

Day and time of admissions to the intensive care units — does it matter?

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Abstract

Background: The literature data pertaining to the significance of day and time of ICU admission for outcomes of patients are inconsistent. The issue has not been analysed in Poland to date. The aim of the study was to gather information about differences between patients admitted to ICU outside regular working hours (off-hours) and those admitted during working hours (on-hours).

Methods: Analysis involved 20,651 patients from the Silesian Registry of Intensive Care Units carried out since 2010. The findings demonstrated that 34.8% of patients were admitted to ICUs during on-hours (between 8.00 a.m. and 3 p.m. on weekdays) and 65.2% were admitted during off-hours (outside regular working hours). The incidence of admissions and data of patients in both groups were compared in terms of the population characteristics and treatment outcomes.

Results: The incidence of admissions (calculated per each 24 hours of treatment) was found to be almost twice as high during on-hours, as compared to off-hours (14.5 vs. 6.9 patients/day). Patients admitted to the ICU during on-hours were less likely to be admitted from the surgical department (19.1% vs. 31.0%, $P < 0.001$), and more likely to be admitted from the emergency department (25.3% vs. 14.2%, $P < 0.001$). The incidence of off-hours admissions was lower for patients with malignancy (5.3% vs. 10.8%, $P < 0.001$) and higher for patients with alcohol dependence syndrome (10.3% vs. 6.9%, $P < 0.001$). Patients admitted during off-hours were in more severe conditions and had higher APACHE II scores (on average, 23.8 ± 8.8 vs. 21.8 ± 8.8 , $P < 0.001$); their mortality rates was higher compared to the remaining population (46.8% vs. 39.4%, $P < 0.001$).

Conclusions: Patients admitted to ICUs during off-hours are in more severe general condition and their treatment outcome is worse, as compared to patients admitted to ICU during on-hours.

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Key words: time of ICU admission, working hours, on-call hours, mortality

The quality of medical services in intensive care units (ICUs) should be always the same, irrespective of time and day of admission. The literature data have demonstrated, however, that the above assumption is not always executed or is infeasible. Despite numerous studies carried out, it has not been explicitly determined whether the time and day of ICU admissions significantly affect treatment outcomes. Moreover, the opinions regarding this issue are extremely

inconsistent. Many authors have stressed that the mortality of patients admitted outside regular working hours (referred to as off-hours) is higher; however, the patients admitted during off-hours are in more severe general conditions [1–5]. According to some other authors, treatment outcomes are similar, irrespective of the time of admission [6–9]. Some authors have even observed better outcomes in patients admitted to ICU during off-hours [10, 11].

To date, the above issue has not been studied in Poland, where the differences resulting from a different structure of ICU admissions can be additionally expected, compared to other countries [12, 13]. The aim of the present study was to gather information to determine any significant differences between patients admitted to ICUs during off-hours and those admitted during on-hours and their effects on treatment outcomes.

METHODS

A retrospective, multi-centre, observational study was carried out involving patients from the Silesian Province hospitalised in Silesian ICUs. Analysis included data of 20,651 patients from the Silesian Registry of Intensive Care Units conducted since October 1, 2010. The study covered the period between October 1, 2010 and June 30, 2017.

The Registry gathers information about health-related issues of patients admitted to ICUs, their general conditions on admission, causes and courses of diseases and treatment outcomes. The detailed rules of functioning of the Registry have been presented in earlier publications [14]. Since the study was retrospective and anonymous in nature, the Bioethics Committee of the Medical University of Silesia in Katowice did not demand the informed consent of patients for participation in the study.

In the study period, the dates of all weekends and days off were identified; subsequently all ICUs from the Registry were assigned to two categories - “on-hours admissions” and “off-hours admissions”. As far as weekdays are concerned, regular working hours were assumed to be between 8.00 a.m. and 3.00 p.m. Following this assumption, all admissions during weekends, days off and weekdays between 3.00 p.m. and 8.00 a.m. were considered off-hours admissions. The calculations demonstrated that the study period consisted of 2,454 days (58,896 hours), including 11,851 on-hours (20.1% of the time) and 47,045 off-hours (79.9% of the time).

