Nurse staffing levels in critical care: The impact of patient characteristics

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Abstract

Background: Intensive care is one of the most resource-intensive forms of care because seriously ill patients are cared for in units with high staffing levels. Studies show that the number of registered nurses (RNs) per patient and nurse education level affects patient outcome. However, there is a lack of studies that consider how nurses/patient ratio with an advanced educational level of specialized nurses in intensive care, affect the intensive care performed in different patient populations.

Aim: To investigate if differences in patient characteristics and nurse–patient ratio have an impact on the quality of care.

Study Design: This is a retrospective observational study with a review of all patients >15 years receiving care at two general intensive care units with different nurse/patient ratio (unit A, 1:1 nurse/patient ratio and unit B, 0.5:1 nurse/patient ratio).

Results: There was no significant difference in the initial severity of illness between the units. However, younger patients, male patients and patients requiring surgery entailed a higher workload and a longer intensive care unit (ICU) stay despite a 1:1 critical care nurse/patient ratio. A small difference, but not significant, with more unplanned re-intubations occurred at unit A compared with unit B.

Conclusion: The differences in the nurse/patient ratio did not reflect a difference in the severity of illness among admitted patients but might be explained by patient characteristics with different needs.

Relevance to Clinical Practice: Health care managers should consider not only the number of nurses but also their educational level, specific competencies and skills mix and nursing-sensitive measures to provide high-quality ICU care in settings with different patient characteristics. Nursing-sensitive patient outcomes should be considered in relation to nurse/patient ratio, as important to measure to ensure a high quality of patient care in the ICU.

KEYWORDS
intensive care, nurse–patient ratio, nursing, quality of care
1 | INTRODUCTION

Intensive care units (ICUs) are among the most resource-demanding forms of medical care because seriously ill patients, usually with a life-threatening conditions, are cared for in a high-tech environment with high staffing and competence levels. ICUs in Sweden care for approximately 50,000 patients each year and an additional 45,000 patients in close proximity to the ICU (post-operative recovery room and heart-intensive care) (Swedish Critical Care registry [SIR]). The need for health care, including ICU, is met by different health care systems across Europe due to demographic and population differences. Compared with other European countries, Sweden has one of the lowest numbers of intensive care beds (5 beds per 100,000 inhabitants) compared with Germany 35.3 per 100,000 inhabitants. Despite this, studies have shown that Sweden has a low estimated mortality risk (0.18%) among patients in ICUs compared with other European countries, which could suggest high-quality care. Possible explanations could be a high academic level among the health care personnel, which implies high clinical competence, and differences in resource allocations and treatment methods compared with other countries.4

To contribute to the knowledge concerning outcomes after intensive care, a national quality register has, since 2001, collected data from ICUs in Sweden. The goal of the registry is to collect and publish optimal medical and nursing-related results as measured by indicators such as mortality, complications, quality of life and functional status after intensive care. To date, there have been few studies that describe how indicators can be a useful measure of intensive care from the nursing perspective.

The nurse’s impact on patients’ health has been debated in the scientific literature. Aiken et al. have shown that nurse education at bachelor level, and an increased number of nurses per patient affects the frequency of complications measured by mortality and hospital-acquired infections and also leads to improved patient satisfaction. However, results from McGahan et al. demonstrated that a basic education level of nurses did not affect mortality and morbidity among ICU patients. Reports have also examined the impact of nursing workload on the quality of care and its relation to nursing-sensitive outcomes, such as lower incidence of pressure ulcers, falls, catheter-associated urinary tract infections (CAUTI), central line-associated blood stream infections (CLABSIs) and mortality. Results have also shown that patients in hospitals with better nursing work environments (OR 0.89; p < .05) and higher proportions of intensive care nurses with a bachelor’s degree in nursing (OR = 0.98; p < .05) experienced significantly lower odds of death. Several international organizations have stated that every patient in an ICU must have immediate access to a registered nurse (RN; nurse/patient ratio 1:1) with a post-registration qualification in a specific specialty; however, no such national recommendations exist for ICUs in Sweden.

The lack of RNs has resulted in RNs being responsible for a high number of patients which has led to impaired patient outcomes with increased patient mortality in acute and critical care units (Driscoll et al). International studies also show that insufficient competence among health care personnel causes more complications compared with underemployment of RNs.

