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**BALANCING NURSES' WORKLOAD:
A CASE STUDY WITH NURSE
ANAESTHETISTS AND INTENSIVE
CARE NURSES****Olga Riklikiene**

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ABSTRACT. Over the last two decades, intensive care has changed significantly. The nursing care intensity and the workload of nurses in the intensive care units have increased. In order to distribute tasks among nurse anaesthetists and intensive care nurses effectively and to balance their workload there is a need to implement nurses' workload calculation techniques on a daily basis. The presented study aims to estimate the nurse anaesthetists and intensive care nurses' workload by assessing nursing care intensity and patients' severity in intensive care unit. The descriptive cross-sectional study design was employed for this study. The data was collected at a university hospital cardio-surgery intensive care unit. The total of 1147 assessments of nurses' workload were performed. The relationship between TISS-28 components and nurses' workload was analysed and a significant positive correlation among nurses' workload, patients' age and length of stay in the unit was determined. An excessive nursing workload increased by the overall nursing actions, support of cardiovascular, renal and metabolic system actions. The implementation of TISS-28 into nursing practice could help with showing the value of nursing practice and nurses' input, also it would help calculating the nurses' workload more accurately and improving the distribution of nurses in the workplace.

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Introduction

The main goal of activities at healthcare institutions is to create added value for patients (Čiarnienė et al., 2017). All over the world, nurses constitute the largest group of human resources in health care, and according to (Ulep, 2018), significant shortage of nursing staff is predicted in the nearest future. Therefore, determining the nurses' workload and the nurse-physician, nurse-patient, nurse-auxiliary staff ratio has become urgently important for balancing human resources in healthcare. Many European states lack a unified policy and a strategy of planning human resources or commonly accepted workload standards and norms in health care. In most cases, recommendations and guidelines formulated by the national or European professional societies and organisations are followed (Riklikienė, 2009; Lithuanian University of Health Sciences [LUHS], 2011).

Appropriate management of nursing human resources and regulation of nurses' workload is of great significance for safe and high-quality patient-oriented care as well as for justifying nursing resources' rational size and structure. On the contrary, when sufficient information about nurses' activities, their workload and work schedule is lacking, nursing managers, directors and healthcare policy makers cannot precisely define the necessary number of nurses and distribute the nursing resources properly (Kwiecien et al., 2012; Carmona-Monge et al., 2013; Sermeus et al., 2011; Porter-O'Grady & Malloch, 2016; Katz, et al., 2018).

Inadequate nurses' work organisation, work time distribution and exploitation have a negative effect on the patient's care outcomes and the quality of nursing care. Insufficient nurse-patient ratio leads to increased patient mortality (Clarke & Aiken, 2003; Kiekkas et al., 2008; Cremasco et al., 2013) and higher frequency of undesirable cases (Hugonnet et al., 2007; Cimiotti, 2012). This leads us to a conclusion that the less time nurses have for direct nursing care, the worse are the results of patients' recovery (Čiarnienė et al., 2019).

Another problematic issue is high intensity of nurse's work. European studies have shown that intensive care nurses are the greatest economic investment in intensive care departments, accounting for about 50 per cent of all the costs. Therefore, appropriate management of human resources is a complex, but necessary management process (Lundgrén-Laine & Suominen, 2007). Inadequate planning of human resources, increasing lack of nurses and growing workload indicate that the healthcare system needs certain solutions to improve the work organisation of nursing staff to enhance the quality of nursing care (Lithuanian University of Health Sciences [LUHS], 2011).

In order to evaluate the complex work of nurses, to determine the patients' nursing needs and to estimate precisely the nurses' workload, various classifications and methodologies have been developed and tested during the last decades (Fasoli & Haddock, 2010; Webster et al., 2011). However, precise balancing of the nurse-patient ratio is extremely difficult due to the level of nurses' competence and motivation, specific fluent characteristics of nursing activities, the number of patients and the severity of their state, their self-sufficiency as well as other specific organisational features of nursing care in a unit (Carmona-Monge et al., 2013; Čiarnienė et al., 2019).

The study aims to estimate the nurse anaesthetists and intensive care nurses' workload by assessing nursing care intensity and patients' severity in an intensive care unit. The first part of the paper presents literature review on nursing care. The second part of the paper presents the methodology of the research. The research results are discussed in the third part of the paper. The fourth part of the paper presents the discussion on the study results, and the last part of the paper concludes with key findings and recommendations for further research.

