
Monograph:
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Strategic Research Alliance

The University Of Sheffield.

in strategic alliance with Royal College of Nursing

Scoping review: patient safety outcomes and nursing skill mix interventions

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Foreword

We welcome this scoping review emerging from our strategic alliance with the University of Sheffield. The positive association between a properly planned nursing skills mix and patient safety outcomes shouldn't be a surprise. The evidence clearly shows that the registered nurse staffing numbers directly impact on mortality, care quality and missed care.

In short, to improve patient safety we need enough nurses with the right skills in the right places at the right times. We can't deliver this until the current NHS staffing crisis is resolved, and the view of the RCN, that requires legislation so that someone in government is explicitly accountable for delivering safe staffing levels.

However, there have been few detailed studies of how skills mix interventions have been used to boost safety. So we have a growing understanding of the impact of nursing staff shortages, but little evidence on how this can most effectively be managed. Given the need for fast and reliable solutions to the crisis we currently face, this is an important finding for the research community to note. More widely, the review identifies the need for research in community and primary care settings and for research across the UK.

The RCN's Strategic Alliance with the University of Sheffield provides an opportunity to identify and build on some of these evidence gaps. We also call on the wider research community to consider some of the challenges set out by the current evidence – particularly in relation to understanding interventions which can be used by senior nurses now.

Within the healthcare and research communities, there are positive developments. Increasing interest is being expressed in leadership and the wider determinants of successful team operation, both organisational and institutional. We look forward to building on this evidence base as we strive to create a more complete picture both of the challenges we face and their potential solutions.

Dame Professor Donna Kinnair
Chief Executive and General Secretary,
Royal College of Nursing.

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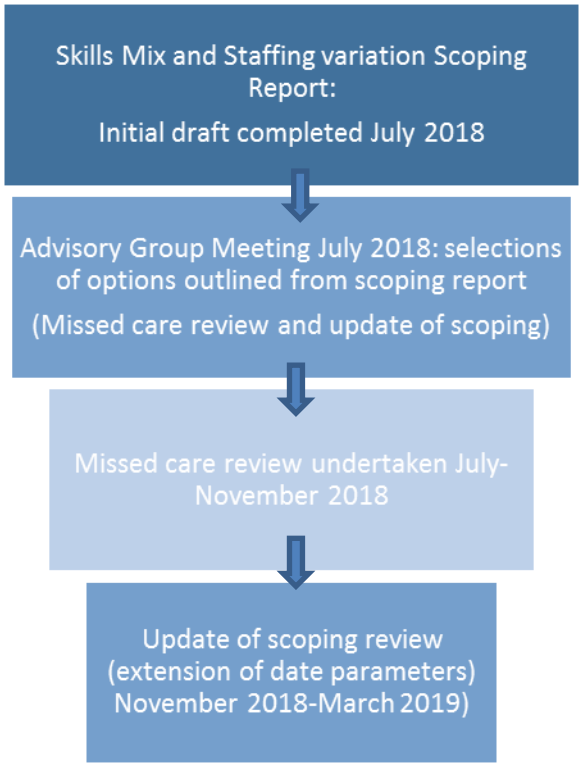
Introduction

This report consists of two phases of work. The first was conducted as a way of scoping out the literature for a focused review. The second phase was conducted after the completion of the initial report of the mapping (and the focused review) in order to broaden the scope of the map to identify earlier publications and avenues for further focused reviews. Phases are represented in the flow chart below.



Therefore, this mapping report aims to provide an overview of progress between May and July 2018 and an update to widen date parameters November 2018-March 2019 on the Nursing skills mix and safety scoping review. This report has been organised according to (i) preliminary findings from the core literature identified; (ii) suggestions that helped to steer the subsequent focused review and (iii) a technical appendix with details of methods and included studies. A focused systematic review protocol was created following discussion of options emerging from this report and input from a stakeholder group.

The supplementary documents to which this report refers are:

- Protocol (Appendix 5)
- Data extraction forms (Available as Excel spreadsheets from the team on request)

The protocol for this draft mapping exercise was approved by School of Nursing and the Royal College of Nursing partners on 14th May 2018. Approval for the update

(extended date parameters for primary studies inclusion was obtained following the advisory group meeting on the 19th July 2018).

The overview of timescales can be found in the protocol in Appendix 5. This report represents work achieved according to the timetabled milestones for the period April- July 2018 and subsequently for the update November 2018 – March 2019.

In preparing this scoping review the review team found the following Table (Table 1) useful for sensitisation to the complexities of measuring nurse staffing. Many of the measures given can be adjusted, for example for such factors as nursing intensity.

Table 1 - Definitions of nurse staffing measures

Nurse staffing measure	Definition
Nurse-to-patient ratio	Calculated based on the number of beds within the unit and the number of nurses per shift, i.e. for a 24 bed ward to have a 1 to 4 nurse-to-patient ratio would require 6 nurses per shift
% ranked nurse-to-patient ratio	Ranked nurse-to-patient ratios in every unit and transformed into percentiles (a value of 50th percentile was median ratio)
Nursing hours per patient day (NHPPD)	Calculated by dividing the number of rostered nursing hours (all categories of nurse) on the ward by the number of patients (either the census of patients at a given time or the average census for the day) to determine the average number of hours of care each patient could potentially receive
Total nursing hours	Total nursing hours of direct nursing care per day. Includes RN, Patient Care Technician and pool nurses
RN hours	RN hours per day of direct nursing care

Nurse staffing measure	Definition
Staff/skill mix	Proportion of total hours of care provided by RN
Total overtime hours of care	Overtime hours of care from all categories of nurse divided by total hours of care
Casual/agency RN hours; (Registered Nurses who are not employed by the ward/unit but work when the ward/unit is short of staff. i.e. transferred from another ward, supplied by a nursing agency)	• Hours of direct nursing care per day by RN float, agency, pool nurses • Hours of care from RN float/agency/ traveller per time period divided by total hours of care over same time period
Nurse workload	Number of patients under care of each nurse, whether a patient was admitted on that day and number of intravenous infusions for each nurse
Years of unit experience	Years of clinical experience in the study unit calculated from the time of starting work to the middle of the study period

Source: Wilson & Bremner (2011). Available from: http://dx.doi.org/10.1111/jbr.2011.9.issue-2

Research Questions:

The scoping review sought to address the following three questions:

- What patient safety outcomes are associated with nursing skill mix interventions and variation?
- How do patient safety outcomes associated with nursing skill mix interventions and variations compare in acute and community care?
- What theories or conceptual frameworks have been used to characterise nursing skill mix interventions and the contexts of implementation in which patient safety outcomes have been demonstrated?

What patient safety outcomes are associated with nursing skill mix interventions and variation?

The total number of records screened for the reviews was 2475. This included 2366 from a Pubmed database search (plus an additional 9 from key papers already identified) and 100 identified through a Google Scholar search of the extended date parameters (see explanation below). Screening was distributed between the two reviewers. Following a title screen for the most relevant reviews- a final 22 were included at full text (See Appendix 2) and primary studies published between 2010 and 2018 that were included within the reviews were followed up and examined at abstract level and subsequently at full text if relevancy could not be determined. Subsequently, coverage of the review was extended to cover the period 2000-2009. The high yield from the search of Pubmed for the original reviews that included primary studies published within 2000-2009 combined with the associated primary studies search which also identified reviews, led the team to decide not to re-run the PubMed search for 2000-2009. This strategy was informed by the fact we found a high rate of specificity in our original searches for a limited list of keywords and for yield from a limited number of databases. However, the risk of missing eligible studies was mitigated by running a Google Scholar search for these adjusted date parameters which offered an additional full-text search facility. Three further reviews were identified, however none of these contained primary studies which were relevant.

132 primary studies were cited within included reviews to create a map of basic study characteristics (See Appendix 3) and outcomes were also mapped. (The core set of primary papers analysed within this review are addressed in the next section: 'key findings from synthesis of primary studies' below).

