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Young Adults Among Patients Admitted to Polish Intensive Care Units in the Silesian ICU Registry

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Background: Patients under 30 years of age constitute a unique population in the Intensive Care Unit (ICU). The aim of this study was to obtain information on young adults admitted to Polish ICUs and to identify independent predictors of favorable outcome in this population.

Material/Methods: Data from 20 651 adult patients from the Silesian Registry of Intensive Care Units conducted in the Silesian Region of Poland since October 2010 were analyzed. Patients aged 18–29 years were identified and their data were compared to the remaining population. Preadmission and admission variables that independently influence the favorable outcome (defined as survival of ICU stay and discharge in a condition other than vegetative state or minimally conscious state) were identified.

Results: Among 20 609 analyzed adult patients, 850 (4.1%) were under the age of 30 years. Young adults had a lower mean APACHE II and SAPS III score at admission and were more frequently admitted to the ICU due to trauma, poisonings, acute neurological disorders, and obstetric complications. ICU mortality was over 2 times lower (20.1% *vs.* 45.3%, p<0.001). Independent variables affecting favorable outcome in this population were: admission to ICU from the operating theatre and multiple trauma as a primary cause of admission.

Conclusions: The greater chance of favorable outcome in adults under the age of 30 years admitted to the ICU is due to their unique characteristics. Favorable outcome in young adults is most likely among patients admitted to the ICU following multiple trauma or admitted from the operating theatre.

MeSH Keywords: Intensive Care Units • Mortality • Risk Assessment • Young Adult

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Background

Patients aged 18–29 years are usually considered "young adults" for purposes of medical analyses [1]. Admission of patients in this age group to an Intensive Care Unit (ICU) is not particularly frequent and is usually associated with a dramatic course of disease that led to a life-threatening condition. It is obvious that the risk of diseases primarily affected by age and lifestyle (which have a huge impact on the health status of older patients) is very low in this population. According to data from the literature, the percentage of young adults in the ICU population is variable, depending on a case mix of the particular ICU and therefore may vary significantly between centers. This population has never been defined or studied in Poland, where ICU patients seem to be fundamentally different from ICU patients in other countries. Additionally, it is not known whether outcomes in this group are consistent with results that could be expected from the results of commonly used ICU scoring systems.

Information on this subject is of great practical importance. In general, it may be assumed that the young adult population should benefit most from ICU admission. Admission of a young adult to an ICU is usually associated with more stress; however, a higher perceived appropriateness of care finally has a beneficial effect on ICU staff [2].

Comparative data on admissions of young adults to the ICU are incomplete. Such information could only be found among demographic data of the patients admitted to ICUs with various medical conditions [3–5].

The primary aim of our study was to describe the population of adult patients below 30 years of age treated in Polish ICUs, and to compare their treatment and outcomes with the remaining population on the basis of data from a local medical registry. The secondary aim was to identify independent variables that affect favorable outcome in this age group.

Material and Methods

We performed a multicentre study, including a population of patients hospitalized in ICUs in the Silesian region of Poland, an industrial area with a high population density. This area covers only 3.9% of the territory of Poland but is inhabited by 11.9% of the Polish population.

Data from 20 651 ICU hospitalizations coming from the Silesian ICU Registry conducted in the Silesian Region of Poland since October 1, 2010 were analyzed. The period from the beginning of the Registry until June 30, 2017 was under analysis. We excluded 42 hospitalizations (0.2%) with missing data. Finally, 20 609 hospitalizations were analyzed.

The Registry collects information on the health burden of patients admitted to ICUs, their general condition on admission, causes of the disease, and the course and results of ICU treatment [6]. Due to the retrospective and anonymous nature of the study, the Ethics Committee at the Medical University of Silesia in Katowice waived the requirement for consent of the patients to participate in the study. Due to the lack of personal data in the Registry, it was not possible to identify individual patients; therefore, the word "patients" stands for hospitalizations in the whole text of the manuscript.

Data from all patients in the Registry were analyzed. All patients 18–29 years of age at ICU admission were identified and compared with the remaining population treated at the same time in the ICU. Demographic parameters, health burden, severity of general condition at the time of ICU admission, main reasons for ICU admission, the course of treatment, and the outcomes were compared.

In addition to the analysis including all patients in the Registry, an additional subgroup analysis was performed with the exclusion of postoperative patients. The results of this analysis may be found in the additional tables submitted as a supplementary file to the main manuscript (Supplementary Tables 1–3).

The leading cause of disease (entered into the Registry in a form of an ICD code) was identified in all patients. We initially used an ICD-10 version published by the World Health Organization in 2010. This was replaced by a new version introduced in 2014. Only diagnoses present in at least 5% of the patients were analyzed, and the remaining reasons were defined as "other causes" for the purpose of this analysis.

