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Evaluation of nurses' workload in intensive care unit of a tertiary care university hospital in relation to the patients' severity of illness: A prospective study

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ABSTRACT

Backgrounds: Costs of intensive care reach up to 30% of the hospital budget with workforce expenses being substantial. Determining proper nurse—patient ratio is necessary for optimizing patients' health related outcomes and hospitals' cost effective functioning.
Objectives: To evaluate nurses' workload using Nine Equivalents of Nursing Manpower Use Score and Nursing Activities Score scoring systems while assessing correlation between both scores and the severity of illness measured by Simplified Acute Physiology Score II.
Design: A Prospective study
Settings: Cardiac Surgery Intensive Care Unit of the Clinical Hospital Centre Rijeka, Croatia, from October 2014 to February 2015. This Intensive Care Unit has 3 beds that can be expanded upon need.
Participants: The study included 99 patients treated at this Unit during the study's period. The scores were obtained by 6 nurses, working in 12 h shifts.
Methods: Measurements were obtained for each patient 24 h after admission and subsequently twice a day, at the end of the day shift (7 pm) and at the end of the night shift (7 am). The necessary data were obtained from the patient's medical records.
Results: Nursing Activities Score showed significantly higher number of nurses are required for one 12 h shift ($Z = 3.76$, $p < 0.001$). Higher scores were obtained on day shifts vs. night shifts. (Nursing Manpower Use Score, $z = 3.25$, $p < 0.001$; Nursing Activities Score, $z = 4.16$, $p < 0.001$). When comparing Nursing Activities Score and Nursing Manpower Use Score during the week, we calculated higher required number of nurses on weekdays than on weekends and holidays, (Nursing Manpower Use Score, $p < 0.001$; Nursing Activities Score, $p < 0.001$). Correlation analysis of Nursing Activities Score and Nursing Manpower Use Score with Simplified Acute Physiology Score II has shown that Nursing Manpower Use Score positively associated with severity of disease, while Nursing Activities Score shows no association.
Conclusion: Both scores can be used to estimate required number of nurses in 12-h shifts, although Nursing Activities Score seems more suitable for units with prolonged length of stay, while Nursing Manpower Use Score appears better for units with shorter duration of stay (up to four days). Higher workload measured by Nursing Manpower Use Score scale can be predicted with higher Simplified Acute Physiology Score II. However, with low Simplified Acute Physiology Score II scores it cannot be assumed that the nursing workload will also be low. Further research is needed to determine the best tool to asses nursing workload in intensive care units.

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What is already known about the topic?

- Cost effective ICU functioning is a challenge in managing hospital's budget with overall intensive care costs reaching up to 30% of the total institutional budget and with the costs of ICU workforce often higher than the cost of equipment.
- Nursing requirements in ICUs are still difficult to define mainly due to possibility of high variation in severity of illness of ICU patients in a short period of stay, hence scores utilized to estimate the ICU related nursing workload are still a subject of discussion among scientists.
- Nine Equivalents of Nursing Manpower Use Score (NEMS) and Nursing Activities Score (NAS) scoring systems were developed to assess nurses' workload and define it quite differently with NEMS being based on the therapeutic interventions which patients receive during ICU stay, while NAS counts specific activities of nurses that are part of the total intensive care treatment and is therefore more nursing oriented.

What this paper adds

- NEMS appears a more suitable instrument for measuring workload for patients who are extremely unstable and for patients with short length of stay in the ICU (up to three or four days), contrary to that, in patients who have a prolonged stay in the ICU and need more demanding procedures related to hygiene, administration, positioning in bed and mobilization, a more acceptable measurement tool could be NAS.
- As there is no correlation of NAS and Simplified Acute Physiology Score (SAPS II), higher workload measured by NEMS scale can be predicted with higher SAPS II, however, with low SAPS-II scores it cannot be assumed that the nursing workload will also be low, due to nursing work that may be necessary in intensive treatment and is unrelated to the severity of illness.
- For countries in transition, the numbers of nurses proposed by state legislation are often hard to achieve due to economic and organizational constraints.However, NAS and NEMS seem to provide realistic standards in nursing workload assessment.

1. Background

Rapid technological progress combined with changes of the health care system and growing expectations of patients resulted in significant change in working conditions of the Intensive care unit (ICU) nurses over the past twenty years. Life expectancy of patients is significantly higher than in the last century and the possibility to impact natural course of many serious illnesses which until recently were incurable is growing. There is a rise in the required number of intensive treatments, as well as in material and human resources necessary for intensive care.

