Outcomes sensitive to intensive care nurse staffing levels: A systematic review protocol

Ruth Endacott[1,4], Pamela J. L. Rae[1], Susie Pearce[1], P. Jane Greaves[2], Chiara Dall'Ora[3], Peter Griffiths[3]

1. School of Nursing & Midwifery, University of Plymouth University
2. Newcastle Hospitals NHS Foundation Trust
3. School of Health Sciences, University of Southampton
4. School of Nursing & Midwifery, Monash University, Melbourne

This protocol is independent research funded by the National Institute for Health Research (Programme Development Grants, Safe staffing in ICU: development and testing of a staffing model, NIHR200100). The views expressed in this publication are those of the author(s) and not necessarily those of the National Institute for Health Research or the Department of Health and Social Care.

Abstract

Objective. The objective of this review is to identify outcomes sensitive to variations in nurse staffing levels in intensive care.

Introduction: Variation in nurse staffing levels have been linked to outcomes such as patient mortality and nurse burnout (1, 2). However, previous reviews on staffing have either excluded intensive care settings (3) or focused on other settings such as acute care (4). Other reviews have narrowed their scope to include only specific outcomes, such as renal anaemia (5) but it is possible that further patient outcomes may be more appropriate for the ICU setting. This review will therefore identify outcomes sensitive to nurse staffing levels in intensive care.

Inclusion criteria: The review will consider quantitative and mixed methods studies that examine the sensitivity of staff, patient, family, care quality and organisational outcomes to changes in the staffing levels of nurses involved in direct patient care in intensive care settings. This includes all nurses working in the capacity of a registered nurse in critical care.

Methods: The search will include English language items held in CINAHL Plus, MEDLINE (EBSCO), PsycINFO, SCOPUS and NDLTD databases up to September 2019. A preliminary search in MEDLINE returned over 11,000 items therefore, titles will initially be subject to rapid screening. Remaining titles and abstracts will be screened against key inclusion and exclusion criteria. The full text of remaining studies will be checked against detailed inclusion/exclusion criteria. A team of two reviewers (PR and RE) will carry out the screening stages. A team of three reviewers (PR, RE and JG) will use tools based on those developed by NICE (3) to assess the quality of, and extract data from, included full-text studies. Data will be synthesised where possible through meta-analysis.

Introduction

Getting nurse staffing right has been brought into sharp focus following the Francis report into failings at Mid Staffordshire NHS Trust (6) and acknowledgement of the need to improve the safety of patients and quality of care (7, 8). To address issues with nursing and quality, NICE issued guidance on safe staffing in acute care beds in English NHS hospitals (3).

Evidence for the importance of safe staffing in acute wards stems from large observational studies conducted in acute hospitals in North America (9, 10) , Europe (2, 11-13) and the UK (14-17). These studies have showed associations between: (a) nurse staffing levels and patient outcomes including mortality and failure to rescue (2, 11); and (b) patient and nurse satisfaction, improved work environment and care quality (12).

In critical care there have been considerably fewer studies but there are similar themes relating the size of the nursing workforce to both patient and staff outcomes. For example, higher nurse:patient ratios are associated with lower in-hospital and 30-day mortality (18). In one of the few UK based studies West et al., (19) investigated whether the size of the workforce (nurses, doctors and support staff) had an impact on the survival chances of critically ill patients both in the intensive care unit (ICU) and in the hospital. After controlling for patient characteristics and workload, they found that higher numbers of nurses per bed (and higher numbers of consultants) were associated with higher

ICU survival rates. The number of nurses had the greatest impact on ICU survival for patients at high risk of death (19).

Lower intensive care nurse staffing levels have also been linked to patient outcomes other than mortality, including increasing pressure injuries (20, 21); healthcare acquired infection (HCAI) (20), increased central-line associated sepsis and ventilator associated sepsis (22) and duration of ventilation (23) .

Nurse staffing levels have also been reported as both a key influencer on patient and family satisfaction in intensive care (24) (25) and a barrier to implementing or sustaining early rehabilitation for critically ill patients (26) as recommended in the NICE guidance (27). Zanni et al.,(28) found rehabilitation therapy was not provided for 50% of ICU days per patient because of limited staffing. This has the potential to affect long term outcomes for patients and families (27).