Independent preadmission and admission variables that might influence the favorable treatment outcome (defined as Glasgow Outcome Scale 3–5, e.g., survival of the ICU stay and discharge in a condition other than a vegetative state and a minimally conscious state) were identified on the basis of clinical judgment, and are listed in Table 1.

Analyses and graphs were performed with the use of Dell Statistica (data analysis software system, 2016, version 13). Demographic data were presented using descriptive statistics methods and compared using the *t* test or the Mann-Whitney test. The choice of the test used was dependent on the result of the Kolmogorov-Smirnov test. For the comparison of qualitative variables, chi-square test with Yates correction was used. Due to a large diversity of data, we supplemented the present analysis with quartiles in the older group. The effect of independent variables on the outcome variable of interest was calculated by univariate logistic regression. Variables with P value<0.05 were then included in multivariate logistic regression analysis. The multivariate model was fitted using

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Table 1. Medical status at ICU admission.

		Age 18–29 (n=850)	Age >30 (n=19.759)	*p* Value	Age 30–57 (n=5.009)	Age 58–67 (n=5.159)	Age 68–76 (n=4.846)	Age >76 (n=4.745)	*p* Value
Admission	First	93.7%	94.2%	0.588	94.0%	93.3%	94.3%	95.2%	**0.001**
	Second	5.8%	5.1%	0.465	5.2%	5.7%	5.1%	4.5%	**0.001**
	Another	0.6%	0.7%	0.840	0.8%	1.0%	0.6%	0.4%	**0.001**
Comorbidities	Coronary artery disease	0.4%	44.5%	**<0.001**	17.0%	42.5%	55.8%	64.2%	**<0.001**
	Heart failure	3.4%	36.8%	**<0.001**	13.9%	32.5%	45.1%	57.4%	**<0.001**
	Arterial hypertension	4.2%	52.4%	**<0.001**	29.1%	53.9%	62.7%	64.7%	**<0.001**
	Disseminated atherosclerosis	0.2%	36.4%	**<0.001**	12.1%	33.3%	45.5%	56.3%	**<0.001**
	Chronic respiratory failure	3.7%	12.6%	**<0.001**	6.1%	14.7%	16.6%	13.3%	**<0.001**
	Home oxygen therapy	0.5%	1.7%	**0.009**	0.9%	2.5%	1.9%	1.5%	**<0.001**
	Extreme obesity	1.1%	5.6%	**<0.001**	4.4%	6.4%	7.4%	4.3%	**<0.001**
	Cachexia	2.9%	3.8%	0.256	5.3%	3.8%	2.9%	2.9%	**<0.001**
	Alcoholism	7.8%	9.2%	0.179	22.0%	10.0%	3.5%	0.5%	**<0.001**
	Diabetes	2.4%	25.6%	**<0.001**	11.4%	26.4%	32.7%	32.4%	**<0.001**
	Chronic renal failure	1.1%	15.1%	**<0.001**	5.4%	12.7%	18.6%	24.3%	**<0.001**
	Dialysis dependency	0.5%	1.3%	**<0.001**	1.2%	1.6%	1.4%	1.0%	0.054
	Previous cerebral stroke	0.9%	7.4%	**<0.001**	3.3%	7.0%	9.0%	10.6%	**<0.001**
	Chronic neurological disorders	10.2%	7.9%	**0.016**	8.5%	7.3%	7.6%	8.2%	0.105
	Systemic autoimmune diseases	0.9%	1.1%	0.793	1.4%	1.5%	0.9%	0.6%	**<0.001**
	Post transplant	0.5%	0.2%	0.170	0.4%	0.3%	0.1%	0.0%	**<0.001**
	Cancer	1.9%	7.4%	**<0.001**	5.4%	8.8%	9.3%	6.2%	**<0.001**
	Pregnancy	1.9%	0.1%	**<0.001**	0.5%	0.0%	0.0%	0.0%	**<0.001**
	None	50.7%	7.5%	**<0.001**	19.1%	6.0%	2.9%	1.8%	**<0.001**

the stepwise method, where p<0.05 was set as inclusion and removal criteria. For the purpose of all calculations, a statistically significant difference was accepted at *P*<0.05.

Results

Among 20 609 analyzed hospitalizations, only 850 (4.1%) concerned patients younger than 30 years on admission to the ICU. A comparison of basic demographic data of young adults with the rest of the population showed that male patients dominated in overall (including older) ICU population, but this tendency was more pronounced among young adults (66.2% *vs.* 57.9%, *P*<0.001). A mean age was 24.2±3.3 years among young adults and 65.9 ± 13.6 years in the remaining population.

Young adults were mainly admitted to the ICU from the emergency department (37.3% of population) or directly from the place of event (6.6%). The distribution of various sources of admission was generally different from the remaining ICU population **(**Figure 1**)**. Patients readmitted to the ICU (during the same or different hospitalization) occurred in both populations with a similar frequency (6.4% for younger patients *vs.* 5.9% for older patients, p=0.588).