Table 2- Outcomes featuring prominently within identified systematic reviews

Outcomes	**Associated primary studies located within reviews**
Mortality: Estimated avoided mortality Mortality after surgical complication	(Griffiths et al., 2016) (Lobo et al., 2015) Griffiths et al (2014) (Shekelle, et al., 2013) (Griffiths 2014) (Johnson et al., 2015) (Driscoll et al., 2018) (Jones et al., 2015) (Recio-Saucedo et al., 2017) (Twigg et al., 2014) (Lobo et al., 2015) (Swiger et et., 2017) (Drennan et al., 2014)
Missed care/unfinished care/Care undone	(Griffiths et al., 2018) (Jones et al., 2015) (Recio-Saucedo et al., 2017)(Kallisch et al., 2014) (Griffiths et al., 2014) (Clendon & Gibbons 2015 (Driscoll et al., 2018) (Kalisch and Xie 2014) (Papastavrou et al., 2014) (Swiger et et ., 2017)
Error: medication errors (prevention)	(Recio-Saucedo 2017) Griffiths et al (2014)

medical error (prevention) near miss	(Gaffney 2016) (Kim et al., 2015) (Clendon and Gibbons, 2015) (Driscoll et al., 2018) (Lobo et al., 2015) (Drennan et al., 2014)
Falls: patient falls patient falls with injuries	(Recio-Saucedo et al., 2017) (Kallisch et al., 2014) (Stalpers et al., 2015) (Griffiths et al., 2014) (Driscoll et al., 2018) (Jones et al., 2015)
Quality of care	(Recio-Saucedo et al., 2017) (Casey et al., 2017) (Jennings et al., 2014)) (Griffiths et al., 2014) (Driscoll et al., 2018) (Swiger et al., 2017) (Papastavrou et al., 2014) (Recio-Saucedo et al., 2018) (Swiger et et ., 2017)
Infection: infections pressure ulcers	(Recio-Saucedo et al., 2017) (Lobo et al., 2015) (Stalpers et al., 2015) (Driscoll et al., 2018) (Jones et al., 2015) (Griffiths et al., 2014)
Adverse events: critical incidents e.g. arrest, bleeds, complications, failure to rescue	(Recio-Saucedo et al., 2017)(Lobo et al., 2015) (Driscoll et al., 2018) (Jennings et al., 2014) (Jones et al., 2015) (Griffiths et al., 2014) (Griffiths et al., 2016) (Swiger et et ., 2017)
Length of stay patient readmissions including ED leave without treatment	(Stalpers et al., 2015) (Driscoll et al., 2018) (Recio-Saucedo et al., 2017)(Lobo et al., 2015) (Griffiths et al., 2014) (Griffiths et al., 2016) (Jennings et al., 2015) (Drennan et al., 2014)
Cost	(Jennings et al., 2014) (Griffiths et al., 2014) (Twigg et al., 2011) (Griffiths et al., 2016)
Waiting times	(Casey et al., 2017)(Jennings et al., 2014) (Drennan et al., 2014)
Satisfaction	(Jennings et al., 2014) (Recio-Saucedo et al., 2017) (Kenwood et al., 2017) (Griffiths et al., 2014)
Turnover	(Kim et al., 2015) (Griffiths et al 2014) (Jones et al., 2015) (Swiger et et ., 2017)
Workload	(Griffiths et al., 2014) (Papastavrou et al., 2014)
Collaborative efforts/work environment	(Kim et al., 2015) Griffiths et al (2014) (Swiger et al ., 2017)
Pain control	(Clendon & Gibbons 2015)(Griffiths et al., 2014) (Drennan et al., 2014)
Protection from harm Sharps	(Kim et al., 2015) (Lobo et al., 2015)
Hospital acquired conditions	(Stalpers et al., 2015)
Nurse job satisfaction Intention to leave Burnout Access to training	(Shin et al., 2018) (Swiger et al ., 2017)
Functional recovery	(Jennings et al., 2014)
Reporting safety	(Swiger et al ., 2017)

We identified relatively little overlap in the review questions or overall coverage of the reviews - however the mapping revealed small numbers of studies cited multiple times. Significant numbers of papers (N=39) were identified from within our target period of 2010-2018 from the reviews already included. (The report by Drennan et al., 2016 was also included at the point of the update.) This reveals the perpetuation of an increasingly dated evidence base.

Key outcomes identified within primary studies included within identified reviews featured mortality, missed care, error, falls, quality of care, infection and adverse events.

Key findings from synthesis of primary studies

The total number of primary studies included at full text reading was 30.

The databases included in the final review were CINAHL, Medline/(Pubmed in update) and Google Scholar. This combination of sources were thought to fit the scope of the review and to yield the most relevant results. A total of 4732 records were retrieved. The total records was comprised of 4632 records from database searching and 100 from a supplementary search of Google Scholar (see below).

CINAHL and PubMed–2010-2018= 2707 records

CINAHL (2000-2009)=947 (DE DUP 722)

Medline (2000-2009)= 1203 (DEDUP 1203)

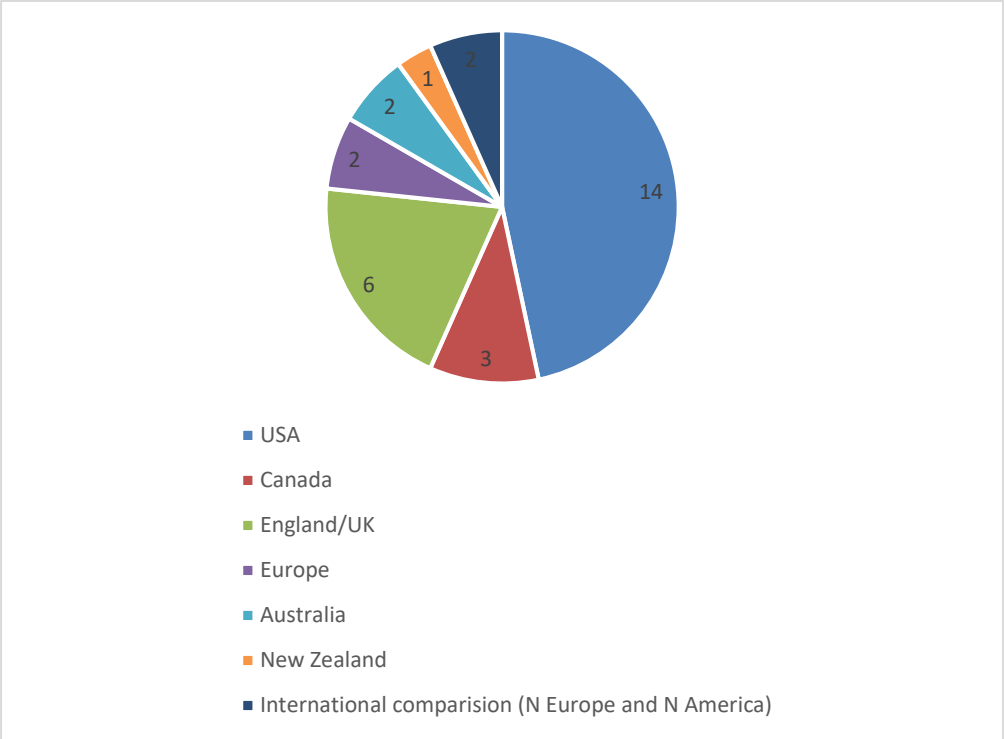
Therefore, the update produced 1925 results (number reached after duplicates were removed). These records were searched for key words.

In addition 100 further records screened from a Google Scholar search (using the terms 'skills mix AND nursing' 2000-2009)- whereby 3 relevant review were identified from the sifted records containing 2 relevant primary studies and 4 relevant primary studies from the same search.

Keywords were: RCT, cross-sectional, interrupted time, before and after, intervention, longitudinal, non-random and qualitative. Reviewers identified the need to include qualitative studies and secondary analysis of data, including survey designs given the shortage of higher empirical design. 30 primary study abstracts were double screened to resolve uncertainties. This process resulted in 30 included studies that met agreed inclusion criteria.