1. Literature review

Patients' nursing care consists of a number of processes and activities, the elements of which are often abstract, quite subjective, hardly measurable and estimable. The analysis of the nursing content, process and outcomes is related to the nursing intensity, which is expressed through the complexity and amount of the provided services, and the work time needed for each exact case of nursing. The more patients a particular nurse has to take care of, the lower are his/her physical and psychological capacities to perform the nursing activities in professional and timely manner, to motivate and encourage the patient, to inform and educate him/her. The poor nurse-patient ratio is often associated with the nurses' burnout syndrome, stress and job dissatisfaction in acute care and intensive care units (Cimiotti et al., 2012; Carmona-Monge et al., 2013; Cremasco et al., 2013).

A balanced nurse-patient ratio is an essential factor in ensuring efficient care, the important condition for timely identification of nursing and medical errors and preventing undesirable events. However, to reach a balanced nurse-patient ratio, special valid and reliable measures are necessary for adequate assessment and distribution of nursing resources as well as balancing their workload on daily basis.

Scientific literature admits that patient classification systems are among the best techniques for nursing managers to plan and evaluate the nurses' work (Degroot, 1989; Cordeiro et al., 2020). In daily practice, a patient classification system is used for matching the staff resources to the patients' needs (Čiarnienė et al., 2019). Various patient classification systems help to group patients according to nursing and medical diagnoses, nursing intensity, treatment and care interventions, diagnosis related groups or demographic factors (Patrician et al., 2010; Porter-O'Grady & Malloch, 2016). The research performed by Degroot (1989) showed that patient classification systems meant for the staff distribution and evaluation of nurses' work intensity, most frequently used in research, are patient acuity systems and workload management systems.

In addition to nursing classification systems, the various scales are used for the assessment of nurses' work intensity in intensive care unit, e.g., Nine equivalents of nursing manpower use score (NEMS) (Hugnes, 1999; Kwiecien et al., 2012), Therapeutic Intervention Scoring System (TISS-28) (Cudak-Bańska et al., 2005; Kane et al., 2007; Padilha et al., 2007; Muehler et al., 2010; Kwiecien et al., 2012). Nine equivalents of nursing manpower use score of nine nursing activities, the most important of which are: monitoring vital functions, administration of intravenous solutions, breathing therapy and treatment, treatment with vasoactive medications and other specific interventions (Hugnes, 1999). TISS-28 contains seven main categories (basic activities, cardiovascular system support, specific interventions, maintenance of artificial ventilation, urinary system maintenance, sustenance of neurological state and metabolism) and instructions for appropriate collection of information. TISS-28 has been validated and used in a variety of contexts to analyse workflow based on specific patient population. Research has shown that TISS-28 is a useful technique for determining the relationship between the severity level of the patient and the nurses' workload indicators in general and surgical intensive care unit (Padilha et al., 2008; Malstam & Lind, 2008; Muehler et al., 2010; Katz et al., 2018).

In Lithuanian health care context, practice of nurse anaesthetists and intensive care nurse belongs to specialized nursing practice, similar to the other four types of specialized nursing practice that exist in a country (i.e. community nursing care, operating room nursing, mental health nursing and emergency nursing). Nurse anaesthetist and intensive care nurse is one and the same professional position that is granted for general practice nurse after specialisation course. This course of the duration of 960 contact hours (36 ECTS) is provided by the higher education institutions (universities or colleges) as the continuing professional development

course. Usually nurse anaesthetists and intensive care nurses choose to practice in either the Department of Intensive Care or Department of Anaesthesiology.

The activity of a nurse and the nursing intensity are inseparable as work intensity determines how many tasks a nurse can perform during a particular time space. In ICU the work intensity is influenced by the staff structure and skills, and by the patients' physical and psychological health state, as well as their nursing needs (Čiarnienė et al., 2019; Lundgren-Laine & Suominen, 2007). On the other hand, unit and staff characteristics, including perceived adequacy of staffing, are associated with nursing teamwork on inpatient hospital units (Bragadottir et al., 2019). Going further, hospital and unit type, staff characteristics, nurses' perception of adequate staffing and level of teamwork have significant relationship with missed nursing care that is recently identified as quality indicator for nursing care and patient safety (Bragadottir et al., 2017; Cordeiro et al., 2020).

2. Methodological approach

The research was carried out in November 2013, and February and May 2014, i.e., lasted for three months. The descriptive cross-sectional study design was employed. The data was collected at University hospital Cardio-surgery Intensive Care Unit. Research site was the Intensive care unit with cardio-surgery profile at the University Hospital (i.e., tertiary level of service) in Lithuania.

Instruments. The nursing activities were observed by employing structural observation method. During the observation, the nurses' work intensity was evaluated according to the nursing intensity scale TISS-28 (Therapeutic Intervention Scoring System-28 available at <https://sfar.org/scores2/tiss282.php>), translated from English to Lithuanian and validated. This scale has been approved as a suitable measure for determining the relationship between the severity of the patient's condition and the nurses' workload indicators in the intensive care unit.