Young adults had significantly fewer comorbidities. They were also less likely to be pathologically obese (BMI >35 kg/m^2), while the percentage of patients with cachexia (defined as BMI <15 kg/m^2) occurred with a similar frequency. Alcohol dependence syndrome was found in the similar percentage in both populations. Another large group – in comparison to the rest

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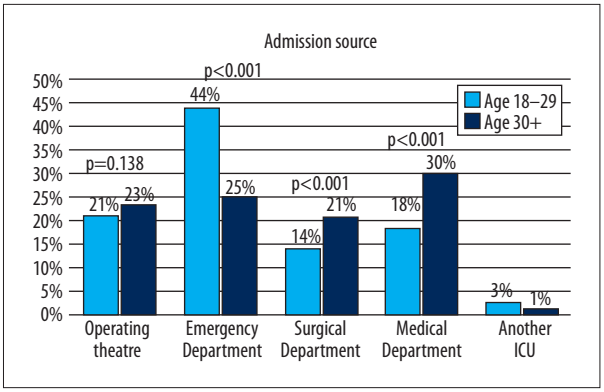

Figure 1. Source of ICU admission.

of the population – was pregnant women. Half of young adults had no significant comorbidities, whereas in the remaining population this was very rare (50.7% *vs.* 7.5%, *P*<0.001) (Table 1).

The distribution of primary reasons of ICU admission was different in young adults and in the remaining population. The higher percentage of young adults was admitted to ICUs after multiorgan trauma (22.2% *vs.* 2.8%, *P*<0.001) or isolated craniocerebral trauma (16.5% *vs.* 4.2%, *P*<0.001). Other, more frequent causes of ICU admission in this population were: poisonings (7.5% *vs.* 1.3%, *P*<0.001), acute neurological disorders (10.8% *vs.* 7.0%, *P*<0.001), and obstetric complications (3.2% *vs.* 0.2%, *P*<0.001). Cardiac arrest prior to ICU admission was uncommon among young adults, while this problem concerned over a quarter of the older population (11.1% *vs.* 25.8%, *P*<0.001) (Table 2).

Similar to the rest of the population, a majority of young adults were admitted to the ICU intubated (66.9%) and mechanically ventilated (68.9%), although these percentages were significantly lower in comparison to the older population (where these figures were 81.0% and 78.7%, respectively, *P*<0.001). A lower percentage of young adults was in shock on ICU admission (15.3% *vs.* 31.1%, *P*<0.01), but a similar percentage presented impaired consciousness on admission (38.7% *vs.* 40.8%, *P*=0.24).

APACHE II score was used to assess 56.1% of young adults and 54.5% of the remaining patients on admission. APACHE II scores were significantly lower among the younger patients (16.7±8.2 *vs.* 23.4±8.7 points, *P*<0.001). Additionally, 36.2% of the younger patients and 32.9% of the older patients were assessed with the use of SAPS III score, and this score was also significantly lower among the younger patients (41.6±21.9 *vs.* 60.3±22.4 points, *P*<0.001). Despite such differences, neurological status of both groups, when assessed with the use of Glasgow Coma Score on ICU admission, was similar (7.4±4.6 *vs.* 7.1±4.4 points, *P*=0.110).

The main diagnoses leading to ICU admission assigned to each patient in a form of ICD codes were grouped into "general diagnoses" and "groups of diseases" categories. The distribution of the most common diagnoses leading to ICU admission in the younger group was different from that in the older cohort (Table 3).

Table 2. Primary reason for ICU admission.

	Age 18–29 (n=850)	Age >30 (n=19.759)	*p* Value	Age 30–57 (n=5.009)	Age 58–67 (n=5.159)	Age 68–76 (n=4.846)	Age >76 (n=4.745)	*p* Value
Shock	15.3%	31.1%	**<0.001**	27.0%	30.7%	32.3%	34.8%	**<0.001**
Cardiac arrest	11.1%	25.8%	**<0.001**	24.7%	27.0%	25.8%	25.8%	0.069
Postoperative	24.0%	29.2%	**<0.001**	23.4%	28.9%	32.4%	32.5%	**<0.001**
Multiple trauma	22.2%	2.8%	**<0.001**	6.1%	2.0%	1.9%	1.2%	**<0.001**
Craniocerebral trauma	16.5%	4.2%	**<0.001**	8.3%	3.8%	2.6%	2.0%	**<0.001**
Acute pancreatitis	2.2%	1.5%	0.137	3.0%	1.1%	1.3%	0.6%	**<0.001**
Obstetric complications	3.2%	0.2%	**<0.001**	0.7%	0.0%	0.0%	0.0%	**<0.001**
Acute neurological disorders	10.8%	7.0%	**<0.001**	10.2%	7.3%	5.6%	4.6%	**<0.001**
Intoxication	7.5%	1.3%	**<0.001**	3.8%	1.0%	0.3%	0.2%	**<0.001**
Severe metabolic diserders	4.4%	5.6%	0.137	7.1%	5.5%	5.7%	4.1%	**<0.001**
Sepsis	6.2%	6.8%	0.566	7.8%	6.7%	6.8%	5.9%	**0.005**
Advanced monitoring	58.4%	56.2%	0.221	55.0%	54.9%	57.2%	57.8%	**0.004**

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Table 3. Most common diagnoses leading to ICU admission (according to ICD codes).