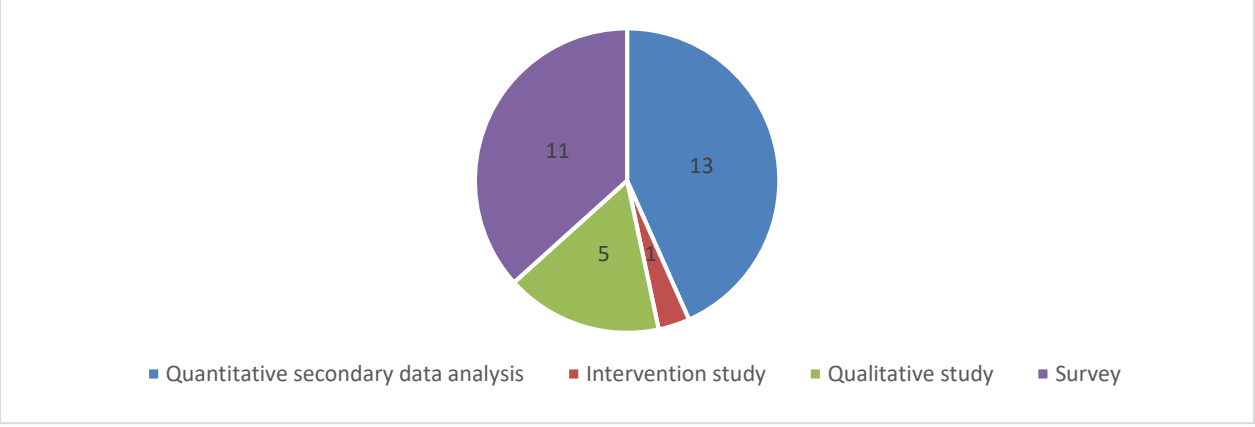
Features of included primary studies

Figure 1- Geographical distribution of included primary studies (n=30)



The majority of studies were of US origin (n=14). The remaining studies were located in Canada (n=3), Europe (n=2), Australia (n=2) New Zealand (n=1), international comparisons (n=2) and England/UK (n=6).

Figure 2 - Study designs of included primary studies



The majority of studies were secondary analyses of data (n=11), including cross-sectional designs (n=8); retrospective cohort design (n=1); time series (n=1)

Longitudinal (n=2). Observational =1). Typically, authors applied statistical analysis of hospital data.

Studies tended to be large-scale studies using a mixture of either staff or patient data. Studies targeted general hospital-based populations, with exceptions of older black adults (Brooks-Carthon et al., 2012; Brooks-Carthon et al., 2015) and patients with heart failure as specific populations. We observed diverse configurations of associations between staffing/skills mix and relationship to safety (e.g. adverse events as predictors). There were 11 survey studies and 5 qualitative studies. We were only able to identify one intervention study (Pappas et al., 2015).

Outcomes associated with primary studies

Papers specifically measuring types of skills mix (as opposed to variations in staffing that altered skills mix) were: Adams et al., 2000, Akien et al., 2017, Blegen et al., 2013, Flynn et al., 2009, Hurst et al., 2004, McCloskey et al., 2005, McIntosh et al., 2000, Roche et al., 2016, and Seago et al., 2006.

Table 3 demonstrates how studies associated skills mix and safety; how they measured staffing and how safety was measured. In relation to skills mix, some included studies focused on the impact of shift patterns (Griffiths et al., 2014; Needleman et al., 2011; Pappas et al., 2015). Educational factors emerged in relation to skills mix (Blegen et al., 2013). Another way of conceptualising and measuring skills mix was organisational/managerial models or resourcing for staffing (Dubois et al., 2013, McCloskey et al., 2005, Aiken et al., 2001, Friese et al., 2008, Spence Lachinger et al., 2007, Hurst et al., 2004.) Specialism in nursing skills mix was explored in one paper(Aiken et al., 2012). A wide variety of safety and staffing measures were documented. Qualitative studies explored patient perceptions of safety in slightly different ways (Attree, Bishop et al., 2017; Hegney et al., 2003 (qualitative elements of survey) and Rathert et al., 2012).

Associations between skills mix and safety could be complex. Safety was analysed in a variety of ways. Some safety outcome associations in a proportion of studies were direct e.g. patient outcome or acuity (Blegen et al., 2013, Brooks-Carthon eet al., 2012, Roche et al., 2016, McCloskey et al., 2001, Spence Laschinger et al., 2006; Seago et al., 2006); mortality (Aiken et al., 2017; Griffiths et al., 2014, Needleman et al., 2011, Rafferty et al., 2007), adverse events (Brooks-Carthon et al., 2012, Pappas et al., 2013 Schilling et al., 2010) and pressure ulcers (Saleh, 2008). Several studies captured safety within broader concepts e.g. missed care (Kalisch et al., 2001 Hegney et al., 2003), quality of care (Aiken et al., 2002 McIntosh 2000, Hurst et al., 2006), hospital performance (Unruh et al., 2016), practice environment (Friese et al., 2008) admission or readmission rates (Bishop et al., 2015, Brooks Carthon et al., 2015) meeting patient needs (Adams et al., 2000).

Studies explored other factors alongside skills mix and safety such as: nurse job satisfaction (Rafferty et al., 2007; Aiken et al., 2002), care undone (Griffiths et al.,

2014), working environment (Attree et al., 2001, McCloskey et al., 2001, Spence Laschinger et al., 2006, Aiken et al., 2002), resources (Attree et al., 2001), burnout (Flynn et al., 2009, Spence Laschinger et al., 2006, Aiken et al., 2002) working relationships (Adams et al2000), patient satisfaction (Hurst et al., 2006., Saleh, 2008) workload Bishop et al., 2016, Roche et al., 2016, Schilling et al., 2010, Hurst et al., 2000), mortality (Aiken et al., 2017) and patient involvement in safety (Bishop et al., 2017).

Overall, Mortality, quality, missed care and adverse events emerged as significant outcomes. although these could be considered top level categories which themselves contain sub-categories relating to specific indicators e.g. falls, ulcers.

There is evidence within study findings that a richer skills mix is positively associated with safety outcomes: Aiken et al., 2017; Aiken et al., 2002; Brooks-Carthon et al., 2012; Brooks Carthon et al., 2015; Douibois et al., 2013; Friese et al., 2007; Griffiths et al., 2016; Kalisch et al 2011; McHugh et al 2016; Needdleman et al 2011; Pappas et al 2015; Rafferty et al., 2007; Rathert et al., 2011; Roche et al., 2016; Saleh, 2008; Schilling et al 2010; Spence Laschinger et al., 2006 and Unruh et al., 2016. (Aiken 2001; McCloskey et al., 2005; Seago et al., 2006; Griffiths et al., 2014 analysed perceptions of safety).

Table 3 - Included study interpretations of skills mix, staffing and safety

Study ID	Design	Aim	What associations between nursing skills mix interventions and safety are explored?	Measure of staffing used	Measure of safety used
Secondary data analyses					
1. Aiken et al. (2017)	Cross sectional Secondary data and survey	To determine the association of hospital nursing skill mix with patient mortality, patient ratings of their care and indicators of quality of care.	Odds of dying under caregiver/nurse substitution	Every 10-point increase in the percentage of professional nurses among all nursing personnel	Safety grading
2. Blegen et al. (2013)	Cross sectional	The aim of this study was to examine the effects of registered nurse (RN) education by determining whether nurse-sensitive patient outcomes were better in hospitals with a higher proportion of RNs with baccalaureate degrees.	Analysed the association between RN education and patient outcomes (risk-adjusted patient safety and quality of care indicators	Proportion in hospitals with Baccalaureate degree or higher	Risk adjusted patient safety
3. Brooks-Carthon et al. (2015)	Cross-sectional – secondary data and survey	The aim of this study was to examine the relationship between missed nursing care and hospital readmissions	Missed care: percentage-point increase in the number of nurses reporting having missed the activity	The nurse work environment was measured using the Practice Environment Scale of the Nursing Work Index (PES-NWI)	Odds of readmission.
4. Friese et al (2008)	Secondary analysis of data- cross sectional	To examine the effect of nursing practice environments on outcomes of hospitalised cancer patients undergoing surgery	Proportion of nurses per hospital with bachelor's degree or higher associated with mortality, FTR, complications	Mean workload: number of patients cared for on the last shift per hospital	30 day mortality, FTR, complications
5. Griffiths et al. (2016)	Cross-sectional – secondary data and survey	To describe shift patterns of European nurses and investigate whether shift length and working beyond contracted hours (overtime) is associated with nurse-reported care quality, safety, and care left undone.	Mortality and staffing-e.g.: For medical admissions, higher mortality was associated with more occupied beds per RN	Staffing measured as beds per staff member & patients per ward nurse	Mortality rates in wards

