodem hospitalizacji.

SŁOWA KLUCZOWE

cukrzyca, intensywna terapia, infekcje, opieka okołooperacyjna, powikłania sercowo-naczyniowe

INTRODUCTION

Diabetes mellitus (DM) is a global health problem. In 2019, the disease is estimated to affect about 463 million adults globally. That number is expected to rise to 700 million by 2045 [1]. In the intensive care unit (ICU) setting, both acute metabolic conditions caused by DM decompensation and complications resulting from long-standing disease are treated. DM is rarely the main reason for ICU admission, more often it is a comorbid condition, e.g., among patients with sepsis, 10–30% had this diagnosis in their medical history [2]. Complications of DM can have a significant impact on quality of life and increase the risk of premature death. The high prevalence of DM and its complications is also associated with increased morbidity and mortality among hospitalized patients [3,4,5]. Patients with DM who require intensive care are at increased risk of complications such as infections, kidney failure, cardiovascular disease [6,7,8,9]. Early identification and therapy of DM is crucial to improving patient outcomes.

In this study, we analyzed the characteristics of patients with DM who were treated in the ICU. The analysis included a significant cohort of critically ill patients and a wide range of data from the Silesian Intensive Care Unit Registry, focusing on both the demographic structure, clinical characteristics and prognosis of patients.

MATERIAL AND METHODS

The paper is a retrospective, multicenter study containing patient data from the Silesian Intensive Care Unit Registry. Patients were treated in multi-profile ICUs in the Silesian Voivodeship. The registry was in operation from 2010 to 2019, and reporting was supervised by the Silesian Branch of the Polish Society of Anesthesiology and Intensive Care. All ICUs in the Silesian Voivodeship (37 wards) had access to the database. Patient reporting was voluntary. An estimated 50% of units took an active part in the database. The form allowed the selection of multiple answers, as well as the addition of a description in non-standard situations. The registry collected clinical data of patients before admission to the ICU, during hospitalization, as well as the results of ongoing treatment. A detailed description regarding the registry was published previously [10]. To determine the effect of diabetes on the variables analyzed (51 variables), patients were divided into two groups: patients with a history of DM (regardless of its type) and patients without DM.

Statistical analysis was performed using Statistica 13. Quantitative variables were presented as mean ± SD or median (IQR), while qualitative variables were presented as percentages. Intergroup differences were compared for quantitative variables using parametric (Student's t-test) or non-parametric (Mann–

–Whitney U) tests, depending on the type of distribution. The distribution of the study population was verified using the Kolmogorov–Smirnov test. Quantitative data were analyzed using the Chi-square test. To assess the association of qualitative variables, odds ratios and their 95% confidence intervals were calculated. Statistically significant values were considered at $p < 0.05$.

RESULTS

In the described cohort of critically ill patients (n = 25456), patients with a history of DM accounted for 25.1% (n = 6393). Patients with DM were older (71, IQR 63–78 vs. 64, IQR 53–75 years, p = 0.001), and were more often female (49% vs. 39%, p < 0.001). Table I includes clinical data on patients' burdens before admission to the ICU. Patients with DM were significantly more likely (p < 0.001) to have coronary artery disease (OR = 2.96), heart failure (OR = 2.78), hypertension (OR = 3.62), chronic respiratory failure (OR = 1.41), chronic renal failure (OR = 4.29; including the need for dialysis, OR = 2.98), cerebrovascular incidents (OR = 1.67), and morbid obesity (OR = 4.01).

Patients with diabetes were most often admitted to the ICU from non-surgical wards (36.6%), for the rest of the wards the distribution was similar (Table II).

Tables III and IV address the reasons for ICU admission. In both the group of patients with and without DM, the most common direct reasons for admission were respiratory failure (91.1%, OR = 1.23), circulatory failure (66.5%, OR = 1.38) and disorders of consciousness (53.3%, OR = 1.00). No statistically significant difference in direct reasons for ICU admission was noted only for disorders of consciousness.

Table V shows the clinical data of patients at the time of ICU admission. The majority of patients (p < 0.05) were: intubated (OR = 1.1), mechanically ventilated (OR = 1.12) and required infusion of catecholamines (OR = 1.2).

During treatment in the ICU (Table VI), patients with DM required statistically more frequent (p < 0.05): infusion of catecholamines (OR = 1.3), mechanical ventilation (OR = 1.11), non-invasive ventilation (OR = 1.23), dialysis therapy (OR = 1.99), continuous renal replacement therapy (OR = 1.58), antibiotic therapy (OR = 1.33).