		Age 18–29 (n=834)	Age >30 (n=19.612)	*p* Value	Age 30–57 (n=4.949)	Age 58–67 (n=5.119)	Age 68–76 (n=4.814)	Age >76 (n=4.730)	*p* Value
General diagnoses	Acute respiratory failure	21.3%	21.0%	0.869	20.2%	20.9%	21.5%	21.2%	**<0.001**
	Postoperative complication	2.4%	6.8%	**<0.001**	4.8%	7.5%	7.2%	7.5%	**<0.001**
	Shock	2.4%	2.8%	0.560	2.4%	2.7%	2.9%	3.2%	**<0.001**
	Sepsis	2.2%	2.4%	0.808	2.7%	2.4%	2.1%	2.1%	**<0.001**
Groups of diseases	Cancer	1.6%	4.0%	**0.001**	2.9%	4.4%	5.0%	3.4%	**<0.001**
	Renal and urinary tract diseases	0.8%	0.9%	0.965	0.7%	0.9%	1.0%	1.0%	**<0.001**
	Neurological diseases	10.7%	7.5%	**0.001**	10.8%	7.8%	6.2%	4.8%	**<0.001**
	Diseases of the lungs	5.0%	8.2%	**0.001**	6.7%	8.3%	9.0%	8.6%	**<0.001**
	Diseases of the gastrointestinal tract	3.2%	6.3%	**<0.001**	6.9%	5.0%	6.2%	6.9%	**<0.001**
	Cardiovascular diseases	8.8%	30.8%	**<0.001**	22.0%	31.9%	32.9%	36.0%	**<0.001**
	Trauma	30.1%	5.8%	**<0.001**	11.4%	4.3%	3.6%	3.9%	**<0.001**
	Intoxications (incl. alcohol)	5.6%	1.6%	**<0.001**	4.7%	1.3%	0.3%	0.2%	**<0.001**
	Other diseases (not listed above)	5.9%	2.0%	**<0.001**	2.1%	1.5%	1.2%	0.8%	**<0.001**

Table 4. ICU treatment.

	Age 18–29 (n=850)		Age >30 (n=19759)		*P*
Catecholamines	397	(46.7%)	14473	(73.3%)	**<0.001**
Intubation	494	(58.1%)	12603	(63.8%)	**0.001**
Tracheostomy	125	(14.7%)	3332	(16.9%)	0.109
Invasive ventilation	633	(74.5%)	16368	(82.8%)	**<0.001**
Renal replacement therapy	54	(6.4%)	1864	(9.4%)	**0.003**
Operation while in the ICU	119	(14.0%)	1747	(8.8%)	**<0.001**
Intra-aortic baloon pump	8	(0.9%)	545	(2.8%)	**0.002**
ECMO	9	(1.1%)	54	(0.3%)	**<0.001**

During ICU stay, the use of catecholamines and continuous renal replacement therapy was less frequent among young adults (46.7% *vs.* 73.3%, *P*<0.001 and 6.4% *vs.* 9.4%, *P*=0.003, respectively). A lower percentage of patients underwent invasive ventilation during ICU stay (74.5% *vs.* 82.8%, *P*<0.01), but a similar percentage underwent tracheostomy (14.7% *vs.* 16.9%, *P* <0.109). Surgical operation during ICU stay was performed more frequently in the younger group (14.0% *vs.* 8.8%, *P*<0.001). Plasmapheresis and ECMO were more common in younger patients (1.1% *vs.* 0.4%, *P*=0.013 and 1.1% *vs.* 0.3%, *P*<0.001, respectively). We analyzed the difference between the younger and the older population in terms of specific diagnoses that contributed to the utilization of these 2 techniques. Acute respiratory failure was the leading diagnosis in patients treated with ECMO in the younger group (77.8% *vs.* 50.0% in patients aged 30 and more), while cardiovascular diseases were more frequently a leading diagnosis in the older group (40.7% *vs.* 22.2% in patients aged 18 to 29), but none of these differences were statistically significant. The majority of patients who underwent plasmapheresis was diagnosed with neurological disorders in both groups (88.9% in the younger group *vs.* 61.5% in the older group, p=0.206). The duration of

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Table 5. Discharge and outcome.