The complexity of care and activity in critical care units means the working environment and staffing issues can have a direct impact on professional outcomes as well as those of the family and patient. The patient population in a critical care unit is increasingly co-morbid but, at the same time, patient care is designed to keep the patient easily rousable. This arguably, increases workload (29) and there is considerable evidence of links between workload and stress ; burnout (30)(31); and the incidence of human-factors related errors in patient care (32). In a survey of 8444 American critical care nurses, Ulrich and colleagues (33) found poor work environments in ICUs were associated with burnout, poor job satisfaction and lower quality of care.

The proportion of the acute NHS hospital resource consumed by ICU is rising year on year as ICU bed numbers increase and acute care beds decrease. Nurse staffing is the largest part of this resource. Recent UK survey data show up to 60% of critical care units are without a full nurse staffing complement and 40% of critical care units are closing beds at least once a week because of workforce shortages (34). Sickness absence rates for critical care nurses are also slightly higher than the national nursing average (35). It is thus timely to examine the critical care nursing resource requirement and how it can be used most effectively.

Existing reviews on nurse staffing levels excluded studies carried out exclusively in intensive/critical care settings (3) or have focussed on other care settings such as acute (4) or paediatric care (36, 37). Other reviews have looked at limited outcomes, such as renal anaemia (5) or nurse outcomes (38). Previous reviews on patient outcomes are dated (39-42). Therefore, this review will synthesise associations between outcomes and variation in nurse staffing in intensive care units. The evidence will help researchers to identify and measure outcomes most sensitive to changes in nurse staffing levels. This will help policy makers to develop evidence-based guidelines that aim to provide optimum RN staffing levels in intensive care settings.

A preliminary search of PROSPERO, MEDLINE, the Cochrane Database of Systematic Reviews and the JBI Database of Systematic Reviews and Implementation Reports was conducted and no completed or currently underway systematic reviews on the topic were identified.

Review question

The objective of this review is to identify patient, family, staff, care quality and organisational outcomes sensitive to nurse staffing levels in intensive/critical care settings.

Keywords

Nurse staffing; intensive care; patient outcome; staff outcome; care quality; organisational outcome.

Inclusion Criteria

Population

The review will consider quantitative and mixed methods studies addressing the association between staffing levels of nurses working in the capacity of a registered nurse in critical care and outcomes. Thus, in addition to registered nurses this may include, for example, licenced practitioners, nursing associates and Licenced Practical Nurses.

Intervention and Comparator

The review will consider studies that examine the sensitivity of outcomes such as patient, family, nurse, care quality and organisational, to different configurations of nurse staffing levels. This may include, for example, comparisons of high versus low staffing levels through natural variations or through alternative establishment setting approaches.

Outcomes

The review will consider studies that include any patient (e.g. mortality), family (e.g. satisfaction), staff (e.g. burnout), care quality (e.g. compliance with protocols) or organisational (e.g. delayed admission) outcomes sensitive to nurse staffing levels in critical care. The term 'family member' is defined as per Rowan et al (2014) in their study evaluating family satisfaction with adult critical care: "*a family member is defined as a person with a close familial, social or emotional relationship with the patient and is not restricted solely by next of kin*" (pg 12) (43).

Types of studies

This review will consider quantitative and mixed methods studies. This includes experimental, quasi-experimental, observational and descriptive studies.

Studies published in English, from 1990 to the present, will be included.

Methods

Search strategy

The search strategy will aim to locate both published and unpublished studies. An initial limited search of MEDLINE was undertaken to identify articles on the topic. The text words contained in the titles and abstracts of relevant articles, and the index terms used to describe the articles were used to develop a full search strategy for MEDLINE (see Appendix I). The search strategy, including all identified keywords and index terms, will be adapted for each included information source. The reference list of all studies selected for critical appraisal will be screened for additional studies.

Information sources

The search for published studies will include CINAHL Plus, MEDLINE (EBSCO), PsycINFO and SCOPUS.

The search for unpublished studies and grey literature will include: the Networked Digital Library of Theses and Dissertations (NDLTD) and conference proceedings listed in SCOPUS.

Study selection

Following the search, all identified citations will be collated and uploaded into Endnote X8 (Clarivate Analytics, PA, USA) and duplicates removed. The citations will then be uploaded to RAYYAN systematic review software (Qatar Computing Research Institute), which facilitates initial screening of abstracts and titles using a semi-automation process. Screening will be undertaken in three stages: rapid exclusion of patently irrelevant studies based on titles; screening of remaining titles and abstracts against key inclusion criteria; screening of remaining studies' full text against detailed eligibility criteria. Reasons for exclusion of full text studies that do not meet the eligibility criteria will be recorded and reported in the systematic review. The results of the search will be reported in full in the final systematic review and presented in a Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram (44).