6.	Hurst et al (2004)	Secondary analysis of workforce statistics	To reconfigure DAQ data from an existing, large UK data for the purpose of generating workload and quality insights; quality insights; (b) recommend good practice for adoption by ward teams more broadly	Patient dependency, delegation and quality of care	At the same time auditors shadowed ward nurses for a total of 16,656 h recording nearly 480,000 nursing interventions categorised as direct care, indirect care, associated work or personal time.	Quality scores which include patient outcomes
7.	McHugh, et al. (2016)	Cross-sectional	To determine the association between nurse staffing, nurse work environments, and IHCA survival.	Determine association of the features of nursing and of In-Hospital Cardiac Arrest (IHCA) survival to discharge	Patient per nurse on unit, patient to nurse ratios	Higher odds of patient survival of INCA
8.	McCloskey & Diers (2005)	Quantitative - secondary data analysis, time series design	To examine the relationship between NZ hospital reengineering and adverse patient outcome rates	Preventable adverse event associations	Hours- multiples of 5 hours worked per week multiplied by 52; hours worked per 1000 surgical/medical discharges; hours worked per 1000 patient days	Preventable adverse outcomes
9.	Roche et al (2016)	Cross-sectional	To determine which tasks unregulated nursing. The aim of this study was to determine which tasks unregulated nursing support staff spend their work time undertaking and to determine differences between the work undertaken by licensed/regulated nurses on units which have nursing support workers and those on units which do not	Direct/indirect care tasks could be linked to safety	Proportion of time spent on 25 nursing activities	direct/indirect care tasks
10.	Saleh, A. M., (2008). Doctoral thesis. (ab)	Quantitative longitudinal	The purpose of this study was to examine the effects of nurse staffing on patient satisfaction, patient adverse events, patient length of stay, and nurse job satisfaction	Increasing total nursing care hours per patient day was associated with decreasing levels of patient satisfaction with nursing care, patient satisfaction with overall care, patient satisfaction with pain, and patient pressure ulcer rates.	RN vs nursing hours per patient day	Quality of nursing care and adverse events (study looked at variables such as ulcers)
11.	Seago et al (2006)	(Quantitative) Longitudinal	To examine variation in the nursing relationship between staffing and the outcomes of interest over time within a given unit and too compare variance across units.	To explore failure to rescue rates (over 4 years) & positive patient outcomes	RNHPPD- total RN hours / total patient days; all other HPPD - all non-RN hours /total patient days ; total HPPD- both RN and non-RN hours/ total patient day	Failure to Rescue- positive measures 1 from medication errors 2 from decubitus ulcers

12. Schilling et al. (2010)	Retrospective cohort study	To compare the risk of in-hospital mortality conferred by high hospital occupancy on admission, increased nurse staffing levels, weekend admission, and seasonal influenza.	Nursing levels and mortality	Ratio of each hospital's number of full-time equivalent registered nurses to its adjusted number of patient-days that year (FTE RNs per patient-day).	Risk of mortality
13. Needleman et al. (2011)	Observational study	To examine the association between mortality and patient exposure to nursing shifts	Association between mortality and patient exposure to nursing shifts during which staffing by RNs was 8 hours or more below the staffing target, Also examined association between mortality and high patient turnover owing to admissions, transfers, and discharges	Increased exposure to unit shifts during which staffing by RNs was 8 hours or more below the target level	Mortality- rate
Survey					
14. Aiken et al (2001)	Questionnaire	To present a case for reform in hospital nurse work environments- cross national comparison	(Safety not specifically linked to skills mix data	staffing adequacy- perceptions of enough registered nurses to provide quality care and enough staff to get the work done:	(Not specifically linked to skills mix data) quality of care includes adverse events indicators: wrong med, infections, falls,
15. Aiken et al (2002)	Multi-site cross-sectional survey	To examine the effects of nurse staffing and organisational support for nursing care on nurses dissatisfaction with their jobs, nurse burnout, and nurse-related quality of care	Staffing and nurse-related quality of care	last shift- and number of patients assigned - odds ratios	Nurse - assessed quality of care
16. Brooks Carthon et al. (2012)	Cross sectional survey	To determine the association between nurse staffing and postsurgical outcomes for older black adults, including 30-day mortality and failure to rescue.	Staffing and postoperative outcomes according to race	Number of additional patients per nurse's workload	Mortality, failure to rescue
17. Dubois et al (2013)	Cross-sectional correlation study	To detect occurrences of patient safety-related events.	Staffing and safety explored	Overall staffing intensity compared across 2 organisational models	6 safety events considered sensitive to nursing care (composite)
18. Flynn et al (2009)	Survey (Dillman 2007 method)	To examine the prevalence of burnout amongst nurses in haemodialysis units; effects of RN staffing and other factors on burnout, what is the effect of burnout on intention to leave	Findings from burnout and intention to leave have implications for 'enhancement of patient safety'	Measured as nurse' s responses to several items developed and tested in previous research and used to calculate the patient to RN ratios (Aiken 2002)	No explicit measures
19. Hegney et al (2003)	Survey	To understand how nurses perceive nursing workload	Indirect- examination of skills mix, workload and perceptions of quality care	Proportions of RN, EN, AIN	No explicit measures

20. Griffiths, et al. (2014)	Cross-sectional survey	To examine associations between mortality and registered nurse (RN) staffing in English hospital trusts taking account of medical and healthcare support worker (HCSW) staffing.	Whether shift length and working beyond contracted hours (overtime) is associated with nurse-reported care quality, safety, and care left undone	Number of hours worked	Mortality, study also looked at care left undone
21. Kalisch et al. (2011)	Cross-sectional descriptive	To examine whether actual nurse staffing predicts missed nursing care	Actual staffing data (hours per patient day [HPPD], registered nurse hours per patient day [RN HPPD], skill mix) also unit level case mix index explored	Actual nurse staffing	Respondents' perceptions of missed nursing care as well as other unit characteristics (i.e. demographics, work schedules and absenteeism).
22. Rafferty et al (2007)	Cross-sectional analysis	To examine the effects of hospital-wide nurse staffing levels (patient-to-nurse ratios) on patient mortality, failure to rescue (mortality risk for patients with complicated stays) and nurse job dissatisfaction, burnout and nurse rated quality of care.	Skills mix - and associations between mortality and FTR; nurse-reported job-outcomes, and nurse quality of care ratings	Derived from questions about the number of patients on the respondent's ward during the last shift worked and the total number of nurses covering that patient. Mean staffing level calculated per hospital	Likelihood of patients dying due to complications
23. Spence Laschinger & Leiter (2007)	Survey of nurses	To test the theoretical model of professional nurse work environments linking conditions for professional nursing to practice to burnout and subsequently to patient outcomes	Staffing adequacy and adverse events (burnout a mediating factor)	Practice environment scale of the nursing work index- 4 items relating to staffing and resources adequacy & collegial nurse physician relationship subscale (3 items)	Maslach Burnout Inventory; adverse events- 4 areas: falls, infections, medication errors, complaints.
24. Unruh & Hofler (2016)	Cross –sectional survey with hospital data	To explore predictors of gaps between observed and best possible Hospital Compare scores in U.S. hospitals	Registered nurse staffing as a predictor of gaps between best possible and observed quality scores	Number of acute care staffed beds	Stochastic Frontier Analysis
Intervention					
25. Pappas, et al. (2015)	Intervention	To evaluate a proactive method for determining patient risk to guide staffing as an intervention to prevent adverse events	To guide staffing decisions and nurse-patient assignment with the goal to improve patient value, reduce adverse events (seen as indicators of inadequate safety, described as safety complications)	Risk-adjusted staffing. Intervention assessment was: Implementation of the Patient Risk Assessment Profile began in December 2011. Each patient assigned a risk score each 12-hour shift. Staffing costs also analysed	Four nurse-sensitive indicators: falls, catheter-associated urinary tract infections (CAUTI), central line-associated blood stream infections (CLABSI), and pressure ulcer prevalence (PUP)

Qualitative					
26. Adams et al (2000)	Qualitative interviews	To understand the impact of nurse re-structuring on nurse' roles as described by line managers - what has been the effect on skills mix and how do participants experience the impact of current human resource management strategies	Skills mix change discussed was described as a critical incident- discussion of quality concerns	Scale of supervision load- no specific measure	No explicit measures
27. Attree (2001)	Qualitative- Grounded Theory	To explore the perceptions of and criteria used by healthcare professional s, managers, patients and relative to represent and evaluate their concept of quality of care	Association through quality of care concept	No explicit measures	No explicit measures
28. Bishop & Macdonald (2017) [Conference abstract]	Qualitative	To describe patient involvement in patient safety practices by exploring patient and staff perceptions of safety.	Perceptions of nursing workload reduce ability of nursing staff and patient participants to connect with one another and promote involvement	N/A	Perception of safety (nursing workload)
29. McIntosh et al (2000)	Ethnographic approach (qualitative)	This study adopted an ethnographic approach and aimed to explore the way in which grade and skill are taken into account in the delegation of nursing care	Skills mix was associated with standards of patient care	Delegation practices for G grade and staff nurses, views also obtained from auxiliary and enrolled nurses	Activities delegated that went beyond Trust policy also meeting required safeguarding of the patient
30. Rathert et al (2012)	qualitative- interviews	To qualitatively explore acute care consumer perceptions of safety	Consumer perceptions of safety could influence outcomes such as trust and satisfaction or compliance with treatment protocols.	No details- staffing problems mentioned	No measures- patient perception of safety

How do patient safety outcomes associated with nursing skill mix interventions and variations compare in acute and community care?