Croatia is a small European country that suffered significant demographic and economic losses during the war from 1991 to 1995. Furthermore, together with the rest of the world, it was severely affected by the global economic crisis of 2008, which intensified the pre-existing post-war economic problems and impacted the already strained healthcare system as well. In Croatia, the health care system is divided into primary, secondary and tertiary sector. All Croatian citizens are entitled to basic health care through mandatory health insurance, while for a minority of health services they must participate financially if they do not have the supplemental health insurance. The exceptions to this rule are senior citizens, the disabled and the unemployed. Basically, Croatia has a social Health insurance, based on solidarity. Every working citizen must contribute to the state-owned health insurance system and everybody receives basic health care services if the need arises. The country also has a largely liberal sick leave and maternity compensation packages in comparison to western European countries, so there is a possibility for abuse, resulting in the need for rationalization of the costs at all levels of health care.

Most hospitals in Croatia are owned by the State and the average lengths of stay in acute hospitals in Croatia are significantly longer than in Slovenia and Hungary (countries bordering Croatia) and most other European countries (Dzakula et al., 2014), The ratios between numbers of nurses per inhabitant, and nurses per physician estimated in 2011 were well below the EU average (Dzakula et al., 2014), and have not changed significantly since then. In 2014, according to the data presented by the Eurostat (official EU website for statistical topics), Luxembourg ranked highest in nurse/100 000 inhabitants ratio (1197/100 000), while Croatia (120/100 000) was ranked among the lowest ratio countries, together with Romania (56/100 000), Greece (182/100 000) and Slovenia (244/100 000) (Eurostat).

In a survey made in 2001, there were 123 ICUs in Croatia, with 900 ICU beds altogether (Degoricija et al., 2002). In majority of them, nurses worked in 12 h shifts, and on average, the nurse/patient ratio was 7:11. The ICUs were poorly equipped (only 43.6% had a perfusor pump per bed, with one pump for enteral nutrition per two beds) (Degoricija et al., 2002).

The European Society of Intensive Care Medicine suggests that the number of nurse full-time equivalents for running one ICU bed is 6, and that nursing shifts should be 8 h (Ferdinande, 1977).

Australian College of Critical Care Nurses (ACCCN) established standard suggests nurse/patient ratio of at least 1:1 (Australian College of Critical Care Nurses (ACCCN)), and similarly to that, the British Association of Critical Care Nurses (BACCN) proposes an ICU should not go below 1:2 nurse/patient ratio (British Association of Critical Care Nurses (BACCN)). In the ICU, where this research was conducted, there were 3.3 full time nurses in the period of the study.

Croatian Nursing Council was not founded until 2003, thus legislation and regulation of the rights and work duties of nurses in the ICU setting are still in development.

The educational system for nursing in Croatia is also not without its problems. Although, it is based on the Bologna Process, the Croatian basic nursing education remains at the secondary school level and the doctoral degree in nursing is still non-existent (Simunovic et al., 2010). Nurses were considered, and often still are, physicians' assistants and based on job complexity index of health care workers, they have three times lower salaries than physicians, even though the standard practice is that they provide most of ICU care and a lot of decision making (Kalauz et al., 2008). In that sense, intensive medicine in Croatia is still greatly conservative.

The overall costs of ICUs reach up to 30% of the total hospital budget (Cerra, 1993), with the cost of ICU workforce being substantial, often higher than the cost of equipment (Debergh et al., 2012a). Hence, cost effective ICU functioning is a challenge in managing hospital's budget. The effect of excessive workload of nurses on patient outcomes and the total costs of treatment are already well known. Numerous studies have shown that the optimization in the number of nurses and conditions of their working environment result in higher patient safety and quality of health care (Hugonnet et al., 2004). The under staffing of nurses is directly related to: the increasing number of infections related to medical care in the ICU (Hugonnet et al., 2004; Grundmann et al., 2002; Vicca, 1999; Daud-Gallotti et al., 2012) and higher number of postoperative complications and prolonged stay in the ICU (Daud-Gallotti et al., 2012; Amaravadi et al., 2000; Dang et al., 2002; Dimick et al., 2001). It is well known that the cost of extended treatment of patients in institutions with insufficient numbers of staff is much higher than the costs of increased employment of nurses (Noseworthy et al., 1996). Aside from affecting patients' outcomes, it often also leads to nurses developing "Burnout"syndrome (Cho et al., 2009; Verdon et al., 2008).

Shortage in nursing care is a global challenge for hospital management systems. Nursing requirements in ICUs are still difficult to define mainly due to the possibility of high variation in severity of illness of ICU patients in a brief period of stay. Thus, diversity of