Data extraction

Data will be extracted from quantitative and mixed methods (quantitative component only) studies by using a template developed by NICE (3). Please see Appendix II for details of data to be extracted. Meta –analysis of data will be carried out on effect sizes, if papers retrieved allow.

Authors of papers will be contacted to request missing or additional data for clarification.

Assessment of methodological quality

The internal and external validity of quantitative studies (and the quantitative component of mixed methods papers) selected for retrieval, will be assessed against a framework adapted from that developed by NICE for observational/cross-sectional studies (3).The framework (Appendix III) assigns each study one of three grades based on methodological rigour: Strong, Moderate or Weak.

Any disagreements that arise between the reviewers will be resolved through discussion, with a third reviewer involved if consensus cannot be reached. The results of the quality assessment will be reported in narrative form and in a table.

Data synthesis and integration

All studies, regardless of the results of their methodological quality, will undergo data extraction and synthesis (where possible). Reporting of quantitative results will be stratified with priority given to Strong studies (see Appendix III). Moderate or Weak studies will be presented in light of whether they confirm or contradict Strong studies.

Preliminary scan of the literature suggests that interventions and outcomes are too diverse to allow meta-analysis. Hence, the findings will be presented in narrative form including tables and figures to aid in data presentation, where appropriate. However, if sufficient suitable studies are found, data will be pooled using statistical meta-analysis. Effect sizes will be expressed as either odds ratios (for dichotomous data) or weighted (or standardized) final post-intervention mean differences (for continuous data) and their 95% confidence intervals will be calculated for analysis. Heterogeneity will be assessed statistically and statistical analyses will be performed using a random effects model. A funnel plot will be generated to assess publication bias if there are 10 or more studies included in a meta-analysis. Statistical tests for funnel plot asymmetry (Egger test, Begg test, Harbord test) will be performed where appropriate.

Funding

This research is funded by an NIHR Programme Development Grant (Grant No: NIHR 200100).

Conflicts of interest

The authors have no conflicts of interest to declare.

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Appendices

Appendix I: Example of an individual search strategy, MEDLNE

1 “nurse staffing” OR "nursing time" OR "nurse time" OR “nursing hours” OR “nurse hours” OR “hours per patient day” OR "staffing ratios" OR “nurse-patient ratio” OR “patient-nurse ratio” OR “patient to nurse ratio” OR “nurse to patient ratio” OR "bed to nurse ratio" OR "nurse to bed ratio" OR "bed nurse ratio" OR "nurse bed ratio" OR "rationing nursing" OR “number of nurses” OR “nurse numbers” OR staffing OR understaffing OR “under staffing” OR “labour force” OR “labor force” OR “healthcare force” OR workload

2. “critical care” OR "intensive care" OR "surgical care" OR "high dependency" OR "critically ill" OR "intensive therapy" OR ICU

3. 1 AND 2

Appendix II. Data extraction

Data Extraction: QUANTITATIVE		**Title:**			**Reviewer:**	
1. Study details	**2. Setting and Population**	**3. Sample**	**4. Risk adjustment**	**6. Results: which outcomes of staffing level variation were analysed?**	**7. Is impact of staffing significant? Significant or not, direction of effect? size of effect and 95% CIs?**	**8. Notes/comments**
1a. First author (Year):	2a. Country:	3a. Staff groups studied:	4a. What were the patient and/or nurse, risk adjustments:	6a. Patient outcomes:	7a. Patient outcomes:	
1b. Study Aim:	2b. Setting(s):	3b. Staffing level variables measured. 3bi Description of the variable (e.g. number of nurses per 8 hour shift): 3bii Units: (e.g. N:P, number of nurses) 3biii Was this measured specifically for the study or was this treated as a general characteristic of the unit? 3biv If measured specifically for the study, was this measured just once or for e.g., per month, per day, per shift, per patient?				