The majority of studies from the synthesis of primary studies focused on hospital-based secondary care outcomes,- with two exceptions of tertiary care (Bishop et al., 2017 and Needleman et al., 2011). We were able to identify one example of a primary study focused on community care by McIntosh et al (2000). This Scottish study adopted an ethnographic approach and aimed to explore the way in which grade and skill are taken into account in the delegation of nursing care in district nursing teams in association with standards of patient care. They concluded the direct involvement of nurses to patient visits (and to supervise nursing auxiliaries) and enhanced patient safety. However, there are no large-scale trial or quantitative analysis of data in this field. While skill mix remains an issue for such settings it is possible that implications within primary and community care are not explored in relation to safety-related outcomes.

To look at this comparison further we did identify included papers within a review that analysed studies conducted in nursing homes as long-term care settings (Dellefield et al., 2015). Griffiths et al (2014) specifically excluded nursing home settings.

Dellefield et al(2015) examined the relationship between registered nurses and nursing home quality. A large number of relevant studies would be eligible if broader review inclusion criteria had included nursing homes. Outcomes included: nursing home culture (Colon-Emeric et al., 2010; Choi, 2011; Thomas et al., 2012); staff licencing and barriers to delegation (Corazzini et al., 2010) education levels of staff (Kash et al., 2010; Corazzi et al., 2012); skill mix (Seblega et al., 2010; Bowblis 2011; Castle and Anderson 2010, Castle et al 2011;); staff level (Havig et al 2011; Tong 2011; Townsley et al 2011;); preventative practice (Dellefield et al., 2012; Tempkiin et al., 2012; Lee et al., 2014); retention (Hunt et al., 2012; Banaszak-Holl et al., 2013; Hunt et al., 2014); mortality (Trivedi et al., 2012); readmission (Spector et al., 2013) and level of care (Chen and Grabowski 2014) .

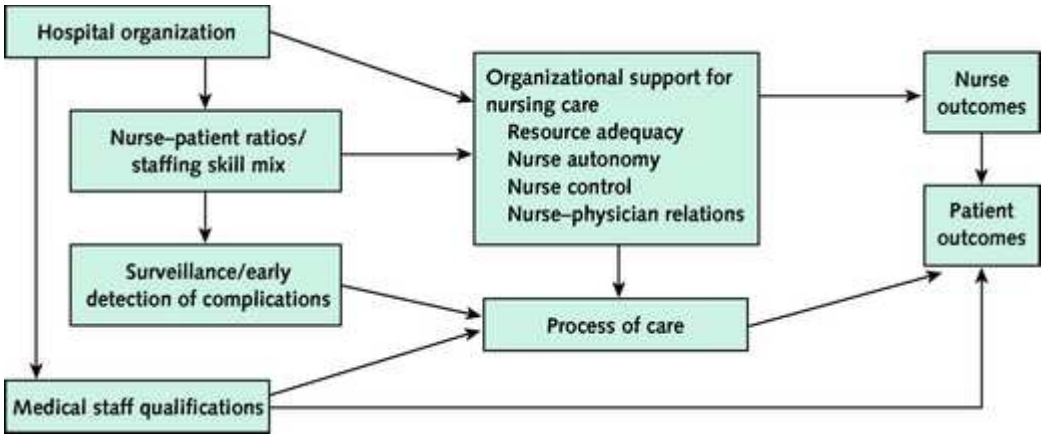
Ten additional studies were identified in the same review published between 2000-2010. The studies covered a variety of topics including exploration of outcomes related to: quality measures (Alexander et al., 2008); (Castle and Engberg et al., 2008a & b); (Castle et al., 2008); (Castle et al., 2009); (Kim et al., 2009a &b); (Park and Stearns, 2009). Other papers explored RN staffing and adverse events (Konetzka et al., 2008) and length of patient stay (Decker et al., 2008).

What theories or conceptual frameworks have been used to characterise nursing skill mix interventions and the contexts of implementation in which patient safety outcomes have been demonstrated?

Our process of study selection for reviews and primary studies did not reveal many examples of conceptual frameworks, models or theories. This supports the widely reported observation of a frequent disconnect between empirical and conceptual writings on the same topic. A full-text search of Google was therefore conducted via the Publish or Perish™ software using a published strategy (model*, framework*, concept* or theor*) in conjunction with nursing skill mix and safety. A total of 482 hits were retrieved and references prioritised according to the relevance of their titles. This facilitated the following brief overview of some of the main conceptual models associated with the topic together with identification of graphical or tabular models where available.

Early conceptual thinking relating to the relationship between nursing skill mix and patient safety was not particularly developed. Several early models were derivative from the Donabedian model of Structure, Processes and Outcomes (Donabedian, 1996) and little attempt was made to quantify the variables by which the relationship could be measured and evaluated. Several conceptual frameworks have been proposed to explain how effective nursing care may reduce inpatient mortality. Improved surveillance is considered a critical factor that can be improved with more staff, better-educated staff, or a better working environment. Aiken and colleagues (2002) propose a framework by which nurse–patient ratios, along with staffing skill mix, can lead to better surveillance, thereby influencing the process of care and, subsequently, leading to improved patient outcomes (Figure 3).

Figure 3 - Hospital organization, nursing organization, and patient outcomes (Aiken et al, 2002)



Dubois & Singh (2009) seek to locate the interdependent issues of staff mix and skill management within a wider human resource management strategy. Their conceptual framework acknowledges wider determinants such as institutional and organizational context as well as a broad range of outcomes at the levels of organisation, staff and patients.

Figure 4 – Framework for optimising human resources in health care Dubois & Singh (2009)

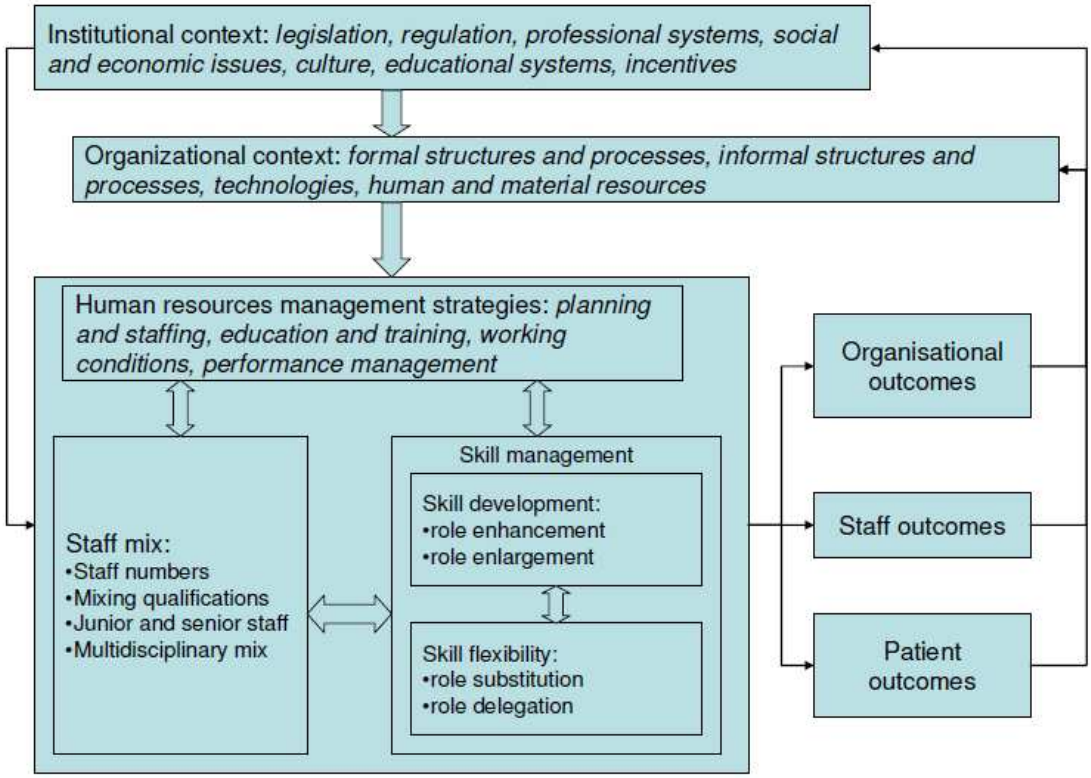


Figure 1
A framework for optimising human resources in health care.

