

ANALYSIS OF READMISSIONS TO NEUROSURGERY INTENSIVE CARE UNIT

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Summary

Background. Around 10% of patients in developed countries are readmitted to the Intensive care unit during the same hospitalisation each year [1,2]. Readmission is associated with increased length of stay, risk of morbidity and mortality and higher hospital costs [1,3]. Finding out the factors increasing the risk of readmission is essential to predict which patients will return to the ICU. **Aim.** To analyse the incidence and causes of readmissions to the NICU and to assess the impact of readmissions on patients' outcomes.

Methods. A retrospective single-center chart review of 90 patients readmitted to the Neurosurgery intensive care unit (NICU) of the Hospital of Lithuanian University of Health Sciences (LUHS) "Kaunas Clinics" from January 1st to December 31st of 2020, was performed. Demographic and clinical variables such as: admission diagnosis, timing and indications for readmissions, length of NICU stay during readmission, presence of infection, the need for vasopressors and mechanical ventilation (MV) were assessed.

Results. 1598 patients were admitted to the NICU in 2020. 90 case histories of readmitted patients were analyzed. Patients were divided into survivors and non-survivors groups. 46 (51.50%) of patients were males, the average age was 63.68 (SD 15.89) years. Most frequent indications for readmission were respiratory failure (25.56%), reoperation (24.44%), neurological reasons (21.11%, e.g. decreased state of consciousness, status epilepticus). The readmission rate was 5.63%. The mor-

tality rate of readmitted patients was 22.50% (the overall mortality in the NICU in 2020 – 10.40%). Presence of nosocomial infection and MV were associated with longer length of stay in the NICU ($p < 0.05$). Higher mortality was related to worse state of consciousness at the time of readmission to the NICU, presence of nosocomial infection, need for vasopressors and/or MV ($p < 0.05$). **Conclusions.** The rate of readmission to the NICU was 5.63%. The most common causes for readmission to the NICU were: respiratory failure, reoperation, and neurological indications. The mortality rate of patients that were readmitted to the NICU was higher than overall mortality. Respiratory failure, the need for vasopressors, mechanical ventilation, and hospital-acquired infection were related to worse outcomes.

Introduction

The rising prevalence of the patient-centred model of care and the increasing focus on patient safety have increased the need to optimise the stages of healthcare where adverse patient outcomes can be prevented [1]. According to the European Society of Intensive Care Medicine, the incidence of readmission to the intensive care units (ICU) is one of the most important indicators of the healthcare system [1,2,4]. As many as 1 in 10 patients (2-14%) in developed countries are readmitted to the ICU during the same hospitalisation [1,2]. Readmission to the ICU increases not only the length of the hospital stays, but also the risk of morbidity and mortality, as well as the costs of healthcare [1,3]. The reasons behind the return of patients to ICUs are varied and determined by multiple factors related to the patient, the main illness and the healthcare system. It is encouraged to pay attention to patient discharge procedures, criteria and timing, as

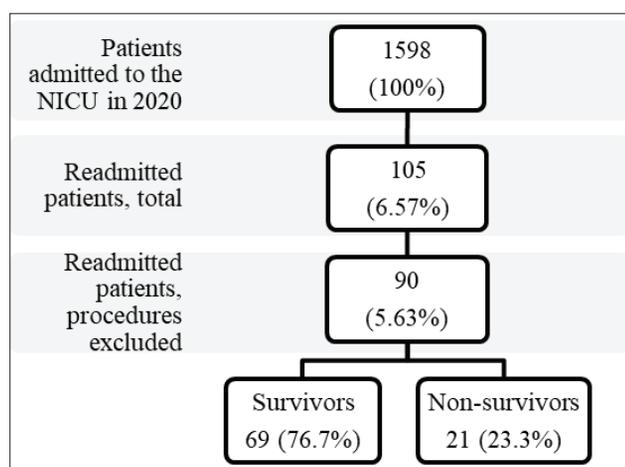


Figure 1. Patient selection flow chart

releasing patients at certain times may influence the rate of readmission [1].

Literature reflecting the relevance of readmission to ICUs and examining the causes of it is limited, while articles analysing the causes of readmission to neurosurgical intensive care units (NICU) are even more scarce [5]. It is essential to clarify the factors that increase the risk of readmission in order to predict which patients will return to NICU.

The aim of this study was to investigate the incidence and causes of readmissions in the NICU and to assess the associations between readmissions and patients' outcomes.