From a European perspective, reports concerning nursing care show great variation in the education level, from nurse assistants to RNs, as well as differences in academic level (non-academic, bachelor or master's degree). Despite this variation, there is often a lack of a clear definition of what competencies are required in different levels of care as well as in different countries. In Sweden, the intra-hospital acute care includes nursing staff consisting of nursing assistants (NAs) and RNs. Neither education nor competencies for NAs are regulated, while RNs are licensed health care professionals. The education for NAs varies substantially, from 0 to a 3-year high school diploma while for RNs it consists of a 3-year university program including a bachelor’s degree. Additionally, to become a specialist in critical care (CCN) there is an additional 1-year post-graduate master’s degree at advanced level. In Sweden, ICUs have employed RNs with a post-graduate education in intensive care. In the in-hospital setting, the RNs are responsible for the overall nursing care and the NAs work as assistants to the RNs, caring for the fundamental physical needs of patients as described by Kitson. In our previous study, evidence that a higher ratio of CCNs per patient resulted in fewer complications was not found due to several differences between the units. Further knowledge is needed to deepen the discussion concerning nurse/patient ratio to provide high-quality care in different ICU settings.

What is known about the topic

- Nurse patient ratio has an impact on mortality and morbidity among patients
- Nurse education degree on a bachelor level and the number of nurses per patient affect the frequency of complications measured by mortality and hospital-acquired infections and also lead to improved patient satisfaction

What this paper adds

- The unit with more male patients and with more unplanned surgery and a 1:1 CCN/patient ratio had an increased workload despite no difference in the severity of injury or reason for admission.
- Health care managers should consider patient characteristics, the number of nurses and their educational level, specific competencies and skills mix to provide high-quality intensive care in different settings.

2 | AIM

The aim was to investigate if differences in patient characteristics and CCN per patient ratio have an impact on the quality of care.
2.1 Design and setting

A retrospective observational study using data from a quality registry, including patient >15 years admitted to level 3 ICUs with different nurse–patient ratio’s and to investigate differences in patient characteristics was used. This study was reported in adherence to the consolidated criteria for reporting observational studies (STROBE).25

We identified two university hospitals, which provided intensive care for patients >15 years with both medical and surgical complaints with a similar number of ICU beds (unit A: 12 beds, unit B: 10 beds), similar total number of clinical health care personnel per ICU bed (physician’s, RN’s and nurse assistants) and number of patients during the years 2010–2014, but with differences in nurse/patient ratio. Unit A with 1:1 Nurse/patient ratio and Unit B with 0.5:1 nurse/patient ratio. Included ICUs were both level 3 ICUs which provide a full spectrum of monitoring and life support technologies, serve as a regional resource for the care of critically ill patients, and have an active role in developing the specialty of intensive care through research and education and are included in a national quality register (SIR).

2.2 Procedure

Data from a national quality register (SIR) was collected (www.icuregswe.org). The goal of the registry is to collect and publish optimal medical and nursing-related results as measured by indicators such as mortality, complications, quality of life and functional status after intensive care. Included data from the registry were: number of patients, age, gender, severity of illness (Simplified Acute Physiology Score [SAPS III]), estimated mortality rates (EMR), length of ICU stay and burden of care (workload) (NCR11). The SAPS III is an ICU scoring system26 and it has been designed to provide real-life predicted mortality for an ICU patient. EMR is derived from the initial SAPS III scores according to the SAPS III equation.27 EMR as predicted mortality is a valid instrument when comparing groups of patients.28

The NCR11 is a measure of general workload using 11 indicators based on patient needs to be associated with the monitoring and treatment of different organ systems, invasive procedures, care of wounds and/or drains, and support of patients' next of kin. Depending on time taken and/or the occurrence of a procedure, each of the categories is assigned a score from 0 to 3 points (range 0–33 point). The

<table>
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<th>TABLE 1 Demographic data (number and percent) and statistical analysis for the included ICUs during the study period</th>
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<tr>
<td><strong>Unit A no (%)</strong></td>
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<td>No. of admitted patients</td>
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<td>Mean age (range)</td>
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<td>Medical complaint</td>
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<td>Mortality during ICU stay</td>
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Abbreviations: ICU, intensive care unit; NIV, non-invasive ventilation; RN, registered nurse; SAPS, Simplified Acute Physiology Score.

aData were only collected as numbers and percent.

bNo data from year 2010.
NCR11 is measured three times a day by the nursing staff. The NCR11 show a good inter-rater reliability.²⁹

Performance measured included ICU mortality and mean time on non-invasive and invasive respiratory support, mean time (hours) on mechanical ventilation, mean time (hours) on non-invasive ventilation (NIV) and unplanned re-intubations.