Duffield and colleagues (2011) identify four types of variable relating to nurse staffing, workload, working environment, and patient outcomes, as well as identifying the data requirements that accompany each type. This offers a useful static framework but makes little attempt to depict causal relationships between variables. However, it does include a wider conceptualisation of patient outcomes by including nursing tasks delayed and nursing tasks undone.

Figure 5 –Principle variables framework Duffield and colleagues (2011)

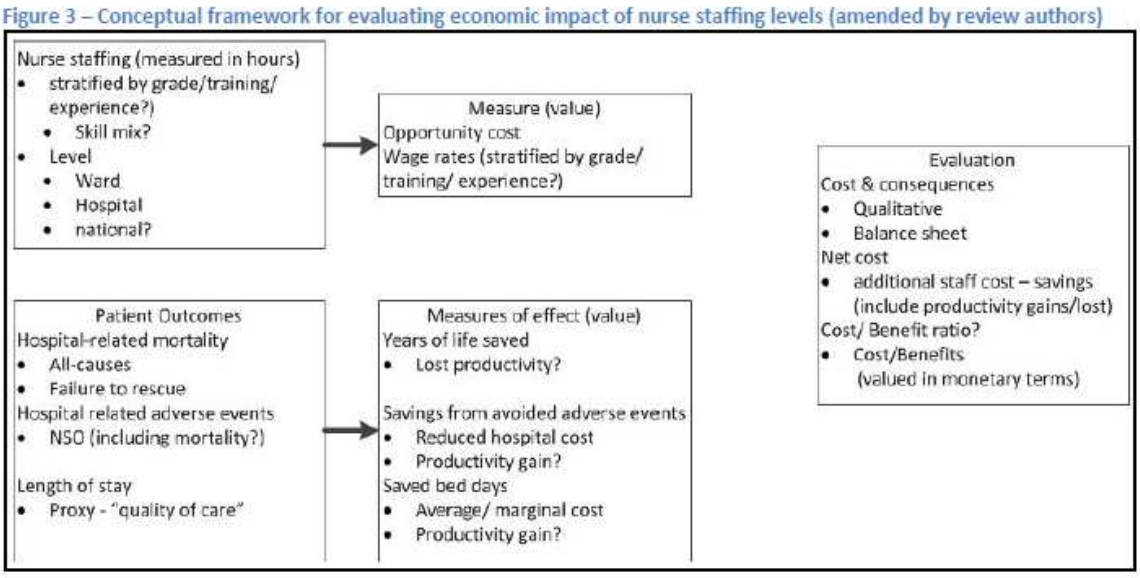
Table 1 Principal Variables

	Nurse Staffing	Nursing Workload	Working Environment	Patient Outcomes
Administrative Data	▪ Number of RN's ▪ Nursing hours worked ▪ Nursing hours per patient day ▪ Skill mix (% RN)	▪ Patient turnover (churn) ▪ Case mix (number of DRGs/ward)	▪ Rural/urban ▪ Ward type	▪ Length of stay (LOS) ▪ Failure to rescue ▪ Outcomes Potentially Sensitive to Nursing (OPSN)[a]
Primary Data Collection	▪ Percent BSN ▪ Presence of CNS ▪ Presence of nurse educator ▪ Years of experience of nursing staff ▪ Nurse overtime hours - Percent nurses on permanent contracts ▪ Percent nurses that usually work on this ward ▪ Percent nurses practicing at high clinical level	▪ Patients per bed ▪ Hours of care required per patient day ▪ Nursing demand/supply - (hours of care required per patient day / nursing hours per patient day) ▪ Housekeeping support hours ▪ Amount additional time needed for patient care per shift	▪ Organizational Factors - Practice control - Nurse autonomy - RN/MD relationships - Nursing leadership - Resource adequacy ▪ Environmental complexity ▪ Perceptions of violence ▪ Job satisfaction ▪ Number patients waiting for care facility ▪ Number planned admissions ▪ Clinical pathways ▪ Clinical/technical assistance on ward (PT, OT, etc)	▪ Falls ▪ Medication errors ▪ Nursing tasks delayed ▪ Nursing tasks undone

[a] UTI; Decubitus; Pneumonia; DVT/PE; GI bleed; CNS complications; Sepsis; Shock/cardiac arrest; Surgical wound infection; Pulmonary failure; Physiological/metabolic derangement (Needleman, et al., 2001).

Perhaps the most complete conceptual model, drawing on previous versions such as that by Shamliyan et al (2009) is extended by Griffiths and colleagues (2014) as part of their review for the National Institute for Health and Clinical Excellence. In locating their model within an economic impact framework the University of Southampton team were able to extend thinking beyond the competing domains of staffing and safety to one where costs and benefits could be attributed throughout the entire model.

Figure 6 – Conceptual framework for evaluating the impact of nurse staffing levels by Shamliyan et al (2009) is extended by Griffiths and colleagues (2014)



Finally, recent application of methodologies for exploring causative links, grounded in realist logic, have been used to explore the relationship between nurse staffing and patient nurse outcomes, including safety (Subirana et al, 2013). This model particularly makes explicit mechanisms otherwise implicit in more structural interpretations of causality. The realist approach recognises the role of increased surveillance and more timely intervention when adequate staffing levels and expertise are maintained.

Figure 7 – Logic model of nurse staffing and patient/nurse outcomes Subirana ***et al (2013)***

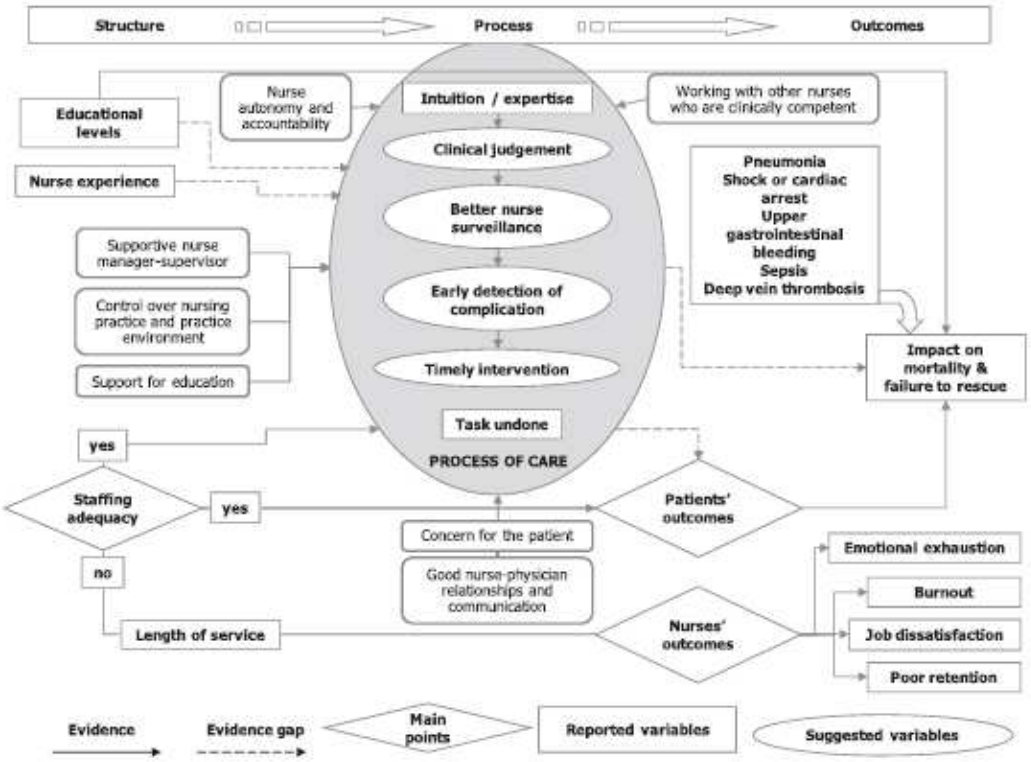


Figure 2. Tentative logic model: nurse staffing and patient/nurse outcomes.
Note: To avoid making the logic diagram highly complex, a minimum of implied causal links are indicated. It should be noted that nursing outcomes themselves are feedback and will affect variables within the process of care.