In order to estimate the time of nurse's activities, all nursing actions for every patient were calculated and evaluated according to the Therapeutic Intervention Scoring System-28 each day. The actions were evaluated by points. The total score of the nurses' work intensity depended on how many patients the nurse took care of during a shift (24hrs). Each TISS-28 point corresponds to 10.6 min. of the nurse's work time; therefore, each TISS-28 point was multiplied by 10.6. The obtained result was treated as the total time of the care provided by the nurse (Padilha et al., 2008). For instance, if the patient's TISS point is 28, multiply it by 10.6 min., and the obtained result is 296.8 min. They are divided by 60 min. (1hr), and the final score is 4.95 hr.

When filling in TISS-28, the anaesthetist and intensive care nurse recorded the patient's gender, age, diagnosis, besides, for patients after cardio-surgery operations, – mortality risk before the operation (in %), according to Euro SCORE (in points). In accordance with the standard Euro SCORE II evaluation, the patients were divided into three groups (low mortality risk – 0-2 points, medium risk – 3-5, high risk – 6 points and above).

The average annual capacity of the Intensive care unit (ICU) with cardio-surgery profile is 1950 patients undergoing treatment; the unit employs 59 anaesthetist and intensive therapy nurses. The severity of the patients treated in this ICU (22 beds) reflects the level of the provided services. The patients are classified into three levels (R II, R III and R III-3). On the average, R III level patients spent three bed-days (2013-2014), R III-3 level patients – two, and R II level patients – one bed-day. During the study, 412 unique patients treated in the ICU after different cardio-surgery operations were observed. In total, 1147 nursing care intensity observations were performed (most patients were observed several times) in 626 nurses' shifts. A random selection of the observations was performed during the chosen period. A permission for the

research was issued by the Bioethics Centre of the Lithuanian University of Health Sciences (No. BC-KS (M)-260).

The data were collected by the senior shift nurses (n=10) who worked in the ICU during the research period and who agreed to participate in the study. A pilot test was carried out to check if TISS-28 is understandable for the nurses. The test results showed that the questionnaire is understandable and applicable.

Statistical data analysis. Upon the basis of TISS-28, Euro SCORE II results and the sociodemographic data obtained from respondents, a database was created. The research findings were evaluated by using standard methods of statistical analysis: calculation of numerical values (mean values, standard deviations, observed frequencies in percentage, their margin of errors, reliable intervals). Linear correlation analysis methods were used for defining the relationship among variables.

For determining the interdependence of the variables, the strength of links between variables was evaluated with regard to the value of Pearson correlation coefficient. In linear regression, to determine statistically the strength of the dependence of independent variables and the dependent variable, the determination coefficient r^2 ($r^2 \leq 1$) was calculated.

The level of significance p was <0.05 . For comparing means of more than two groups, at normal distribution, dispersal analysis was used – ANOVA, the Student's (t) test was applied for two dependent samples. In order to analyse whether the nurses' work intensity differs in the cases of different patients' diagnoses, dispersal analysis of blocked data (ANOVA) was applied, post hoc analysis (Bonferroni criterion). Table 1 presents the patients' distribution according to gender, age and operation type.

Table 1. Characteristics of patients (1147 observations)

| Characteristics of patients | % |
|---|------|
| Gender | |
| Female | 47 |
| Male | 53 |
| Age (in years) | |
| 18-40 | 7.2 |
| 41-60 | 28.3 |
| 61-80 | 59.7 |
| 81-100 | 4.8 |
| Operation type | |
| Coronary artery bypass grafting surgery | 26.5 |
| Valve prosthesis operation | 25.5 |
| Other operations | 48.0 |

Source: *own compilation*

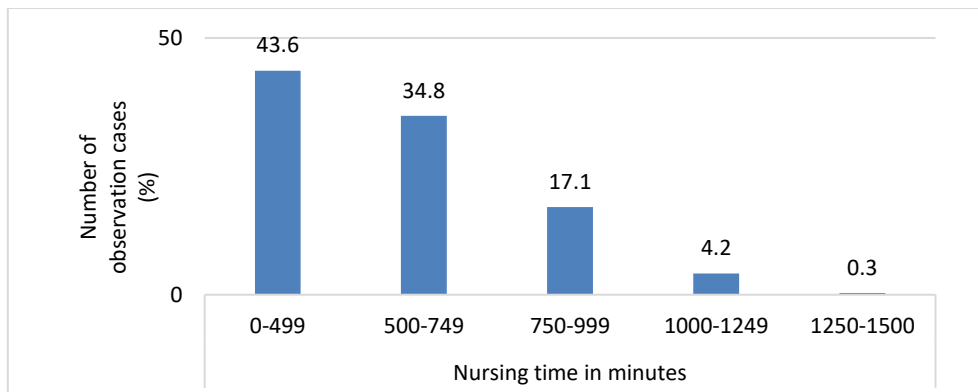
3. Results

When evaluating the observed patients after cardio-surgery operations and applying Euro SCORE II scale, it was determined that 35.4 % of patients belonged to the low mortality risk group, i.e., scored from 0 to 2 points; the smallest group of patients was at the highest mortality risk – 31.6 %, scored from 6 points and above; while the rest 33 % fell into the medium mortality risk group according to Euro SCORE II scale. Their average risk point was 3.08 ± 2.29 and median was 2.26.