30.1% of patients with diabetes were discharged with good neurological outcome (Table VII), compared to 34% of patients without a history of diabetes (p < 0.001, OR = 0.83). Patients with DM had a 24% higher risk of death in the ICU (p < 0.001; Table VIII).

Table I. Pre-intensive care unit (ICU) admission clinical data

Variable	All patients	Patients with DM	Patients without DM	P	OR (95%CI)
Coronary artery disease	10496 (41.2%)	3901 (61.0%)	6595 (34.6%)	< 0.001	2.96 (2.79–3.14)
Heart failure	8848 (34.8%)	3377 (52.8%)	5471 (28.7%)	< 0.001	2.78 (2.62–2.95)
Hypertension	13252 (52.1%)	4757 (74.4%)	8495 (44.5%)	< 0.001	3.62 (3.39–3.85)
Chronic respiratory failure	3162 (12.4%)	982 (15.4%)	2180 (11.4%)	< 0.001	1.41 (1.30–1.53)
Chronic kidney failure	3750 (14.7%)	1963 (30.7%)	1787 (9.4%)	< 0.001	4.29 (3.99–4.61)
Dialysis	321 (1.3%)	159 (2.5%)	162 (0.85%)	< 0.001	2.98 (2.39–3.71)
Cerebrovascular accident	1902 (7.47%)	664 (10.4%)	1238 (6.5%)	< 0.001	1.67 (1.51–1.84)
Cachexia	903 (3.6%)	137 (2.14%)	766 (4.02%)	< 0.001	0.52 (0.44–0.63)
Severe obesity	1457 (5.72%)	800 (12.5%)	657 (3.4%)	< 0.001	4.01 (3.60–4.47)

DM – diabetes mellitus; p – value; OR – odds ratio; CI – confidence interval

Table II. Source of intensive care unit (ICU) admission

Variable	All patients	Patients with DM	Patients without DM	p	OR (95%CI)
Operating theatre	6298 (24.7)	1372 (21.5%)	4926 (25.8%)	< 0.001	0.78 (0.73–0.84)
Emergency department	6393 (25.1%)	1109 (20.9%)	5284 (26.2%)	< 0.001	0.74 (0.69–0.80)
Surgical department	5123 (20.1%)	1316 (20.6%)	3807 (19.9%)	0.28	1.04 (0.96–1.11)
Non-surgical department	7413 (29.1%)	2337 (36.6%)	5076 (26.6%)	< 0.001	1.59 (1.50–1.69)
Another intensive care unit	384 (1.5%)	78 (1.2%)	306 (1.6%)	0.03	0.76 (0.59–0.97)
Ambulance	946 (3.7%)	181 (2.8%)	765 (4.01%)	< 0.001	0.70 (0.59–0.82)

DM – diabetes mellitus; p – value; OR – odds ratio; CI – confidence interval

Table III. Primary intensive care unit (ICU) admission diagnosis

Disease entity	All patients	Patients with DM	Patients without DM	p	OR (95%CI)
Acute respiratory failure	19004 (74.6%)	4800 (75.1%)	14204 (74.5%)	0.33	1.03 (0.97–1.10)
Exacerbation of chronic respiratory failure	2057 (8.1%)	639 (10.0%)	1418 (7.4%)	< 0.001	1.38 (1.25–1.52)
Circulatory insufficiency	11921 (46.8%)	3359 (52.3%)	8652 (44.8%)	< 0.001	1.36 (1.28–1.44)
Multiple trauma	3305 (13.0%)	925 (14.5%)	2380 (12.5%)	< 0.001	1.18 (1.09–1.29)
Shock	7643 (30.0%)	2105 (32.9%)	5538 (29.0)	< 0.001	1.20 (1.13–1.27)
Spinocerebellar ataxia	6129 (24.1%)	1694 (26.5%)	4435 (23.4%)	< 0.001	1.19 (1.12–1.27)
Obtunded consciousness	10069 (39.5%)	2566 (40.1%)	7503 (39.3%)	0.26	1.03 (0.98–1.10)
Post-surgical complications	7809 (30.7%)	1831 (28.6%)	5978 (31.3%)	< 0.001	0.88 (0.83–0.94)
Antiphospholipid syndrome	387 (1.5%)	80 (1.3%)	307 (1.6%)	0.04	0.78 (0.60–0.99)
Acute neurological conditions	1931 (7.6%)	339 (5.3%)	1592 (8.4%)	< 0.001	0.61 (0.54–0.69)
Severe metabolic disorders	1394 (5.5%)	415 (6.5%)	979 (5.1%)	< 0.001	1.28 (1.14–1.44)
Infections	4828 (18.9%)	1443 (22.6%)	3385 (17.8%)	< 0.001	1.35 (1.26–1.45)
Sepsis	1808 (7.1%)	503 (7.9%)	1305 (6.8%)	0.006	1.16 (1.04–1.29)