		Age 18–29 (n=850)		Age >30 (n=19759)		*P*
Neurological status (Glasgow Outcome Score)	Good	428	(50.4%)	5849	(29.6%)	**<0.001**
	Moderate disability	120	(14.1%)	2575	(13.0%)	0.386
	Severe disablity	89	(10.5%)	1478	(7.5%)	**0.002**
	Minimally conscious or vegetative	42	(4.9%)	914	(4.6%)	0.730
	Death	171	(20.1%)	8943	(45.3%)	**<0.001**
Discharge	Same hospital – other department	420	(49.4%)	7587	(38.4%)	**<0.001**
	Other hospital	196	(23.1%)	2696	(13.6%)	**<0.001**
	Long-term facility	5	(0.6%)	216	(1.1%)	0.219
	Home	58	(6.8%)	317	(1.6%)	**<0.001**
	Death	171	(20.1%)	8943	(45.3%)	**<0.001**

ICU stay in both groups was similar (9.7±13.4 *vs.* 10.5±14.8 days, *P*=0.481). Full details describing the treatment process in both groups of patients are shown in Table 4.

ICU mortality among young adults was significantly lower in comparison to the remaining population (20.1% *vs* 45.3%, *P*<0.001), but a similar percentage of patients in both groups was discharged from ICU in a vegetative or minimally conscious state (4.9% *vs.* 4.6%, *P*=0.730) (Table 5). The distribution of the most common leading diagnoses in patients with these 2 endpoints was different in the younger and the older populations. Young patients discharged from the ICU with permanent neurological injury more often had a leading diagnosis of trauma (33.3% *vs.* 10.9%, p<0.001) and acute respiratory failure (33.3% *vs.* 18.8%, p=0.034), while the diagnosis of cardiovascular disease was less frequent (9.5% *vs.* 43.3%, p<0.001).

Diagnoses leading to death in the ICU were generally more diverse. Young patients who died in the ICU more frequently had a leading diagnosis of trauma (24.6% *vs.* 4.4%, p<0.001) and acute intoxication (5.3% *vs.* 1.3%, p<0.001), while cardiovascular and gastrointestinal diseases were less frequent in this group (21.1% *vs.* 36.9%, p<0.001 and 3.5% *vs.* 8.1%, p=0.042, respectively).

It was already mentioned that APACHE II and SAPS III scoring were assessed in a significant proportion of patients on ICU admission. The observed to expected mortality ratio (O/E ratio) for APACHE II score was 0.68 for the younger population (*P*<0.001) and 0.94 for the remaining population (*P*<0.001). The O/E ratio for SAPS III score was 1.06 for the younger population (*P*=0.662) and 1.19 for the remaining population (*P*<0.001).

The mean age of young patients with favorable and non-favorable outcomes was similar (24.2±3.3 *vs.* 24.1±3.3 years, *P*=0.714). Patients with favorable outcomes were also not different from patients with non-favorable outcomes across all analyzed variables defining comorbidities. Young patients with favorable outcomes were more likely to be admitted to the ICU straight from the operating theatre (24.2% *vs.* 11.7%, *P*<0.001). Admission APACHE II score and SAPS III score were lower in patients with favorable outcomes (14.5±7.0 *vs.* 23.3±8.1 points, *P*<0.001 and 36.5±18.6 *vs.* 57.6±24.1 points, *P*<0.001, respectively).

Multivariate analysis carried out on the basis of data listed in presented tables and figures showed that independent variables affecting favorable outcome of ICU treatment were: the operating theatre as the admission source (OR 2.01, CI: 1.21–3.32, *P*=0.007) and multiple trauma as a primary cause of ICU admission (OR 1.65, CI: 1.02–2.66, *P*=0.04). Few variables were also independently associated with non-favorable outcome. A full list of independent variables influencing the outcome of ICU treatment is presented in Figure 2.

Discussion

Comparison of our results to the other published data is somewhat problematic. It is well known that heterogeneity in patient populations, variation in the structural design, and differences in terminology create difficulties in comparing data of critically ill patients across countries [7]. Compared populations should be at least similar. In our study, this condition was impossible to be met, as patients treated in ICUs in Poland seem to be fundamentally different from ICU patients in other countries.

It is worth using a significant example to explain this. In analysis performed by Straney et al., data from 662 525 admissions to