1c. Study design:	2c. Source population:	3c. Sample size: number of RN level nurses (out of total number of staff, if part of a wider study):	4b. What were the unit/hospital risk adjustments:	6b. Nurse outcomes:	7b. Nurse outcomes:	
1d. Internal validity: 2 1 0	2d. Selection procedure	3d. Sample size: Hospitals	**5. Analysis** 5a. How was link between staffing levels and outcome(s) statistically evaluated *(e.g. logistic regression, correlation etc.)*	6c. Care quality outcomes: Process/ organisational outcomes:	7c. Care quality outcomes: Process/ organisational outcomes:	
1e. External validity: 2 1 0		3e. Sample size: ICU/critical care units (out of total number of units if part of a wider study)		6d. Family outcomes:	7d. Family outcomes:	

Appendix III: Quality appraisal

Quality Appraisal			
Title: **First author (year):**		**Reviewer:**	
Key research question/aim:		**Validity scores**	
		Internal	**External**
Critical Appraisal breakdown:	Rough guide to allocating 2 (strong methodology), 1 (moderate) and 0 (weak)	2 Strong, 1 Moderate, 0 Weak	
1. Is the setting applicable to an international definition of intensive care units?	Marshall et al., (2017) "An intensive care unit (ICU) is an organized system for the provision of care to critically ill patients that provides intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of acute organ system insufficiency." **Yes 2 uncertain/ mixed 1 no = 0 and exclude**		
2. Design: how are potential associations between exposure to a change in staffing level and patient, family, staff, organisational or care quality outcome examined?	**cross sectional** is **weak 0** (exposure and outcome assessed at the same time on an individual level); **retrospective** is **moderate 1** (e.g. group sharing the same target outcome is identified and then retrospectively checked for the likelihood of having been exposed to low/high staffing); **prospective** study allowing for cause / effect is **strong 2** (i.e. exposure precedes outcome)		
3. Is the eligible population or area representative of the source population or area?	Consider whether hospitals potentially included in the study are representative of acute general hospitals in that country / state (**1**) Were the wards/ staff / patients eligible to be included representative of ICU/critical care units/ RNs/ICU, critical care patients (**another 1**)		
4. Do the selected participants or areas represent the eligible population or area?	What % of selected hospitals agreed to participate (60% plus, **1**) What % of eligible individuals (staff / patients) participated (60% plus, **1**) Were any data-sets derived from administrative systems complete? Were the inclusion or exclusion criteria explicit and appropriate? (**1** for either if not already two)		
5. Were the outcome measures reliable?	Were main patient outcome measures subjective or objective **(2 for objective)** For **subjective**: How reliable were outcome measures (e.g. inter- or intra-rater reliability scores?) **1** Was there any indication that measures had been validated (e.g. validated against a gold standard measure or assessed for content? **1**		

6. Were the outcome measurements complete?	Were all or most of the study participants who met the defined study outcome definitions likely to have been identified? **(2 for definitely … e.g. patient mortality**, **1 for outcomes collected using clearly defined methods but where some may have been missed**, **0 for info. abstracted from e.g. discharge abstracts**)		
7. Was the study sufficiently powered to detect an effect (if one exists)?	Were there sufficient units / hospitals / wards to give variation and enough patients to detect effects? Generally, look at effect sizes and units of measure; a large clinically important effect size which is not significant suggests the study is underpowered. Some guidance: Large multi-hospital (20+) studies (state / national / international) with administrative data **2** Smaller studies / single hospital with large numbers of patients (000,000's) **1,** Other **0**		
8. How well were likely confounding factors identified and controlled?	Risk adjustment for main outcomes. Was there patient/staff level risk adjustment for e.g. for AGE, DIAGNOSIS, COMORBIDITY, YEARS EXPERIENCE **(2, 1 moderate, 0 none**)		
9. Were the analytical methods appropriate?	Was there adjustment for clustering of data within wards / hospitals? (**1)** Where relevant was there control for ward / hospital characteristics (**1**)		
10. Was the precision of association given or calculable? Is association meaningful?	Were confidence intervals or p values for effect estimates given or possible to calculate? (**1**) Were CIs wide or were they sufficiently precise to aid decision-making? (**1**) If precision is lacking, is this because the study is underpowered? (**0**)		
		Overall internal validity (bias) 2 1 0	**Overall external validity 2 1 0**
11. Are the study results internally valid (i.e. unbiased)?	How well did the study minimise sources of bias (i.e. adjusting for potential confounders)? Were there significant flaws in the study design?		
12. Are the findings generalisable to the source population (i.e. externally valid)?	Are there sufficient details given about the study to determine if the findings are generalisable to the source population? Consider: participants, interventions and comparisons, outcomes, resource and policy implications.		