The proportion of RN's (CCNs) per patient (1:1 vs. 1:2) was obtained through direct contact with each unit. Each head of the ICU unit reported that no organizational and/or personnel changes were made during the study period, the nurse/patient ratio, and the number of nurse assistants. RNs (on bachelor level) and specialist nurses (CCN 1-year master) in intensive care per patient during the study period.

2.3 | Data analysis

All data were collected in Excel format. Demographics such as number of patients, length of ICU stay, and complications (re-intubation) were reported in numbers and percent. Time in hours on invasive and NIV and complications (re-intubation) was reported in mean time (hours) throughout the study period 2010–2014. The nurse/patient ratios were dichotomised into 1:1 or 1:2 nurse/patient ratio.

The data were analysed using IBM SPSS Statistics version 20.0, by descriptive and comparative statistical methods. Categorical variables, such as CCN per patient ratios 1:1/1:2 and ordinal data were compared using Fisher’s exact two-tailed test or Pearson's chi-square test. Univariate of continuous variables (age) were tested with Spearman’s Rank Correlation. Normality was checked by frequency distribution using histogram. A probability below .05 was accepted as statistically significant.

2.4 | Ethical considerations

The study was approved by the regional ethical committee Dnr: 2014/762-31/2, and approval to collect data from the Swedish intensive care registry (SIR) was obtained in 2015. Variables were processed at group level and no individuals were identified.

3 | RESULTS

A total of 9814 patients were included in this study. No significant difference was found in the initial severity of illness according to SAPS III between the units. Our result shows that unit A admitted younger patients, more male patients, and more surgical patients with unplanned surgery ($\chi^2 = 1334.0$, $df = 1202$, $p = .004$), with a slightly higher estimated mortality (but the differences were not significant; Table 1).

Result also shows a difference with higher workload and an increased length of ICU stay in unit A compared with unit B, despite no difference in the initial severity of injury according to SAPS III. A small difference, but not significant, with more unplanned re-intubations occurred at unit A compared with unit B.

No significant difference was found in patient mortality during the ICU period between the two units. Both units reported that all employed RNs had a specialist degree (CCN) but with differences in the nurse/patient ratio.

4 | DISCUSSION

Our result showed a significant difference in patient characteristics between the level 3 units despite both being university hospitals with general patient mix, with more male patients at younger age with surgical conditions requiring unplanned surgery.

The differences between more male patients compared with female patients cared for in ICUs have been reported by several researchers from different countries.¹⁷ ³⁰ ³¹ The differences could be related to the fact that male and female sex hormones have an impact on the pathophysiology, that is, acuity of injury and recovery from critical illness, because oestrogen is a potent antioxidant that has a protective effect in trauma and haemorrhage.³² ³³ The result of Mahmoud et al.³⁴ also showed that male ICU patients receive more active interventions, that is, mechanical ventilation and unplanned surgery compared with female patients which could have an impact on increased workload with longer ICU stay as shown by Samuelsson et al.⁴ and Zettersten,³⁶ which is confirmed in our study. Whether this means that female patients have a different pathological pattern or differences in threshold for being admitted to ICU care which could explain the shorter length of stay in the ICU, or whether health care staff base their assumptions on the symptoms and care needs expressed by the male patients as suggested by Samuelsson⁴ and Modra et al.³⁷ is yet to be answered.