Methods

A retrospective single centre chart review of 90 patients' who were readmitted to NICU of Hospital of Lithuanian University of Health Sciences (LUHS) "Kaunas Clinics" from 2020 to 2021 was performed. The study was approved by the Local Bioethics Committee of the LUHS (No. BECMF-259). Inclusion criteria were: readmission to the NICU,

Table 1. Patients' characteristics

Characteristics		Total, % (n)	Survivors, 76,7% (n = 69)	Non-survivors, 23,3 % (n = 21)	<i>p</i> value
Age		63.68y; [19-93]; SD 15.89	63.04 y;[19-87]; SD 15.50	65.76 y;[34-93]; SD 17.34	0.496
Gender	Females	48.99 (44)	75.00 (33)	25.00 (11)	0.715
	Males	51.11 (46)	78.26 (36)	21.74 (10)	
BMI	< 30	75.60 (68)	75.00 (51)	25.00 (17)	0.511
	> 30	24.40 (22)	81.81 (18)	18.18 (4)	
GCS score at the time of readmission		9.24; [3-15] SD 4.69	10.33; [3-15] SD 4.59	5.67; [3-11] SD 2.99	< 0.001
Indication for 1 st admission to the NICU	Traumatic brain injury	23.33 (21)	66.66 (14)	33.33 (7)	0.511
	Spontaneous intracerebral hemorrhage	21.11 (19)	68.42 (13)	31.57 (6)	
	Stroke	18.88 (17)	82.35 (14)	17.65 (3)	
	Malignancy	16.66 (15)	73.33 (11)	26.66 (4)	
	Non-malignant tumor	8.88 (8)	100.00 (8)	0.00 (0)	
	Infection	3.33 (3)	100.00 (3)	0.00 (0)	
	Other	0.77 (7)	85.71 (6)	14.29 (1)	
Duration of admission (mean, min, max)	1 st admission	4.82; [1-28], SD 5.75	4.54; [1-28], SD 5.76	5.76; [1-19], SD 5.73	0.395
	Readmission	5.92; [1-57], SD 8.12	5.61; [1-57]; SD 8.20	6.95; [1-24], SD 7.73	0.509

age ≥ 18 years. The patients who were admitted to the NICU for a procedure (as central venous catheter insertion, hemodialysis) were excluded from the data analysis (Figure 1). Included patients were divided into two groups: survivors and non-survivors. We analysed: demographics, body mass index (BMI), Glasgow coma scale (GCS) score at the time of readmission, admission diagnosis, indication for readmission, duration and timing of readmission, presence of infection, need for vasopressors and/or MV. Statistical analysis was performed using IBM SPSS Statistics 27. The Chi-square, Independent T-samples test, Mann-Whitney U test were used to determine the relationship between variables.

Results

Patients' characteristics.

From 90 readmitted patients 46 (51.11 %) were males, the aver-

age age was 63.68 (SD 15.89) years. All patients were divided into two groups: survivors and non-survivors. Groups were comparable in terms of age, gender, BMI, indication and type of admission, duration of admission and readmission. The main difference between the groups was that non-survivors had significantly lower GCS score at the time of readmission ($p < 0.001$). All detailed patients' characteristics are presented in the Table 1.

Indications and timing of the readmission. The rate of readmission to the NICU was 5.63%. The most common indications for readmissions were respiratory failure, reoperation, and neurological reasons (e.g., decreased state of consciousness, *status epilepticus*). Z-test revealed that significant differences between the two groups were only observed in regards to respiratory failure and reoperation ($p = 0.008$). The majority of the patients (62.22%) were readmitted after 48 hours. Readmission timing did not differ between the groups ($p = 1$). The detailed data are presented in Table 2.

Table 2. Patients' survival according to readmission time and indication for readmission.

	Total, % (n)	Survivors, % (n)	Non-survivors, % (n)	p value
Readmission time				
< 24 h	17.77 (16)	75.00 (12)	25.00 (4)	1.000
24-48 h	20.00 (18)	77.78 (14)	22.22 (4)	
> 48 h	62.22 (56)	76.79 (43)	23.21 (13)	
Indication for readmission				
Respiratory	25.56 (23)	60.87 (14)	39.13 (9)	0.008
Reoperation	24.44 (22)	100.00 (22)	0.00 (0)	
Neurological reasons	21.11 (19)	78.95 (15)	21.05 (4)	
Therapeutic	20.00 (18)	66.67 (12)	33.33 (6)	
Infection	8.89 (8)	75.00 (6)	25.00 (2)	

Table 3. The factors influencing the outcomes of the patients. Strong relationship was considered to be Cramer's V > 0.3 , medium strength – 0.1-0.3.