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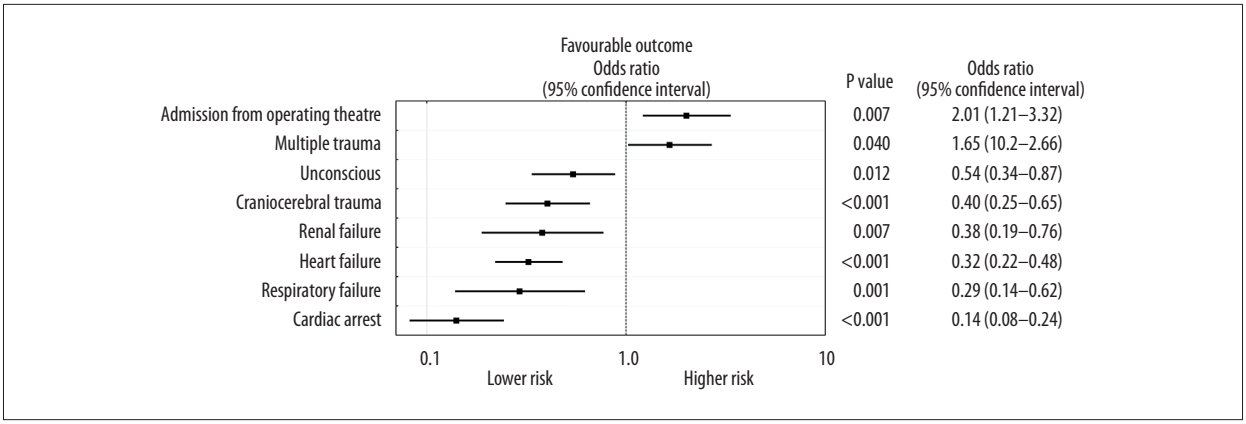

Figure 2. Independent predictors of favorable outcome in a young adults group.

168 ICUs from the Australian and New Zealand Intensive Care Society (ANZICS) Adult Patient Database were presented [8]. In this large population, the majority of patients (51.9%) were admitted to the ICU after surgery, while in the Polish ICU the corresponding figure was only 23.2%. This is related to the fact that specialized surgical Intensive Care Units do not report to the Silesian Registry. The mean length of ICU stay in the Australian and New Zealand population was only 3.2 days, while in Poland it was approximately 10 days. Hospital mortality in a cited study was 9.2% [8], while the mean ICU mortality rate in our ICU Registry was 44.2%. There are many other examples of such differences.

These differences apply directly to the recent correspondence with the Editor of Intensive Care Medicine focusing on high mortality in Polish ICUs [9–11]. It has been already proved that excess mortality is due to profound differences in patient populations, availability of ICU beds, indications for ICU admission, and problems with early stages of post-ICU care in Poland in comparison to other European countries. In fact, mortality rates in Polish Intensive Care Units are lower than predicted according to the APACHE II scoring system [10]. Therefore, there is an urgent need to change the approach to intensive care in the Polish healthcare system, but such changes should be based on well-documented data, including data from medical registries in the first instance [10]. Operating from only 2010, the Silesian ICU Registry is currently the only (but local) medical registry documenting medical activity in Polish ICUs [6].

Undertaking an attempt to reduce mortality in Polish ICUs, it would be necessary to initially focus on the identification of those patients who, although admitted to ICU in a life-threatening condition, have the highest chance of survival and would benefit most from ICU admission. For this reason, young adults became our focus in this study, but there are undoubtedly also other subgroups in the ICU-treated population that should be analyzed for the same reason.

We found that in the adult population treated in ICUs reporting to our Registry, young adults constituted only 4.1% of the population. Comparative figures are surely much higher in other countries. In a study published by Fuhrman et al. on risk factors and outcomes of acute kidney injury, the percentage of young adults (aged 16–25 years) in the total ICU population was 13.8% [3]. Kumar et al. [12] published a study on outcomes of morbidly obese patients receiving invasive mechanical ventilation. It seems that among mechanically ventilated patients, the percentage of subjects aged 18–34 was around 8.5% [12].

In Polish ICUs, young adults were frequently admitted to the ICU from an emergency department (37.3% of population). This percentage was higher than in a mixed surgical and medical ICU population described by Karelliuson et al., where the corresponding figure was 26% [13]. A high proportion of young adults admitted from the emergency department is understandable because these patients are rarely chronically hospitalized in various hospital wards. This might also be linked to the fact that almost one-fourth of young adults admitted to ICUs in Poland are referred to the ICU following multiple trauma (22.3% in young adults *vs.* only 2.8% in the remaining population).

Interestingly, a similar percentage of patients readmitted to the ICU was identified among young adults and in the older population (6.4% and 5.8%). This is difficult to explain, as patients rehospitalized in ICUs in other countries are generally older, with more comorbidities [13–15].

Pathological obesity (defined for the purpose of this study as BMI >35 kg/m^2) was significantly less frequent among young adults in comparison to the older population (1.1% *vs.* 5.6%). In the previously cited work by Kumar et al., [12] based on a large dataset from the United States, the percentages of patients with BMI >40 kg/m^2 among mechanically ventilated patients were only 0.2% and 2.9% in corresponding age groups.

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These lower percentages probably stem from the fact that in that study only mechanically ventilated patients with BMI >40 kg/m^2 were analyzed [12], while we analyzed all patients admitted to ICUs with BMI >35 kg/m^2.