DM – diabetes mellitus; p – value; OR – odds ratio; CI – confidence interval

Table IV. Direct admission diagnosis

Variable	All patients	Patients with DM	Patients without DM	p	OR (95%CI)
Circulatory insufficiency	15474 (60.1%)	4248 (66.5%)	11226 (58.9%)	< 0.001	1.38 (1.30–1.47)
Respiratory failure	22858 (89.8%)	5825 (91.1%)	17033 (89.3%)	< 0.001	1.23 (1.11–1.35)
Renal failure	4688 (18.4%)	1654 (25.9%)	3034 (15.9%)	< 0.001	1.84 (1.72–1.97)
Multiple trauma	1142 (4.49%)	91 (1.4%)	1051 (5.5%)	< 0.001	0.25 (0.20–0.31)
Metabolic disorders	5083 (20.0%)	1582 (24.8%)	3501 (18.4%)	< 0.001	1.46 (1.37–1.56)
Obtunded consciousness	13522 (53.1%)	3405 (53.3%)	10117 (53.1%)	0.77	1.00 (0.95–1.07)

DM – diabetes mellitus; p – value; OR – odds ratio; CI – confidence interval

Table V. Status upon admission

Procedure	All patients	Patients with DM	Patients without DM	p	OR (95%CI)
Use of catecholamines	11432 (44.9%)	3091 (48.4%)	8341 (43.7%)	< 0.001	1.20 (1.14–1.27)
Unconsciouss	17324 (68.1%)	4342 (67.9%)	12982 (68.0%)	0.82	0.99 (0.93–1.06)
Mechanical ventilation	18889 (74.2%)	4843 (75.8%)	14046 (73.4%)	< 0.001	1.12 (1.05–1.19)
Intubated	19423 (76.3%)	4957 (77.5%)	14466 (75.9%)	0.006	1.10 (1.03–1.18)

DM – diabetes mellitus; p – value; OR – odds ratio; CI – confidence interval

Table VI. Clinical data of intensive care unit (ICU) stay

Procedure	All patients	Patients with DM	Patients without DM	p	OR (95%CI)
Application of catecholamines	18606 (73.1%)	4912 (76.8%)	13694 (71.8%)	< 0.001	1.30 (1.22–-1.39)
Intubation	16490 (64.8%)	4167 (65.2%)	12323 (64.6%)	0.41	1.03 (0.97–1.09)
Tracheostomy	4186 (16.4%)	1100 (17.2%)	3086 (16.2%)	0.057	1.08 (1.00–1.16)
Invasive ventilation	21020 (82.5%)	5346 (83.6%)	15674 (82.2%)	0.009	1.11 (1.03–1.19)
Non-invasive ventilation	1195 (4.7%)	346 (5.4%)	849 (4.5%)	0.002	1.23 (1.08–1.40)
Dialysis	533 (2.1%)	211 (3.3%)	322 (1.7%)	< 0.001	1.99 (1.67–2.37)
Continuous replacement dialysis	2726 (10.7%)	910 (14.2%)	1816 (9.5%)	< 0.001	1.58 (1.45–1.72)
Antibiotic therapy	20531 (80.6%)	5358 (83.8%)	15173 (79.6%)	< 0.001	1.33 (1.23–1.43)
Extracorporeal membrane oxygenation	119 (0.47%)	23 (0.36%)	96 (0.5%)	0.15	0.7 (0.45–1.13)

DM – diabetes mellitus; p – value; OR – odds ratio; CI – confidence interval

Table VII. Neurological outcome

Variable	All patients	Patients with DM	Patients without DM	p	OR (95%CI)
Good	8419 (33.0%)	1925 (30.1%)	6494 (34.0%)	< 0.001	0.83 (0.78–0.88)
Moderate disability	6393 (25.1%)	778 (25.2%)	5615 (25.1%)	0.96	1.00 (0.92–1.09)
High disability	1821 (7.15%)	434 (6.79%)	1387 (7.27%)	0.19	0.92 (0.83–1.04)
Vegetative condition	6393 (25.1%)	225 (21.1%)	6168 (25.3%)	0.002	0.79 (0.68–0.92)