According to the nurse distribution in the workplace in the intensive care unit with cardio-surgery profile, the number of nurses per shift was as follows: during the majority of shifts, i.e. 60%, 11 anaesthetist and intensive care nurses worked in each; in 26% of shifts 12 nurses worked in each, while 10 nurses worked during the smallest number of shifts (14 %).

During the shift, nurses' anaesthetists and intensive care nurses were taking care of 1 (16.7 % of the observed cases) to 3 patients (25.1 % of the observed cases). The working time of the nurse during the shift (24 hrs.) in points, according to TISS-28 scale, was as follows: the highest value - 128 TISS points, the lowest – 9 points.

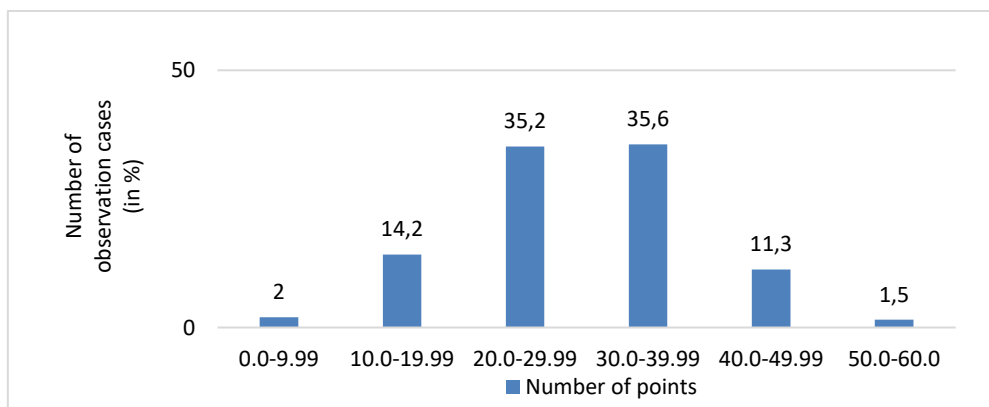
The distribution of the nurses' working time (Graph 1) indicates how much time (in minutes) nurses spent during the shift for providing intensive care for patients. On the average, nurses spent 10 hours during a 24-hour work shift for performing direct nursing care. During the rest of the shift time, the nurses were involved in indirect nursing care and other activities related to the unit work. In the major part of observations (78.4 %), the nurse's working time spent for patient care fluctuated from 1 to 750 minutes (12.5 hrs.) during a 24-hour work shift.



Graph 1. The nurses' working time (in minutes) during a shift according to TISS-28 (626 nursing shifts)

Source: *own data*

Graph 2 shows how the demand of patient nursing care was distributed, expressed in points according to TISS-28 scale. The highest nursing care demand, expressed in 58 points, happened in 18 observation cases (1.5 %), while the lowest – 7 points (in 23 observation cases – 2 %), median – 30. The average demand of patient nursing care, expressed in points according to TISS-28 scale, corresponded to 29.99 ± 9.34 points. The majority of patients (71 %) were characterized by the demand for care from 20 to 40 points.



Graph 2. The demand of patients' nursing care (expressed in points) according to TISS-28 (n=1147)

Source: *own data*

In over half of the patients' observations (53.4 %) the determined 12-15-point demand of patient nursing care was related to the maintenance of the general system (monitoring and registering of vital signs, calculating the fluid balance, taking laboratory test samples, intravenous injections and wound care and wound dressing). The highest demand of care for maintaining the general system activities reached 16 TISS points (3 observation cases from 1147), while the lowest demand of care was expressed by 2 points (6 observation cases), the average – 11.89 points. The findings indicate that on the average, nurses spent 2 hours ($11.89 \times 10.6 \div 60 = 2$ hrs) for maintaining the patients' general system.

In almost one fourth of observations (23 %), a 5-7-point demand of nursing care was estimated for maintaining the cardiovascular system. The highest value of the nursing care demand for sustaining the patient's cardiovascular system reached 26 points (1 observation case from 1147), the lowest – 2 points (193 observation cases), the average – 8.26 ± 4.70 . The findings show that during the observations, the nurses spent approximately 1.45 hour ($8.26 \times 10.6 \div 60 \text{ min.} = 1.45 \text{ hr}$) of the work shift time (24hrs) for maintaining the patients' cardiovascular system functions (infusions of vasoactive medications, massive intravenous fluid restoration, maintenance of central venous, arterial or lung catheters).