Factors	Total, % (n)	Survivors, % (n)	Non-survivors, % (n)	p value	Cramer's V, p value	
Vasopressors	32.22 (29)	37.93 (11)	62.07 (18)	<0.001	0.631, (< 0.001)	
Mechanical ventilation	56.67 (51)	62.75 (32)	37.25 (19)	<0.001	0.376, (< 0.001)	
Infection	57.78 (52)	65.38 (34)	34.62 (18)	0.003	0.312, (0.003)	
Primary unit of admission						
Therapeutic	22.22 (20)	80.00 (16)	20.00 (4)	0.689	Not significant	
Surgical	77.78 (70)	75.71 (53)	24.29 (17)			
Type of admission (to the hospital)						
Emergency	13.33 (12)	91.67 (11)	8.33 (1)	0.187		
Planned	86.67 (78)	74.36 (58)	25.64 (20)			
Number of readmissions	1.37; [1-7] SD 0.89	1.38; [1-7] SD 0.89	1.33; [1-5] SD 0.91	0.846		
Duration of readmission	5.92 (SD 8.12) days	5.61 (SD 8.26) days	6.95 (SD 7.73) days	0.509		

Outcomes of the patients and factors influencing them. The mortality rate of readmitted patients was 22.50% ($n = 21$). In comparison, the overall mortality rate in the NICU in 2020 was 10.40%. The highest mortality was observed amongst patients readmitted due to respiratory failure (39.13%) and therapeutic reasons (33.33%). The vasopressor therapy, need for MV, hospital-acquired (nosocomial) infections, and respiratory failure ($p < 0.05$) were related to bad patient outcomes. Detailed data are presented in Table 3.

The average length of readmission was 5.92 (SD 8.12) days, ranging from 1 to 57 days. The longer duration of readmission was associated with the need of MV and nosocomial infection ($p < 0.001$). Other factors did not have an impact on readmissions' length of stay. The length of stay did not differ between the survivors and non-survivors ($p > 0.05$). The relationships between different factors and patients' length of stay are presented in Table 4.

Discussion

Our retrospective study, analysing the patients with readmissions to the NICU, had several significant findings corresponding with literature. 5.63% of the patients admitted to the NICU were readmitted, which was in agreement with findings in previous studies. Various studies have reported that between 1.5 and 14% of people admitted to the NICU were readmitted, with an average of 7% [1,2,6]. Data from the Dutch intensive care database show that their readmission rate ranges between 6.5 and 8.5% and varies by hospital [2], while a 10-year literature review found that the rate ranges from 1.5 to 13.4% [6]. This number has stayed similar for decades and suggests that despite medical improvement, readmissions remain a persistent problem [7].

Our study found that the most common causes for readmission were respiratory distress or failure, this was consistent with findings from previous studies. A literature review performed by McNeill and Khairat (2020), found that 18 to

59% of readmissions were associated with respiratory issues [6]. Lin and co-authors analysed early (within 48 hours) readmissions of which 48.5% were readmitted for respiratory failure [8]. Respiratory issues, along with postoperative care, neurological deterioration and therapeutic indications were the main indications for readmission in our study. Unlike the previously mentioned studies, our study did not isolate cardiac deterioration as a separate reason for readmission. The studies were performed in general/wider profile ICUs and this was found to be the second most common indication [6,7]. In contrast, NICU is a very specific unit where patients with this pathology are rare and therefore included in therapeutic indications.

Readmission to the ICU has been found to be associated with poorer outcomes for patients, increasing the length of hospital stays and overall costs per patients, while the availability of ICU beds decreases [1,6,8]. Our study revealed that readmissions to the NICU raise the risk of mortality by at least twofold, with 10.39% in non-readmitted and 22.5% in readmitted patients. These findings were in accordance with research showing that readmission increases mortality from 10% to 27.5%, in addition, higher mortality rates were noted if intubation was required during readmission [6]. In the Ponzoni et al. study, the in-hospital mortality rate was almost three times higher for patients who were readmitted [1]. They also highlight that readmitted patients are more likely to require the use of resources such as vasopressors, mechanical or non-invasive ventilation and renal replacement therapy [1]. These needs have also been found to be associated with an increased risk of death [1]. In our study, as in others, the need for vasopressors, MV and hospital-acquired infections was associated with worse outcomes, including prolonged length of NICU stay and patient mortality. Given the elevated rate of mortality associated with readmission more attention should be drawn at identifying risk factors to prevent it.

Our study has several limitations. Firstly, this was a retrospective study, with data collected from an existing data base; therefore, the quality of the information gathered may have varied between specialists, e. g., when only the main reason for readmission was recorded, whilst there were several. Neither did we have information on what happened after discharge from the NICU. A prospective study collecting targeted data would be meaningful. Secondly, the study was carried out in the NICU; therefore, the results may differ and not be applicable to other ICUs of our hospital or ICUs in other developing countries.

Table 4. Factors related to longer readmission.