Emerging options for the focused review (AB)

Box 1 - Summary of Scoping Review Findings

- Safety is increasingly being viewed in its broadest sense to include not just errors and neglect but also in terms of missed care and care left undone.
- We identified an acute shortage of intervention studies (n = 1) in relation to skill mix interventions where safety was a principal outcome.

- Primary and community care appears to be a neglected area of research, specifically in relation to safety-related outcomes with the exception of a considerable research agenda in nursing homes.
- Recent studies by the RN4Cast Consortium are changing the current extent and quality of the evidence base.
- Increasing interest is being expressed in leadership and the wider determinants of successful team operation, both organisational and institutional.

Preliminary mapping reveals a complexity that extends beyond an initial conception, crudely characterised as errors of commission (e.g. medication errors) and errors of omission (e.g. falls, pressure ulcers etcetera) to include the rapidly emerging concept of "missed care" or "care left undone". This concept can be interpreted more widely and holistically in a way that is consonant with the nurse's wider role e.g. missed care can include missed opportunities for communication with the patient or missed opportunities to engage in education with patients or carers. Jones et al (2015) engage with this wider context for considering the domain of patient safety by distinguishing "unfinished nursing care, missed care, and implicitly rationed care". Greatest concern would focus on areas where implicit rationing was applied for reasons other than according to clinical need.

One subtheme that has emerged from the scoping review relates to issues around measurement and metrics. Certain tools for capturing the context of the working environment (e.g. the Practice Environment Scale of the Nursing Work Index) have been used extensively across multiple studies (over 100 references) and offer a basis for comparison. The evidence around this Scale was reviewed comprehensively by Swiger et al (2017). Similarly the nursing hours per patient day (NHPPD) staffing method reports frequent instances of its use (Twigg et al, 2011).

One unexpected finding has been academic interest in leadership among the broader determinants of skill mix (Auer et al, 2014a, 2014b). This broadening of the interpretation from beyond the front-line team to the wider supportive environment is captured in more recent conceptual models that adopt a more holistic view of the nursing workforce and patient safety relationship.

Recent studies (2009-2018) reveal the importance of the RN4Cast international initiative which has started to publish its data. It may be opportune to factor in this more recent data into any plans for a review.

Box 2 - Relevant Outputs from the RN4Cast Consortium

Sasso L, Bagnasco A, Petralia P, et al. RN4CAST@IT-Ped: Nurse staffing and children's safety. J Adv Nurs. 2018 Jun;74(6):1223-1225. doi: 10.1111/jan.13462. Epub 2017 Oct 24.

Ball JE, Bruyneel L, Aiken LH, et al; RN4Cast Consortium. Post-operative mortality, missed care and nurse staffing in nine countries: A cross-sectional study. Int J Nurs Stud. 2018 Feb;78:10-15. doi: 10.1016/j.ijnurstu.2017.08.004. Epub 2017 Aug 24.

Ball J, Day T, Murrells T, et al. Cross-sectional examination of the association between shift length and hospital nurses job satisfaction and nurse reported quality measures. BMC Nurs. 2017 May 25;16:26. doi: 10.1186/s12912-017-0221-7. eCollection 2017.

Gkantaras I, Mahfoud ZR, Foreman B, et al. The effect of Nurse GraduaTeness on patient mortality: a cross-sectional survey (the NuGaT study). J Adv Nurs. 2016 Dec;72(12):3034-3044. doi: 10.1111/jan.13059. Epub 2016 Jul 27.

Lacher S, De Geest S, Denhaerynck K, et al. The Quality of Nurses' Work Environment and Workforce Outcomes From the Perspective of Swiss Allied Healthcare Assistants and Registered Nurses: A Cross-Sectional Survey. J Nurs Scholarsh. 2015 Sep;47(5):458-67. doi: 10.1111/jnu.12151. Epub 2015 Jul 28.

Auer C, Schwendimann R, Koch R, et al. How hospital leaders contribute to patient safety through the development of trust. J Nurs Adm. 2014 Oct;44(10 Suppl):S38-44. doi: 10.1097/NNA.0000000000000123.

Leineweber C, Westerlund H, Chungkham HS, et al. Nurses' practice environment and work-family conflict in relation to burn out: a multilevel modelling approach. PLoS One. 2014 May 12;9(5):e96991. doi: 10.1371/journal.pone.0096991. eCollection 2014.

Aiken LH, Sloane DM, Bruyneel L, et al; RN4CAST consortium. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. Lancet. 2014 May 24;383(9931):1824-30. doi: 10.1016/S0140-6736(13)62631-8. Epub 2014 Feb 26.

Auer C, Schwendimann R, Koch R, et al. How hospital leaders contribute to patient safety through the development of trust. J Nurs Adm. 2014 Jan;44(1):23-9. doi: 10.1097/NNA.0000000000000017.

Desmedt M, De Geest S, Schubert M, et al. A multi-method study on the quality of the nurse work environment in acute-care hospitals: positioning Switzerland in the Magnet hospital research. Swiss Med Wkly. 2012 Dec 21;142:w13733. doi: 10.4414/smw.2012.13733.

Aiken LH, Sloane DM, Bruyneel L, et al; RN4CAST Consortium. Nurses' reports of working conditions and hospital quality of care in 12 countries in Europe. Int J Nurs Stud. 2013 Feb;50(2):143-53. doi: 10.1016/j.ijnurstu.2012.11.009. Epub 2012 Dec 17. PubMed PMID: 23254247.

Schubert M, Ausserhofer D, Desmedt M, et al. Levels and correlates of implicit rationing of nursing care in Swiss acute care hospitals--a cross sectional study. Int J Nurs Stud. 2013 Feb;50(2):230-9. doi: 10.1016/j.ijnurstu.2012.09.016. Epub 2012 Oct 22.

Li B, Bruyneel L, Sermeus W, et al. Group-level impact of work environment dimensions on burnout experiences among nurses: a multivariate multilevel probit model. Int J Nurs Stud. 2013 Feb;50(2):281-91. doi: 10.1016/j.ijnurstu.2012.07.001. Epub 2012 Jul 24.

Ausserhofer D, Schubert M, Desmedt M, et al. The association of patient safety climate and nurse-related organizational factors with selected patient outcomes: a cross-sectional survey. Int J Nurs Stud. 2013 Feb;50(2):240-52. doi: 10.1016/j.ijnurstu.2012.04.007. Epub 2012 May 4.

Ausserhofer D, Schubert M, Engberg S, et al. Nurse-reported patient safety climate in Swiss hospitals: a descriptive-explorative substudy of the Swiss RN4CAST study. Swiss Med Wkly. 2012 Jan 20;142:w13501. doi: 10.4414/smw.2012.13501.

Possible options for the way forward:

The following are tentative suggestions for further review work suggested at the point of completion of the original review prior to the update.

Option 1: To explore the concept of missed care as it relates to safety in a primary and community care setting, possibly including nursing homes.

Option 2: To seek nursing skill mix intervention studies that link to surrogate outcomes that may then be extrapolated as being linked to improved patient safety (e.g. burnout, fatigue, impaired surveillance, distraction etcetera).

Option 3: To map identified evidence to one of the existing conceptual models (e.g. Griffiths et al, 2014) to complete a more holistic view of safety, including care left undone and related concepts such as unfinished nursing care and implicitly rationed care.

Option 4: To extend the time period covered by primary studies and reviews in order to elicit a more substantive evidence base.

NB, From the scoping review there appears little justification for revisiting our geographical delimits as very few empirical studies were revealed outside our specified list of countries.

References

Donabedian A. Evaluating the quality of medical care. *The Milbank Memorial Fund Quarterly.* 1966 Jul 1;44(3):166-206.

Dubois C-A, Singh D. From staff-mix to skill-mix and beyond: towards a systemic approach to health workforce management. Human Resources for Health; 2009 Dec;7(1). Available from: http://dx.doi.org/10.1186/1478-4491-7-87.