In less than half of observations (45 %), the 1-2-point demand of nursing care for maintaining the ventilation system was determined. The highest nurses' work intensity in taking care of the patients and satisfying their needs in maintaining the ventilation system was marked by 9 points (29 observation cases), the average – 3.60 ± 2.45 points. The findings show that during the observations, on the average, the nurses spent 38 min. ($3.60 \times 10.6 \div 60 = 0.636$ hrs) of the work shift time (24 hrs) for maintaining the patients' ventilation system.

In the major part of observations (73 %), the nursing care demand of 1 to 2.5 points was calculated for maintaining the specific system. The highest value of the care demand for maintaining the specific system was 8 points (5 observation cases), the mean value – 0.92 ± 1.57 points. The observations show that the nurses spent approximately 10 min. ($0.92 \times 10.6 \div 60 = 0.162$ hr) of the work shift time (24 hrs) for maintaining the patient specific system.

The nurses' work intensity, when assessing the demand of nursing care in maintaining the urinary system, was distributed as follows: the highest value was 9 points (44 observation cases), the mean value – 3.93 points, median 5. In a large part of observations (61 %), the 2.5-5-point nursing care demand for maintaining the urinary system was determined

Other nursing activities for satisfying the patients' nursing care demand (maintenance of nervous and metabolic system) and the nurses' work intensity related to these activities distributed as follows: the average point of the nursing care demand for maintaining the functions of the nervous system was 0.02. The demand of care for maintaining the metabolic system was 1.38 ± 1.95 points on the average. Complicated treatment of metabolic acidosis/alkalosis, par-enteric and enteric feeding was expressed by 1.38 points (15 min.) on the average, according to TISS-28 scale.

The findings indicate that the anaesthetist and intensive care nurses from this study site devote the major part of their working time (during a 24-hour work shift) to maintain the functions of general system (39.8 %) and to support the cardiovascular system functions of the patient (27.5 %) (Table 2).

Table 2. Distribution of nurses' working time spent for the patient care according to TISS-28

| Patient care activities | Working time for patient care during the shift (24 hrs) in % |
|-----------------------------------|---|
| Maintaining basic system | 39.8 |
| Maintaining cardiovascular system | 27.5 |
| Maintaining ventilation system | 11.9 |
| Maintaining urinary system | 13.1 |
| Maintaining metabolic system | 4.6 |
| Specific interventions | 3.1 |
| Total | 100.0 |

Source: *own compilation*

The analysis of patients' age, gender, severity level of the patient's health condition (according to Euro SCORE II), duration of stay in ICU, operation type, demand of patient care (according to TISS-28) and the nurses' work intensity revealed statistically significant but weak positive correlation between the patients' age and the nurses' work intensity ($r=0.064$, $p=0.034$); between the severity of the patients' health condition and the nurses' work intensity ($r=0.318$, $p<0.001$) and between the duration of the patients' stay in ICU and the nurses' work intensity ($r=0.172$, $p=0.002$) (Table 3).

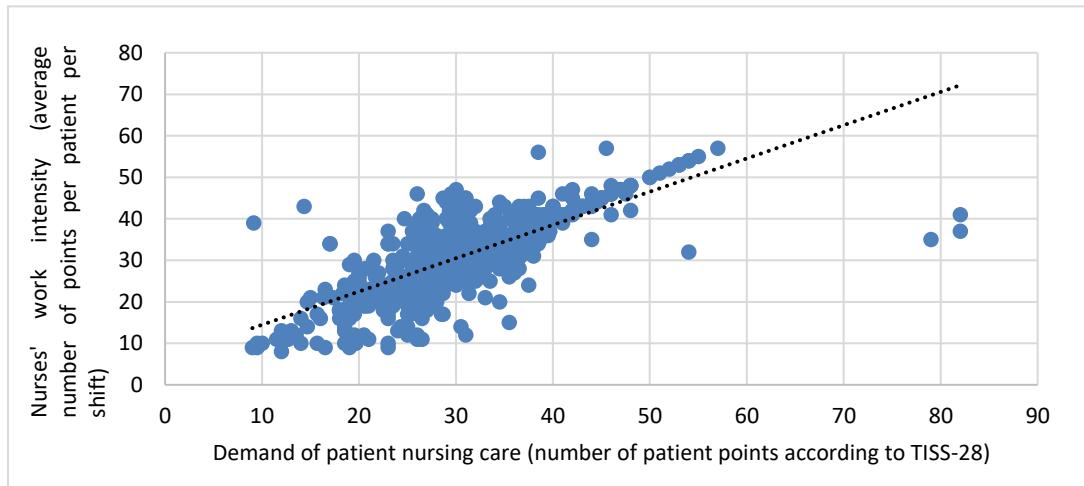
Table 3. Relationship between nurses' work intensity and patients' age, severity of health condition and duration of stay in ICU

| Nurses' work intensity | r* | p |
|--|-------|---------|
| Characteristics of the patients | | |
| Age | 0.064 | 0.034 |
| Health condition severity level (according to Euro SCORE II) | 0.318 | < 0.001 |
| Duration of stay in ICU | 0.172 | 0.002 |