Factors		Duration of readmission			p value
		Range	Median	Q ₁ ; Q ₃	
Infection	Yes	[1-57]	7	2.25; 11.75	< 0.001
	No	[1-7]	1	1; 2.25	
MV	Yes	[1-57]	6	2; 11	< 0.001
	No	[1-24]	1	1; 3	
Primary unit of admission	Therapeutic	[1-57]	3	1; 8.75	0.872
	Surgical	[1-33]	3	1; 8	
Urgency of the condition	Urgent	[1-57]	3	1; 8	0.801
	Non-urgent	[1-23]	3	1; 5.75	

Conclusions

1. The rate of readmission to the NICU was 5.63%.
2. The most common indications for readmitting a patient to the NICU were respiratory failure, postoperative care (reoperation), and neurological indications.
3. The mortality rate of rehospitalised patients was higher than overall mortality in the NICU.
4. Respiratory failure, need for vasopressors, mechanical ventilation, and hospital-acquired infection were related to worse outcomes.

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REHOSPITALIZACIJOS PRIEŽASČIŲ IR GYDYMO BAIGTIES ANALIZĖ NEUROCHIRURGIJOS INTENSIVIOSIOS TERAPIJOS SKYRIUJE

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Raktažodžiai: Neurochirurgijos intensyvosios terapijos skyrius, rehospitalizacija, gydymo baigtis.

Sa特拉uka

Išsivysčiusiose šalyse kasmet apie 10 proc. pacientų tos pačios hospitalizacijos metu pakartotinai paguldomi į intensyvosios terapijos skyrių [1,2]. Pakartotinis hospitalizavimas susijęs su ilgesne gydymo ligoninėje trukme, didesne sergamumo ir mirtingumo rizika bei didesnėmis ligoninės išlaidomis [1,3]. Norint numatyti, kurie pacientai grįš į intensyvosios terapijos skyrių, būtina išsiaiškinti pakartotinės hospitalizacijos riziką didinančius veiksnius.

Tyrimo tikslas – išanalizuoti kartotinės hospitalizacijos į Neurochirurgijos intensyvosios terapijos skyrių (NITS) dažnį, priežastis ir įvertinti rehospitalizacijos įtaką pacientų gydymo baigčiai.

Metodai. Retrospektyvinis tyrimas, kuriame analizuoti 90 pacientų, pakartotinai hospitalizuotų į NITS nuo 2020 m. sausio 1d. iki gruodžio 31d., ligos istorijų duomenys. Buvo vertinami bendrieji demografiniai duomenys, pagrindinė diagnozė, gretutinės ligos, pakartotinio hospitalizavimo laikas bei indikacijos, buvimo NITS trukmė rehospitalizacijos metu, įgytos infekcijos, vazopresorių ir dirbtinės plaučių ventilacijos (DPV) poreikis.

Rezultatai. Į NITS 2020 metais buvo hospitalizuoti 1598 pacientai, iš kurių rehospitalizuota – 90 pacientų. Tiriamieji buvo suskirstyti į išgyvenusiujų ir neišgyvenusiujų grupes. 46 (51,50 proc.) pacientai buvo vyrai, amžiaus vidurkis 63,68 metų (SD 15,89). Dažniausiai pacientai į NITS pakartotinai hospitalizuoti dėl kvėpavimo nepakankamumo (25,56 proc.), po pakartotinės chirurginės intervencijos (24,44 proc.), neurologinių priežasčių (21,11 proc., pvz., sąmonės būklės blogėjimas, epilepsinė būklė). Rehospitalizacijos dažnis – 5,63 procento. Pakartotinai hospitalizuotų pacientų mirtingumas buvo 22,50 proc. (bendras NITS mirtingumas 2020 m. – 10,40 proc.). Hospitalinės infekcijos ir DPV poreikis buvo siejami su ilgesne rehospitalizacijos trukme ($p < 0,05$). Didesnis mirtingumas reikšmingai susijęs su pablogėjusia sąmonės būkle rehospitalizacijos metu, hospitalinės infekcijos diagnoze, vazopresorių ir (ar) DPV poreikiu ($p < 0,05$).

Išvados. Rehospitalizacijų dažnis į NITS sudarė 5,63 procento nuo hospitalizuotųjų skaičiaus. Dažniausios rehospitalizacijos priežastys buvo chirurginės (kartotinės operacijos), neurologinės ir kvėpavimo nepakankamumas. Pacientų, kurie buvo pakartotinai hospitalizuoti į NITS, mirtingumas buvo didesnis už bendrąjį. Kvėpavimo nepakankamumas, vazopresorių poreikis, dirbtinė plaučių ventilacija ir hospitalinė infekcija buvo susiję su blogesnėmis gydymo baigtimis.

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