In Sweden, NCR11 is the most commonly used tool to measure workload. However, the NCR11 measures not only nursing interventions based on patient needs but also measures the estimated time for the completion of medical procedures. Workload can be measured through different tools with different purposes and as reported by Greaves et al.³⁸ and Hoogendorn et al.³⁹ further research is necessary to develop a tool that can be widely used and accepted to influence the planning of nurse staffing decisions in the ICU setting. Despite a general shortage of RN’s and specifically CCNs,⁴⁰ ⁴¹ the nurse/patient ratio in Swedish ICUs is 1:2 or 1:1 which is in concordance with international recommendations from several organizations.¹⁵ ¹⁷ ⁴² ⁴⁴ However, the recommendations do not consider the impact of different educational levels of RNs or skills mix in different ICUs. From a Swedish perspective, no nursing-sensitive indicators as suggested by Montalvo et al.¹⁰ were found among the variables collected in the SIR to measure the quality of patient care. However, quality of care could also be reflected by ICU mortality, length of stay and reported complications. Our result showed no differences between the units in relation to mortality and length of stay but a slight difference was found with more complications, such as unplanned re-intubations and longer length of time on mechanical ventilator in the unit with a 1:1 nurse–patient ratio. This difference might be explained by differences in utilization of resources, such as support personnel; for example, NAs.
physiotherapists, pharmacist, or the found differences in demographics with younger male patients in unit A compared with unit B. Further investigations to explore the impact of support personnel, as well as both quality of nursing care and patient-reported outcome measures, are necessary.

As reported by Blackwood et al. and Aiken et al., nursing care has an impact on both complications and patient satisfaction during a hospital stay. Systematic reviews show that higher RN staffing levels in acute and critical care settings are associated with improved patient outcomes, reduction in mortality, medication errors, pressure ulcers, and infections as well as nurse outcomes (increased job satisfaction, decreased burnout and intention to leave) and family outcomes (greater satisfaction with care). Therefore, our result could be used by health care managers in their planning for high-quality care and for healthy workforce organization for nurses specialized in critical care. As suggested by Kiekkas et al. and Jansson et al., nurse staffing levels in ICU units should consider the estimation of total patient acuity and complexity of illness, rather than the absolute number of patients and hospital beds.

5 | LIMITATIONS

The result from this study should be interpreted with caution. The retrospective study design of registry data from 2010 to 2014 could imply that the results may be due to other, not documented reasons that could impact patient outcomes and our result. The fact that Sweden has few reported ICU beds compared with other European countries, could imply that the result could not be transferred to other countries. However, no change in the amount of ICU beds has occurred during the recent years, which could mean that the results on nurse–patient ratio are still valid.

Another limitation is the self-reported data from the manager of the ICU, which could mean that differences in the nurse–patient ratio occurred. To our knowledge, no overall change to nursing care, and no organizational or educational changes were made during the study period. Another limitation is that patient outcome reflects not only nursing care but also the standard of ICU care with high competence among all health care personnel. However, the large number of patients included in the study could reflect ICUs on a general level.

5.1 | Implications and recommendations for practice

Differences in patient populations, even between level 3 ICUs at university hospitals, should be considered in the discussion of nurse/patient ratios and quality of care among health care managers.

Health care managers should consider nurses, educational level, specific competencies and skills mix in relation to patient characteristics to provide high-quality care in different settings. Measuring nursing-sensitive patient outcomes, for example, pressure ulcers, catheter-related infections and ventilator-associated pneumonia, in relation to nurse/patient ratio to ensure a high quality of patient care.

6 | CONCLUSIONS

The unit with a higher nurse/patient ratio admitted patients with different patient characteristics such as younger age and more male patients, and there were significant differences, with more patients with surgical complaints, a higher workload as well as a higher incidence of unplanned surgery, longer length of ICU stay and a slight increase in unplanned re-intubations. The differences in the nurse/patient ratio did not reflect a difference in the severity of illness among admitted patients but might be explained by patient characteristics with different needs.

An increased workload despite a nurse-patient ratio of 1:1 with a high educational level among RN’s still shows an impact with more complications such as unplanned re-intubations and longer length of time on mechanical ventilators.

Therefore, further knowledge is needed on the impact on quality (i.e., pressure ulcers, falls, CAUTI, central line-associated bloodstream infections) of nursing care and the nurse–patient ratio with different educational levels in different ICU settings. In addition to nurse-patient ratios, it is also important to incorporate a skill mix within an ICU, particularly when planning workforce shifts.

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