*Pearson correlation coefficient

Source: *own compilation*

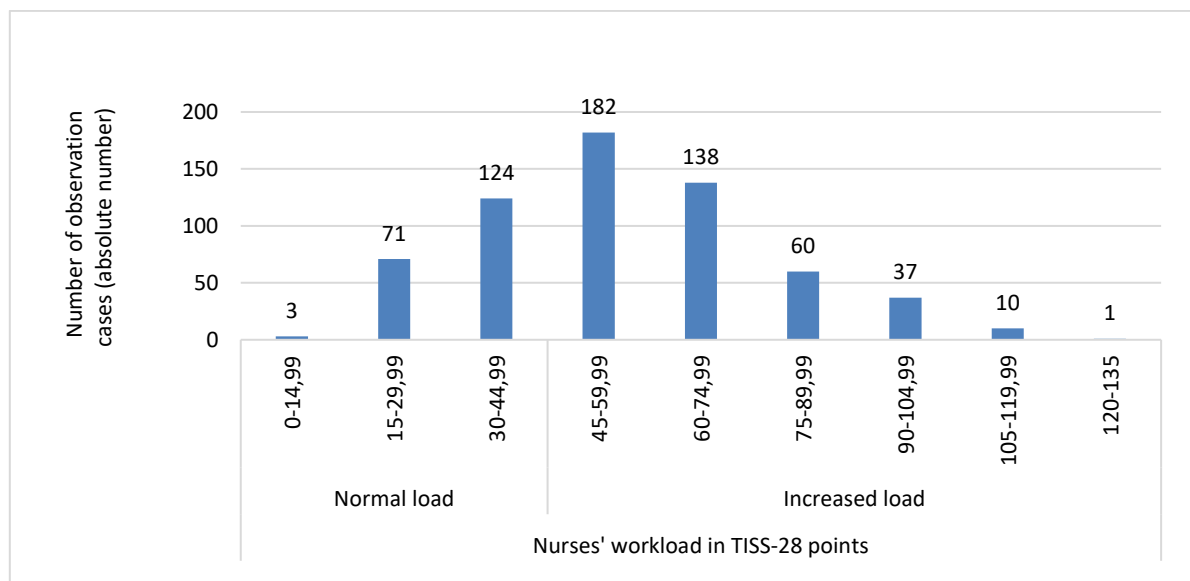
When analysing correlation between the demand of patient nursing care (expressed in TISS points) and the nurses' work intensity (according to the nurses' daily workload), a significant moderately positive relationship was determined ($r=0.75$, $R^2=0.564$, $p<0.001$) (Graph 3). This means that with the greater demand for nursing care, work intensity increases. Consequently, nurses' workload also increases since the amount and capacity of human resources remain the same. The findings prove that the demand of nursing care for patient is satisfied only due to the increased nurses' workload, which is higher than recommended.



Graph 3. Relationship between the demand of patient nursing care (in TISS-28 points) and the nurses' work intensity (626 nurses' shifts)

Source: *own data*

During the data analysis nurses were divided into a normal workload group, i.e. less than 45.28 TISS points per shift, and a group with higher than recommended workload, i.e. more than 45.28 TISS points. A majority of nurses (68.4 %) have had a higher workload than recommended (428 cases of nurses' shift observation) (Graph 4).



Graph 4. Distribution of nurses in accordance to normal and increased workload (in TISS-28 points; 626 nursing shifts)

Source: *own data*

Statistically significant differences between the nurses' workload groups were determined according to the assessment of patients' care demand in the following activities: maintenance of basic system ($p < 0.001$), maintenance of cardiovascular system ($p < 0.001$), maintenance of urinary system ($p < 0.007$), of metabolic system ($p < 0.017$) and that of specific system ($p < 0.025$) (Table 4).