The data of both groups were compared as for demographic parameters of the population admitted, severity of general conditions on ICU admission, treatment methods

applied and treatment outcomes. Moreover, averaged incidence rates of on- and off-hours admissions of patients to Silesian ICUs were calculated in both analysed periods by dividing the number of admissions in all units by the available treatment time (re-calculated into 24-hour periods), which enabled one to assess the mean number of patients admitted to ICUs reporting to the Registry during each 24 hours of treatment. For the patients with APACHE II and SAPS III scores available on admission, an observed/expected mortality ratio (O/E ratio) was calculated, by comparing the mean values of the ratio for the population of patients admitted to ICUs during on-hours and off-hours.

Statistical analysis was conducted using Statistica 12 PL software (StatSoft, Tulsa, USA). Demographic data were presented using descriptive statistics and compared using Student’s t-test or the Mann-Whitney test (depending on Wilk-Shapiro test results). Qualitative data were compared by the χ^2 test with Yates’ correction for discontinuity. $P < 0.05$ was considered statistically significant.

RESULTS

During regular working hours of ICUs, 7,178 patients were admitted (34.8%) while the remaining 13,473 patients (65.2%) were admitted during off-hours.

The patients admitted during off-hours were less frequently admitted from the operating theatre (19.1% vs. 31.0%, $P < 0.001$) and more frequently from the emergency or admission department (25.3% vs. 14.2%, $P < 0.001$). The data regarding the places the patients were admitted from are presented in Table 1.

During off-hours, the incidence of ICU admissions of male patients was significantly higher (59.0% vs. 56.8%, $P < 0.001$). In total, the entire population admitted to ICU during off-hours was younger, compared to those admitted during on-hours (63.7 ± 16.1 vs. 64.7 ± 15.2 years, $P < 0.001$). Moreover, the APACHE II scores were available on admission in 54.6% of patients; despite their younger ages, the scores of those admitted during off-hours were significantly higher (23.8 ± 8.8 vs. 21.8 ± 8.8 , $P < 0.001$). In 33.0% of patients, the

Table 1. Place or department from which patients were admitted to intensive care unit (ICU)

ICU admission	On-hours (n = 7,178)		Off-hours (n = 13,473)		P-value
Operating theatre	2.228	(31.0%)	2.568	(19.1%)	< 0.001
A&E or admission department	1.020	(14.2%)	3.411	(25.3%)	< 0.001
Other surgical departments	1.436	(20.0%)	2.772	(20.6%)	0.343
Other medical departments	2.142	(29.8%)	3.929	(29.2%)	0.315
Another ICU	123	(1.7%)	131	(1.0%)	< 0.001
Directly from the site of incident	229	(3.2%)	662	(4.9%)	< 0.001

A&E — accident and emergency department

Table 2. Comorbidities prior to intensive care unit (ICU) admission in study groups

Comorbidities	On-hours admission (n = 7,178)		Off-hours admission (n = 13,473)		P-value
Coronary disease	3.158	44.0%	5.639	41.9%	0.003
Chronic circulatory failure	2.510	35.0%	4.800	35.6%	0.354
Arterial hypertension	3.839	53.5%	6.548	48.6%	< 0.001
Diffuse atherosclerosis	2.546	35.5%	4.661	34.6%	0.215
Chronic respiratory failure	867	12.1%	1.661	12.3%	0.618
Home oxygen therapy	120	1.7%	219	1.6%	0.848
Morbid obesity (BMI > 35 kg m ⁻²)	369	5.1%	749	5.6%	0.217
Cachexia (BMI < 15 kg m ⁻²)	257	3.6%	511	3.8%	0.466
Alcohol dependence syndrome	492	6.9%	1.389	10.3%	< 0.001
Diabetes mellitus	1.808	25.2%	3.273	24.3%	0.160
Chronic renal failure	1.060	14.8%	1.930	14.3%	0.401
Dialysis programme	76	1.1%	184	1.4%	0.069
Cerebral stroke	513	7.2%	962	7.1%	0.991
Chronic neurologic diseases	568	7.9%	1.079	8.0%	0.830
Systemic autoaggression diseases	85	1.2%	140	1.0%	0.376
Status after organ transplantation	22	0.3%	20	0.2%	0.025
Cancer	776	10.8%	707	5.3%	< 0.001
Pregnancy < 12 weeks	12	0.2%	29	0.2%	0.565
No comorbidities	578	8.1%	1.369	10.2%	< 0.001