Alcohol dependency syndrome as the underlying disease was found in similar percentages in both populations (approximately 8%). The magnitude of this problem in Poland seems to be very similar to that in other Western European countries. Christensen et al. reported that up to 7.3% of patients entering ICUs in Denmark were alcoholics [16]. It should be noted that only 25% of these patients were defined as having "complicated" alcohol dependency syndrome [17].

A relatively large group among young adults in the ICU in our study, in comparison to the remaining population, were pregnant women (1.9% *vs.* 0.1%). Data presented by Wanderer et al., based on analysis of all obstetric-related ICU admissions in Maryland, USA between 1999 and 2008, showed that only 0.4% of all obstetric patients were admitted to an ICU. The leading diagnoses associated with ICU admission were: pregnancy-related hypertension, postpartum hemorrhage, and various cardiac conditions (including cardiomyopathy). Overall, 7.1% of patients were admitted with sepsis and 3.7% were admitted with pulmonary embolism [4]. In a meta-analysis of 40 eligible studies, pregnant or postpartum women accounted for 0.4–16.0% of ICU admissions in study centers. Hypertensive disorders of pregnancy were the most prevalent indications for ICU admission [18].

Another common reason for ICU admission among young adults in Poland was poisoning (7.5%). This may be compared to the study from Finland, where data from patients with acute poisoning from all 28 ICUs in university and non-teaching hospitals were collected [19]. Patients with poisoning accounted for 4.5% of the general population of patients admitted to ICUs, and their prognosis for survival was generally very good [19]. Data from the Danish ICU database indicate that the main causes of poisoning among 7331 patients admitted to ICUs were: alcohol, analgesics, antidepressants, street drugs, sedatives, and toxic substances (e.g., carbon monoxide) [20].

ICU mortality among young adults was similar to that reported in other countries for the overall ICU population [9]. The observed to expected mortality ratio (O/E ratio) was low, particularly in younger patients. This confirms that mortality in Polish Intensive Care Units remains lower than expected [10].

It should be noted that our work has several important limitations, such as the retrospective, observational character of the study and incomplete representativeness of the sample (only some of the Silesian ICUs report to the Silesian ICU Registry). There are also no clear definitions for some terms used in the Registry. These deficiencies are balanced, however, by our large sample size.

Conclusions

Young adults are rarely admitted to ICUs in Poland, and ICU mortality in this group is significantly lower in comparison to the remaining population. Factors that predispose to the favorable outcome among young adults include admission to the ICU from the operating theatre and multiple trauma as a primary cause of ICU admission.

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Conflict of interest

None.

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Supplementary Tables

Supplementary Table 1. Medical status at ICU admission with the exclusion of post-surgical patients.

		All patients					Post-surgical patients excluded				
		Age 18–29 (n=850)		Age >30 (n=19.759)		P	Age 18–29 (n=671)		Age >30 (n=15.152)		P
Admission	First	796	(93.7%)	18604	(94.2%)	0.588	629	93 7%	14187	93 6%	0.974
	Second	49	(5.8%)	1015	(5.1%)	0.465	37	5 5%	834	5 5%	0.940
	Another	5	(0.6%)	140	(0.7%)	0.840	5	0 8%	131	0 9%	0.909
Co-morbidities	Coronary artery disease	3	(0.4%)	8791	(44.5%)	**<0.001**	3	0 5%	6814	45 0%	**<0.001**
	Heart failure	29	(3.4%)	7277	(36.8%)	**<0.001**	22	3 3%	5939	39 2%	**<0.001**
	Arterial hypertension	36	(4.2%)	10347	(52.4%)	**<0.001**	28	4 2%	7721	51 0%	**<0.001**
	Disseminated atherosclerosis	2	(0.2%)	7201	(36.4%)	**<0.001**	2	0 3%	5599	37 0%	**<0.001**
	Chronic respiratory failure	31	(3.7%)	2495	(12.6%)	**<0.001**	28	4 2%	2205	14 6%	**<0.001**
	Home oxygen therapy	4	(0.5%)	334	(1.7%)	**0.009**	4	0 6%	319	2 1%	0.010
	Extreme obesity	9	(1.1%)	1108	(5.6%)	**<0.001**	7	1 0%	939	6 2%	**<0.001**
	Cachexia	25	(2.9%)	742	(3.8%)	0.256	22	3 3%	611	4 0%	0.382
	Alcoholism	66	(7.8%)	1814	(9.2%)	0.179	57	8 5%	1656	10 9%	0.055
	Diabetes	20	(2.4%)	5058	(25.6%)	**<0.001**	20	3 0%	4065	26 8%	**<0.001**
	Chronic renal failure	9	(1.1%)	2980	(15.1%)	**<0.001**	8	1 2%	2408	15 9%	**<0.001**
	Dialysis dependency	4	(0.5%)	256	(1.3%)	**<0.001**	3	0 5%	223	1 5%	0.043
	Previous cerebral stroke	8	(0.9%)	1467	(7.4%)	**<0.001**	7	1 0%	1244	8 2%	**<0.001**
	Chronic neurological disorders	87	(10.2%)	1558	(7.9%)	**0.016**	76	11 3%	1314	8 7%	**0.021**
	Systemic autoimmune diseases	8	(0.9%)	217	(1.1%)	0.793	8	1 2%	180	1 2%	0.863
	Post transplant	4	(0.5%)	38	(0.2%)	0.170	3	0 5%	29	0 2%	0.316
	Cancer	16	(1.9%)	1467	(7.4%)	**<0.001**	11	1 6%	578	3 8%	**0.005**
	Pregnancy	16	(1.9%)	25	(0.1%)	**<0.001**	9	1 3%	8	0 1%	**<0.001**
	None	431	(50.7%)	1490	(7.5%)	**<0.001**	112	16 7%	2592	17 1%	0.820