Table 4. Distribution of the demand for nursing care in different nurses' workload groups

| Nursing activities | Group with increased workload (407 cases of nurse observation) | | Group with normal workload (198 cases of nurse observation) | | t | p* |
|--------------------------------------|---|------|--|------|--------|--------|
| | Average of TISS-28 points | SD | Average of TISS-28 points | SD | | |
| Maintenance of basic system | 12.26 | 1.80 | 10.89 | 1.98 | -8.425 | <0.001 |
| Maintenance of cardiovascular system | 9.14 | 4.7 | 6.92 | 4.79 | -5.524 | <0.001 |
| Maintenance of urinary system | 4.10 | 1.72 | 3.69 | 1.84 | -2.722 | 0.007 |
| Maintenance of metabolic system | 1.56 | 2.01 | 1.98 | 2.12 | 2.387 | 0.017 |
| Maintenance of neurologic system | 0.03 | 0.34 | 0.02 | 0.28 | -0.30 | 0.742 |
| Maintenance of specific system | 1.12 | 1.64 | 0.81 | 1.56 | -2.242 | 0.025 |
| Maintenance of ventilation system | 3.72 | 2.53 | 3.83 | 2.45 | -0.503 | 0.615 |

*Student's t-test

Source: *own compilation*

Table 5. Differences in pre-surgery demand for nursing care in two nurses' groups (with increased and normal workload)

| Patients' characteristics | Group with increased workload (n=407) | | Group with normal workload (n=198) | | t | p* |
|---|---------------------------------------|-------|------------------------------------|-------|--------|--------|
| | Mean (TISS-28 points) | SD | Mean (TISS-28 points) | SD | | |
| Valve prosthesis surgery | 32.42 | 7.38 | 29.21 | 9.6 | -7.432 | <0.001 |
| Coronary artery bypass grafting surgery | 30.01 | 6.39 | 29.94 | 10.15 | -1.954 | 0.768 |
| Other type surgery | 28.78 | 10.96 | 31.06 | 7.48 | 9.424 | <0.001 |
| Patients' severity level (according to Euro SCORE II) low risk group | 30.93 | 6.71 | 29.77 | 9.85 | -2.671 | 0.096 |
| Patients' severity level (according to Euro SCORE II) medium risk group | 33.03 | 7.70 | 29.33 | 9.53 | -5.897 | <0.001 |
| Patients' severity level (according to Euro SCORE II) high risk group | 35.27 | 8.97 | 28.9 | 9.04 | -16.42 | <0.001 |
| Age | 64.27 | 13.46 | 63.20 | 11.74 | -3.134 | 0.347 |

*Student's t-test

Source: *own compilation*

When analysing the patients' pre-operational characteristics (age, operation type, severity level according to Euro SCORE II scale) and the nurses' groups with increased and

normal workload, it was determined that the demand for nursing care and also the nurses' work intensity varied, depending on the patients' surgery type (valve prosthesis surgery ($p < 0.001$); other types of surgery such as Heart mate implantation or ventricular assist device implantation) and the severity level of the patient with medium and high risk group (according to Euro SCORE II scale) ($p < 0.001$). In all cases mean of TISS-28 points (severity of patients) was higher in the group of increased nurses' workload (Table 5).

Discussion

During the study, the Therapeutic Intervention Scoring System-28 was used for observing the distribution of anaesthetist and intensive care nurses' worktime according to their activities. TISS-28 scale was applied as a tool for evaluating whether the care tasks were properly distributed between anaesthetist and intensive care nurses. The nurses' activities were observed, and according to them, the demand for patient nursing care and the nurses' work intensity were estimated.

For research purposes, 1147 nursing care intensity observations were performed. During the initial analysis, 412 unique patients under treatment in the Intensive care unit with cardio-surgery profile were chosen. Estimations revealed that the patient/nurse ratio at study site was 2:1 in 658 observation cases (57.4 %). Craven (2006) claims that the patient/nurse ration in ICU should be 1:1 in nursing severe patients who are prone to different complications, while 2:1 would be sufficient when taking care of not so severe cases. According to another study, the recommended nursing staff ratio in ICU should be 1.2:1 (patient/nurse) (Dyk & Cudak, 2008). Lundgrén-Laine & Suominen (2007) performed a one-year research in the ICU unit in Finland, with 1757 patients that provided 15866 observation cases according to TISS-28. The findings revealed significant strong relationship between the TISS-28 points and the nurses' work intensity ($r = 0.57$). Upon the basis of TISS-28, the suggested patient/nurse ratio in ICU should be as follows: if TISS points > 22 , the nurse/patient ratio should be 1:1, while if TISS-28 < 22 points, the nurse/patient ratio should be 2:1 (Padilha et al., 2007).

The findings demonstrate that the anaesthetist and intensive care nurses' work intensity in study site was high. The average nurses' work intensity is 56 points out of the 88 maximum possible and the 46 recommended by foreign authors (Malstam & Lind, 2008). On the average, nurses spend 5 hours (60 %) for direct patient care during a 24-hour work shift, according to TISS-28. The other time of their work is dedicated to indirect patient care and unit related activities.