BMI — body mass index

SAPS III scores were additionally available, which were also found to be significantly higher (60.2 ± 22.7 vs. 57.7 ± 22.8 , $P < 0.001$). Despite more severe conditions of patients, the mean TISS-28 scores on treatment day 1 were comparable in both groups (35.0 ± 7.7 vs. 35.1 ± 8.7 , $P = 0.97$).

The patients admitted to ICUs during off-hours were characterised by a different distribution of various health conditions prior to ICU admission. For instance, the incidence of ICU off-hours admissions of patients with neoplastic diseases was lower (5.3% vs. 10.8%, $P < 0.001$), while the admissions of patients with alcohol dependence syndrome was higher (10.3% vs. 6.9%, $P < 0.001$); and there were more differences found. The detailed data concerning health-related issues on admission in both groups were presented in Table 2.

Furthermore, the treatment of patients admitted to ICUs during off-hours differed from the treatment of those admitted during on-hours. In the former case, patients significantly more often required catecholamines, invasive ventilation and therapeutic hypothermia whereas antibiotic therapy and plasmapheresis were needed significantly less frequently (Table 3). However, the hospitalisation time in both groups was found to be comparable (10.5 ± 14.6 vs. 10.3 ± 14.8 , $P = 0.911$).

The treatment outcomes of patients admitted to ICUs during off-hours were worse compared to the remaining

population. The mortality in this group was significantly higher (46.8% vs. 39.4%, $P < 0.001$). Likewise, the percentage of patients discharged in vegetative or minimally conscious conditions was higher (5.1% vs. 3.8%, $P < 0.001$). Moreover, among patients discharged from ICUs, the percentage of those whose conditions were assessed as good was lower (65.5% vs. 76.4%, $P < 0.001$).

As mentioned above, 54.6% of patients were assessed according to the APACHE II and 33% according to SAPS III. The observed/expected mortality ratio for APACHE II was 0.92 for the population admitted during on-hours and 0.94 for the population admitted during off-hours. The O/E ratio for SAPS III was 1.18 and 1.19, respectively.

During ICU on-hours, 7,178 patients were admitted in total (34.8%); the remaining 13,473 patients (65.2%) were admitted during off-hours. However, the incidence of admissions (re-calculated per each 24 hours of treatment) was almost twice as high during regular working hours, as compared with off-hours. The Silesian ICUs admitted an average of 14.5 patients per day during on-hours and 6.9 patients per day during off-hours. Nevertheless, the incidence of admissions during off-hours was similar, irrespective of whether these were weekday off-hours or weekend off-hours (on average 7.1 patients per day versus 6.5 patients per day, respectively).

The total number of all admissions to Silesian ICUs in the period analysed is presented in Figure 1 (weekdays) and 2

Table 3. Data on medical treatment in both study groups

Data on medical treatment	On-hours admission (n = 7,178)		Off-hours admission (n = 13,473)		P-value
Catecholamines	4,949	69.0%	9,945	73.8%	< 0.001
Intubation	4,534	63.2%	8,585	63.7%	0.439
Tracheostomy	1,165	16.2%	2,296	17.0%	0.142
Invasive ventilation	5,739	80.0%	11,297	83.9%	< 0.001
Dialysis	141	2.0%	280	2.1%	0.617
CRRT	693	9.7%	1,229	9.1%	0.219
Antibiotic therapy	6,038	84.1%	10,991	81.6%	< 0.001
Surgery while in the ICU	653	9.1%	1,218	9.0%	0.912
IABP	193	2.7%	361	2.7%	0.995
ECMO	23	0.3%	41	0.3%	0.947
Non-invasive ventilation	313	4.4%	587	4.4%	0.981
Plasmapheresis	51	0.7%	41	0.3%	< 0.001
Therapeutic hypothermia	49	0.7%	173	1.3%	< 0.001