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Supplementary Table 2. Primary reason for ICU admission with the exclusion of post-surgical patients.

	All patients					Post-surgical patients excluded				
	Age 18–29 (n=850)		Age >30 (n=19.759)		*P*	Age 18–29 (n=671)		Age >30 (n=15.152)		*P*
Shock	130	(15.3%)	6151	(31.1%)	**<0.001**	95	14.2%	4965	32.8%	**<0.001**
Cardiac arrest	94	(11.1%)	5102	(25.8%)	**<0.001**	88	13.1%	4913	32.4%	**<0.001**
Postoperative	204	(24.0%)	5778	(29.2%)	**<0.001**	67	10.0%	1818	12.0%	0.130
Multiple trauma	189	(22.2%)	554	(2.8%)	**<0.001**	134	20.0%	406	2.7%	**<0.001**
Craniocerebral trauma	140	(16.5%)	832	(4.2%)	**<0.001**	114	17.0%	646	4.3%	**<0.001**
Acute pancreatitis	19	(2.2%)	302	(1.5%)	0.137	16	2.4%	235	1.6%	0.125
Obstetric complications	27	(3.2%)	37	(0.2%)	**<0.001**	18	2.7%	19	0.1%	**<0.001**
Acute neurological disorders	92	(10.8%)	1375	(7.0%)	**<0.001**	80	11.9%	1187	7.8%	**<0.001**
Intoxication	64	(7.5%)	262	(1.3%)	**<0.001**	64	9.5%	258	1.7%	**<0.001**
Severe metabolic diserders	37	(4.4%)	1108	(5.6%)	0.137	35	5.2%	928	6.1%	0.378
Sepsis	53	(6.2%)	1344	(6.8%)	0.566	50	7.5%	1011	6.7%	0.477
Advanced monitoring	496	(58.4%)	11098	(56.2%)	0.221	382	56.9%	7805	51.5%	**0.007**

Supplementary Table 3. Most common diagnoses leading to ICU admission (according to ICD codes) with the exclusion of post-surgical patients.

		All patients					Post-surgical patients excluded				
		Age 18–29 (n=834)		Age >30 (n=19612)		P	Age 18–29 (n=671)		Age >30 (n=15152)		P
General diagnoses	Acute respiratory failure	178	(21.3%)	4127	(21.0%)	0.869	146	21.8%	3543	23.4%	0.354
	Postoperative complication	20	(2.4%)	1330	(6.8%)	**<0.001**	5	0.8%	165	1.1%	0.513
	Shock	20	(2.4%)	549	(2.8%)	0.560	11	1.6%	370	2.5%	0.231
	Sepsis	18	(2.2%)	461	(2.4%)	0.808	16	2.4%	372	2.5%	0.991
Groups of diseases	Cancer	13	(1.6%)	776	(4.0%)	**0.001**	5	0.8%	275	1.8%	0.056
	Renal and urinary tract diseases	7	(0.8%)	174	(0.9%)	0.965	7	1.0%	146	1.0%	0.996
	Neurological diseases	89	(10.7%)	1467	(7.5%)	**0.001**	81	12.1%	1318	8.7%	**0.003**
	Diseases of the lungs	42	(5.0%)	1606	(8.2%)	**0.001**	35	5.2%	1526	10.1%	**<0.001**
	Diseases of the gastrointestinal tract	27	(3.2%)	1229	(6.3%)	**<0.001**	18	2.7%	645	4.3%	0.058
	Cardiovascular diseases	73	(8.8%)	6039	(30.8%)	**<0.001**	64	9.6%	5229	34.6%	**<0.001**
	Trauma	251	(30.1%)	1147	(5.8%)	**<0.001**	183	27.3%	799	5.3%	**<0.001**
	Intoxications (incl. alcohol)	47	(5.6%)	323	(1.6%)	**<0.001**	47	7.0%	318	2.1%	**<0.001**
	Other diseases (not listed above)	49	(5.9%)	384	(2.0%)	**<0.001**	33	4.9%	223	1.5%	**<0.001**

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