DM – diabetes mellitus; p – value; OR – odds ratio; CI – confidence interval

Table VIII. Mortality rate of patients in intensive care unit (ICU)

Variable	All patients	Patients with DM	Patients without DM	p	OR (95%CI)
Mortality in ICU	11064 (43.5%)	3031 (47.4%)	8033 (42.1%)	< 0.001	1.24 (1.17–1.31)

DM – diabetes mellitus; p – value; OR – odds ratio; CI – confidence interval

DISCUSSION

DM is a significant clinical problem in patients treated in the ICU. The purpose of this study was to analyze the impact of this disease on the course of hospitalization and the prognosis of patients. In our study, we showed that patients with diabetes mellitus are characterized by worse treatment outcomes compared to a group of patients without a history of DM. In the patient population of the Silesian Intensive Care Unit Registry, the prevalence of diabetes was high, affecting 25.1% of patients. In a meta-analysis by Siegelaar et al. [9] it was demonstrated that an average of 19% of patients hospitalized in multi-profile ICUs are diagnosed with diabetes. Obesity is one of the main risk factors for developing type 2 DM [11]. The debilitating effect of obesity was also confirmed in our study; the percentage of patients with grade III obesity was nearly four times higher among patients with DM than among patients without DM. In contrast, non--modifiable risk factors include female gender and age [11]. These assumptions confirm our results, i.e. there were more women and elderly patients in the study group. Patients with DM were most often brought to the ICU from non-surgical wards. It can be concluded that this is due to more frequent exacerbation of chronic diseases and decompensation of the general condition. The main complications of diabetes mellitus, due to the adverse effects of hyperglycemia on vascular endothelial function, are primarily broad cardiovascular complications [12,13]. We showed that patients with DM already at the time of admission to the ICU were more likely to have additional medical conditions, especially cardiovascular, renal and pulmonary diseases. They were also admitted in a worse clinical condition, as they significantly more often required intubation, mechanical ventilation and infusion of catecholamines. Such observations have also been confirmed in many other papers [6,14]. The primary reasons for ICU admission included acute respiratory failure, circulatory failure, impaired consciousness, shock and infections. This translates, into the number of procedures performed during hospitalization such as renal replacement therapy, the need for catecholamines, mechanical ventilation and antibiotic therapy. All these procedures are significantly more frequent in DM patients. Our study showed that patients with diabetes were 17% less likely to be discharged from the ICU in good neurological condition compared to patients without DM. DM is a risk factor for stroke, peripheral neuropathy and, through hypo and hyperglycemic incidents, the development of cognitive impairment [4,15]. However, despite the more numerous complications and worse response to the treatment used, not all studies could confirm that DM increases mortality in critically ill patients. In a meta-analysis of 141 publications by Siegelaar et al. [9] it was demonstrated that DM had no effect on increased mortality, except in cardiac surgery patients. In our study, patients with DM had a 24% higher risk of death than patients without diabetes. The overall death rate was higher than the national average and stood at 47.4%. According to the National Institute of Public Health in Poland, the ICU mortality rate among the general patient population in 2012 was 42% [16].

CONCLUSIONS

There are some limitations to our study. It is a retrospective paper in which data were entered by numerous individuals, which may affect the quality of the information included. In terms of diabetes, variables showing absolute glycemic values and the breakdown by disease type were missing, which is extremely important, given the different characteristics of patients with type 1 and type 2 diabetes. Nevertheless, the large group of patients and the very large number of variables analyzed make it possible to trace patients from the moment they are admitted to the ICU to the end of their treatment. This makes it possible to characterize the needs and risks associated with

hospitalization of patients with DM within the ICU. The above results highlight the significant impact of DM on the clinical status and outcome of critically ill patients, even if it remains a comorbid condition and not the main reason for ICU admission.

Authors' contribution

Study design – Ł. Krzych, D. Bednarski
Data collection – Ł. Krzych
Data interpretation – D. Bednarski
Statistical analysis – D. Bednarski
Manuscript preparation – D. Bednarski, Ł. Krzych
Literature research – D. Bednarski

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