CRRT — continuous renal replacement therapy; IABP — intra-aortic balloon pump; ECMO — extracorporeal membrane oxygenation

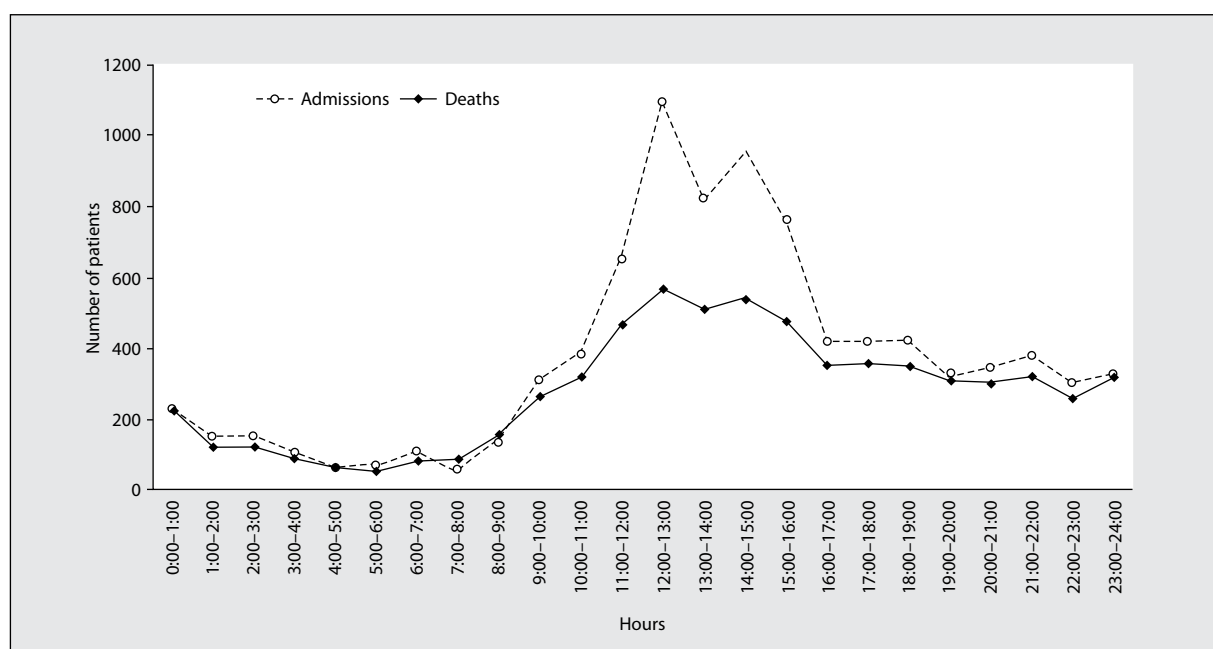


Figure 1. Total number of ICU admissions in the individual weekday hours (separate lines for admissions with discharge and resulting in death)

(days off). The separate lines denoted the number of admissions of patients discharged from ICUs and those who died.

Analysis of data demonstrated that the incidence of ICU admissions was significantly lower during night hours, irrespective of whether weekdays or days off were analysed. On weekdays between 11.00 a.m. and 4.00 p.m., patients with beneficial treatment outcomes predominated. During the remaining hours and days off, the above correlation was not observed (Figs 1, 2).

The mortality among patients admitted to ICUs at different hours varied. On weekdays, the highest mortality (59.1%)

was noted among patients admitted to ICUs between 8.00 a.m. and 9.00 a.m. whereas the lowest one among those admitted between 1.00 p.m. and 2 p.m. During days off the mortality of patients admitted at various hours was less variable and the relationships were completely different — the highest mortality (53.4%) was observed among patients admitted to ICUs between 1.00 p.m. and 2.00 p.m. (i.e. when the mortality during weekdays was the lowest one); the lowest mortality (40.0%) was found among patients admitted between 4.00 a.m. and 5.00 a.m.