In relation to different care of patient needs nurses spent a major part of their worktime for maintaining the general and cardiovascular system of the patient, while the least time was spent for nursing actions to support the specific, ventilation, urinary and metabolic systems.

The patients undergoing treatment in ICU with cardio-surgery profile demonstrated high nursing need according to TISS-28. The patients' age was registered for the study with a presumption that older patients might have larger demand for nursing care, which would influence the nurses' workload and work intensity. After analysing the relationship between the patients' age and the nurses' work intensity, a conclusion was made that the relation is statistically irrelevant. The relationship between the demand of nursing care and the nursing care appointed to a nurse was calculated according to the same day workload and the patient severity. The relationship was found between the care demand and the nurse work intensity ($r = 0.75$). This result demonstrates that the care of patients needs are satisfied and care demand are met because of the increased workload of nurses, larger than recommended.

In data analysis nurses were divided into a normal workload group with TISS points < 45.28 per shift, and the group with workload larger than recommended, with TISS points > 45.28 per shift. According to the results, 68.4 % of nurses had a larger workload, while the

minority (1.6 %) – a smaller workload. It shows that the current routine distribution of anaesthetist and intensive care nurse with respect to the patient number in an ICU is irrational because the nurses' workloads differ significantly.

Statistically significant differences were observed between the two groups of nurses (with normal and increased workload) in the activities related to maintaining the general system ($p < 0.001$), the cardiovascular system ($p < 0.001$), the metabolic system ($p < 0.017$), the specific system ($p < 0.025$), thus demonstrating that the care demand in these cases increases nurses' workload. Lucchini (2015) made a comparative six-year analysis of nurses' work intensity in three ICU's (general, cardio-surgery and neurosurgery), which led to a conclusion that the nurses' work intensity increases with the activities for maintaining the general and cardiovascular systems, i.e., monitoring and medication titration.

It was determined that the anaesthetist and intensive care nurses' work intensity is also related to the severity level of the patient (according to Euro SCORE II) and was the highest when taking care of the patients after valve prosthesis and other operations (other operations including patients from thoracic, angio-surgery, cardiological and emergency wards, patients after heart transplantation and Heart Mate II implantations, etc.). The research performed by Muechler et al. (2010) showed that the highest demand of nursing care according to TISS-28 was identified for patients after cardio-surgery operations (47.7 points of TISS-28), and a statistically significant relationship was found between TISS-28 points and the severity level of the patient according to SAPS II and SOFA (both scales are used for determining the mortality risk of the patients, analogical to Euro SCORE II).

Patients in the ICU with cardio-surgery profile are of older age, severe health condition, and they demand larger amount of nursing care. In conclusion, with the information about the patients' pre-surgery characteristics, nurse managers should take more attention for proper distribution the staff and for arranging a better balance of the nurses' workload.

This study has some limitations. First, this was single site study, including only one intensive care unit with the specific care service for cardio-surgery patients. Therefore, the results of this study may be generalised to other similar working sites with the precaution. Secondly, other nurse professional characteristics and nursing care related factors, such as nurses' education level, professional work experience, work experience at ICU, unit admission and discharge intensity, managerial and leadership style and others should be included among the variables that may affect nurses' workload and work intensity. Additionally, further studies have to pay attention on and test the other more advanced methodologies for nurses' workload calculation and nursing resources distribution techniques.

Conclusions and practical recommendations

This study confirmed the fact that the clinical practice of nurse anaesthetists and intensive care nurses has become extremely complex and labour consuming. Anaesthetist and intensive care nurses' work intensity in providing care for patients after cardio-surgery was higher than average according to nursing intensity scale maximum score and is 1.22 times larger than that recommended by experts. The current patients' care demand in intensive care unit with cardio-surgery profile is satisfied due to the increased nurses' workload.

The excessive nurses' workload is related to the maintenance of patient's general system functions, maintenance of the cardiovascular system, urinary system and metabolic system. The intensity of the nurses' work differs with respect to the pre-surgery patients' characteristics, i.e. the type of surgery and the severity level of the patient condition (according to Euro SCORE II scale).

In order to ensure safe and high-quality patient care, the intensive care unit with cardio-surgery profile ought to have an adequate number of nursing and auxiliary staff as well as an

approved methodology for the nurses' workload assessment and management. For this purpose, the workload measuring methodology by applying Therapeutic Intervention Scoring System-28 could serve as a valuable tool in the daily work of nurse anaesthetists and intensive care nurses, and their managers for precise estimation of the patient care demand and distribution of human resources in nursing in the workplace. Application of valid and reliable nurses' workload measuring methodology in clinical practice would provide stronger authority for nursing managers that enable them to make timely and necessary decisions about planning and organizing efficient nursing care and optimizing nursing care rationing.

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