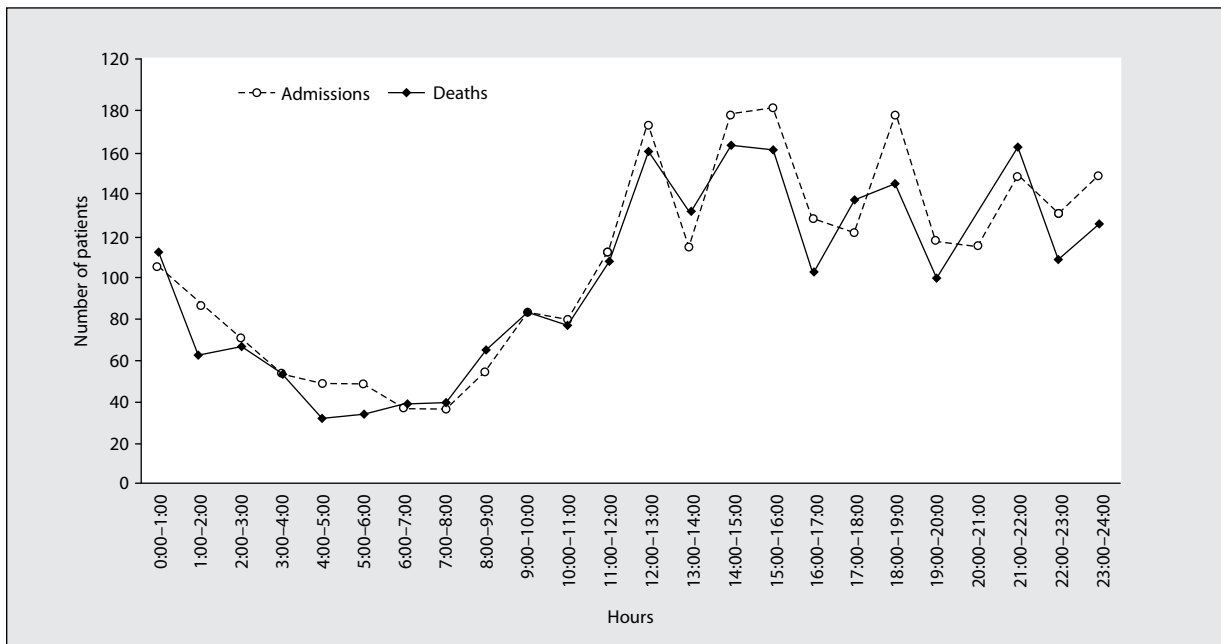


Figure 2. Total number of ICU admissions in the individual off-day hours (separate lines for admissions with discharge and those ending in death)

DISCUSSION

Analysis of the study findings demonstrated that the vast majority (65.2%) of patients treated in ICUs reporting to the Silesian Registry of ICUs are admitted outside regular working hours (off-hours), i.e. during on-call hours. This is not surprising as the situation looks very similar in other countries. According to various reports, the percentage of those admitted during off-hours is 69.2% in Finland [1], 69% in the United Arab Emirates, 65,6% in France [15], and 49% in Canada [2]. Therefore, to maintain a high quality of medical services in ICUs, special attention should be paid to proper provision of on-call staffing.

Our study evidenced that during off-hours admissions the number of patients admitted from the operating suite was lower, which is obvious since in many hospitals patients are admitted to ICUs after serious elective surgical procedures (performed during on-hours) because they cannot be safely managed in the surgical departments as they require increased monitoring and methods of treatment available only in ICUs. According to the guidelines of the Polish Society of Anaesthesiology and Intensive Care defining the rules of selection and the criteria for admission to ICU, second-level priority patients are to be admitted, requiring intensive monitoring under increased surveillance, who may need invasive methods of treatment at any time [16]. Therefore, during on-call hours, patients from the emergency or admission departments predominate.

The fact that ICUs quite often admit patients after elective surgical procedures performed during regular working hours has been reflected in the data presented in Figs 1 and

2. On weekdays between 11.00 a.m. and 4.00 p.m. patients with beneficial outcomes markedly predominated among those admitted to ICUs. It is generally known that prognosis in post-surgical patients is better and one of the causes of high mortality in Polish intensive care units is likely to be that such units less frequently admit patients after surgical procedures, requiring only intensive monitoring under increased surveillance [12, 13].

Our results indicated that despite their younger age, patients admitted to ICUs during shifts had significantly higher APACHE II and SAPS III scores, and thus were in substantially more severe general conditions, as age is one of the factors significantly affecting the above scores. The fact that “shift” admissions concern patients in more severe general conditions has also been reported by other authors [1–3, 5] while this observation pertained not only to intensive care units but to all hospitalisations [4].

The observations concerning differences in the incidence of individual health conditions in patients admitted to ICUs during on- and off-hours are of special interest. For instance, it was found that during off-hours the number of patients with the diagnosis of cancer admitted to ICUs was almost twice as low (Table 2). According to the guidelines mentioned earlier, their health conditions preceding a life-threatening situation, as well as the severity of process of the ongoing disease, markedly limit their chances for recovery and beneficial effects resulting from ICU admission yet qualify them for the provision of intensive care, which can immediately relieve their suffering during the irreversible disease process. As could have been expected,

such admissions (the next, third-level priority according to the guidelines) would be rather during working hours. The common stereotypes generate doubts whether cancer patients should generally be admitted to ICUs. Therefore, it is worth mentioning that in other European countries cancer patients are also admitted to intensive care units and often with advanced stages of disease. A study by Lyngaa *et al.* [17] observed that among 240,757 patients with cancer hospitalised in various departments within the last 6 months before death, up to 8.7% had been hospitalised in intensive care units.

During shifts, patients with alcohol dependence syndrome were substantially more often admitted to ICUs (10.3% vs. 6.9%), which obviously evidences that ICU admissions are markedly more predictable during normal working hours. The available literature data revealed that the scale of issues regarding patients with alcohol dependence syndrome admitted to intensive care units was comparable to other European countries. According to Christensen *et al.* [18], in Denmark 7.3% of patients admitted to intensive care units are alcoholics.

Higher incidences of the use of catecholamines and invasive ventilation observed in our study most likely result from more severe general conditions of patients admitted during shifts. Moreover, Silesian ICUs more frequently use therapeutic hypothermia during off-hours, although the popularity of this method is still markedly lower than in other countries, e.g. in United Kingdom [19].

Treatment outcomes of patients admitted to Silesian ICUs during off-hours were generally worse in terms of several indices; significantly higher mortality rates during treatment in ICUs were obviously pivotal; however, a higher percentage of patients discharged in vegetative or minimally conscious states was also of great importance. Among patients admitted to ICUs during off-hours, the percentage of patients on discharge whose conditions could be considered as good was over 10% lower, which presumably will be extremely relevant for their quality of life after discharge.

Of note is the fact that our study has several limitations, i.e. its retrospective, observational nature, incomplete representativeness of the sample (the Silesian Registry received data only from some Silesian intensive care units) and the lack of explicit definitions regarding some terms used in the Registry. The strength of our study is, however, a large population analysed and a wide representation of intensive care units of various profiles.

Irrespective of new and valuable information concerning the differences between the population of patients admitted to intensive care units during on- and off-hours, our results also confirm high mortality rates among patients treated in ICUs, which is hardly surprising. "Intensive Care Medicine" recently published correspondence indicating

that mortality in Polish intensive care units has been higher compared to other European countries [13]. Moreover, it has been demonstrated that this higher mortality does not result from worse quality of care but from the fact that Polish intensive care units admit a completely different population of patients [12]. The structure of admissions to Polish ICUs contains a system-related error, whose correction will require decisive administrative and educational actions.

Furthermore, the first recently published data on treatment outcomes in patients discharged from ICU in our centre are alarming [20]. Among patients aged < 80 years with positive treatment outcomes (thus discharged), 48% die within one year after discharge; in those aged > 79 years, the annual mortality is up to 82% [20]. It seems that such indices should not go unnoticed; as in other countries, post-discharge follow-up of patients (not only those discharged from ICUs) should be of special interest to researchers of various medical fields.

CONCLUSIONS

During off-hours, Polish intensive care units admit a different and more difficult-to-manage population of patients. The majority of ICU admissions take place during off-hours and the general conditions of admitted patients are more severe, which translates into higher hospital mortality, despite the comparable quality of care provided. Providing a high quality of medical services during off hours is crucial for the proper functioning of any unit or department.

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