Duffield C Diers D O'Brien-Pallas L Aisbett C Roche M King M et al Nursing staffing, nursing workload, the work environment and patient outcomes., Appl Nurs Res, 2011, 24: 244-55.

Griffiths, P., Ball, J., Drennan, J., James, L., Jones, J., Recio-Saucedo, A., Simon, M., 2014. *The association between patient safety outcomes and nurse/healthcare assistant skill mix and staffing levels and factors that may influence staffing requirements* (NICE evidence review). University of Southampton Centre for innovation and Leadership in Health Sciences

Shamliyan TA, Kane RL, Mueller C, Duval S, Wilt TJ. Cost savings associated with increased RN staffing in acute care hospitals: simulation exercise. Nursing Economics. 2009 Sep 1;27(5):302.

Subirana M, Long A, Greenhalgh J, Firth J. A realist logic model of the links between nurse staffing and the outcomes of nursing. Journal of Research in Nursing; 2013 Apr 11;19(1):8–23. Available from: http://dx.doi.org/10.1177/1744987113481782

Wilson S and Bremner A. The effect of nurse staffing on clinical outcomes of children in hospital: a systematic review. *International Journal of Evidence-Based Healthcare*; 2011 Jun;9(2). Available from: http://dx.doi.org/10.1111/jbr.2011.9.issue-2

References from Dellefield et al., 2015 review – based on abstracts screen

Alexander G. L. (2008). An analysis of nursing home quality measures and staffing. *Quality Management in Health Care*, *17*(3), 242-251.

Banaszak-Holl J., Castle N.G., Lin M.K., Shrivastwa N. & Spreitzer G. (2013). The role of organizational culture in retaining workforce. The Gerontologist, PMID: 24218146.

Bowblis J.R. (2011). Staffing ratios and quality: an analysis of minimum direct care staffing requirements for nursing homes. Health Services Research, 46(5), 1495-1515.

Castle N.G. & Anderson R.A. (2011). Caregiver staffing in nursing homes and their

influence on quality of care: using dynamic panel estimation methods. Medical Care, 49(6), 545-552.

Castle N.G. (2011). The influence of consistent assignment on nursing home deficiency citations. The Gerontologist, 51(60), 750-760.

Castle N.G. (2009). Use of agency staff in nursing homes. *Research in Genontological Nursing*,*2*(3), 192-201

Castle N.G. & Engberg J. (2008). Further examination of the influence of caregiver staffing levels on nursing home quality*. The Gerontologist, 48*(4), 464-476.

Castle N.G. & Engberg J.B. (2008). The influence of agency staffing on quality of care in nursing homes. *Journal of Aging & Social Policy, 20*(4), 437-457.

Chen M.M .& Grabowski D.C. (2014). Intended and unintended consequences of minimum staffing standards for nursing homes. Health Economics. DOI: 10.1002/hec.3063.

Choi J., Flynn L., Aiken L.H. (2011). Nursing practice environment and registered nurses' job satisfaction in nursing homes. The Gerontologist, 52(4), 484-492.

Colon-Emeric C.S., Plowman D., Bailey D., Corazzini K., Utley-Smith Q., Ammarell N., Toles M.,& Anderson R. (2010). Regulation and mindful resident care in nursing homes. *Qualitative Health Research, 20*(9),1283-1294 .

Corazzini K.N., Anderson R.A., Mueller C., Thorpe J.M., & McConnell E.S. (2012). Jurisdiction over nursing care systems in nursing homes: latent class analysis. *Nursing Research, 61*(1), 28- 38 .

Corazzini K.N., Anderson R.A., Rapp C.G., Mueller C., McConnell E.S., Lekan D. (2010). Delegation in long-term care: scope of practice or job description? The Online Journal of Issues in Nursing, May.

Decker F.H. (2008). Outcomes and length of medicare nursing home stays: the role of registered nurses and physical therapists. *American Journal of Medical Quality, 23*(6), 465-474.

Dellefield M.E., Harrington, Kelly A. (2012). Observing how RNs use clinical time in a nursing home: a pilot study. Geriatric Nursing, 33(4), 256-263.

Havig A.K., Skogstad A., Kjekshus L.E., Romoren T.I. (2011). Leadership, staffing, and quality of care in nursing homes. BMC Health Services Research, 11, 327.

Hunt S., Corazzinni K. & Anderson R.A. (2012). Top nurse-management staffing collapse and care quality in nursing homes. Journal of Applied Gerontology, 33 (1), 51-74.

Hunt S.R., Probst J.C. ,Haddock K.S., Moran R., Baker S.L., Anderson R.A., Corazzini K. (2012). Registered nurse retention strategies in nursing homes: a tow factor perspective. Health Care Management Review, 37(93), 246-256.

Kash B.A., Naufal G.S., Dagher R.K., Johnson C.E. (2010). Individual factors associated with intentions to leave among directors of nursing in nursing homes. Health Care Management Review, 35(3), 246-255.

Konetzka R.T., Stearns S.C. & Park J. (2008). The staffing-outcomes relationship in nursing homes. *Health Services Research, 43*(3),1025-1042.

Kim H., Harrington C., & Greene W.H. (2009). Registered nurse staffing mix and quality of carein nursing homes: a longitudinal analysis. *The Gerontologist, 49*(10), 81-90.

Kim H., Kovner C., Harrington C., Greene W. & Mezey M. (2009). A panel data analysis of the relationships of nursing home staffing levels and standards to regulatory deficiencies. *Journal of Gerontology: Social Sciences, 64B*(2), 269-278.

Lee H.Y., Blegen M.A. & Harrington C. (2014). The effects of RN staffing hours on nursing home quality: a two-stage model. International Journal of Nursing Studies, 51, 409-417.

Park J. & Stearns S.C. (2009). Effects of state minimum staffing standards on nursing home staffing and quality of care. *Health Services Research*, 44(1), 56-78.

Seblega B.K., Zhang N.H., Unruh L.Y., Breen G.M., Paek S.C., & Wan T.T.H. (2010). Changes in nursing home staffing levels, 1997-2007. Medical Care Research Review, 67(2), 232-246.

Spector W.D., Limcangco R., Williams C., Rhodes W., & Hurd D. (2013). Potentially avoidable hospitalizations for elderly long-stay residents in nursing homes. Medical Care, 51(8), 673-681.

Temkin-Greener H., Cai S., Zheng N.T., Zhao H., Mukamel D.B. (2012). Nursing home work environment and risk of pressure ulcers and incontinence. Health Services Research, 47(3), Part I: 1179-1200.

Thomas K.S., Hyer K., Castle N.G., Branch L.G., Andel R. & Weech-Maldonado R. (2012). Patient safety culture and the association with safe resident care in nursing homes. The Gerontologist, 52(6), 802-811.

Tong P.K. (2011). The effects of California minimum nurse staffing laws on nurse labor and patient mortality in skilled nursing facilities. Health Economics. 20, 802-816.

Towsley G.L., Beck S.L., Dudley W.N., Pepper G.A. (2011). Staffing levels in rural nursing homes. Research in Gerontological Nursing, 4(3), 1-14.

Trivedi T.K,. DeSalvo T., Lee L., Palumbo A., Moll A., Curns A., Hall, A.J., Manish P., Parashar U.D., & Lopman B.A. (2012). Hospitalizations and mortality associated with norovirus outbreaks in nursing homes, 2009-2010. Journal of the American Medical Association, 308(16), 1668- 1675.

Appendix 1 – Methods of the Scoping Review

The methods of the scoping review were based on a framework developed by Arksey and O'Malley[10], and refined by Daudt et al[11]. The key steps in the review are:

- Identifying the research questions
- Identifying relevant studies
- Study selection and quality assessment
- Charting data
- Summarising and reporting results
- Consultation exercise

Identifying the research questions

Three a priori review questions were agreed as:

RQ1. What patient safety outcomes are associated with nursing skill mix interventions and variation?

RQ2. How do patient safety outcomes associated with nursing skill mix interventions and variations compare in acute and community care?

RQ3. What theories or conceptual frameworks have been used to characterise nursing skill mix interventions and the contexts of implementation in which patient safety outcomes have been demonstrated?

Identifying relevant studies

Review Questions 1 and 2 would both be addressed by identification of (i) systematic reviews and (ii) primary research studies conducted in the big five countries most influential on UK practice (i.e. UK and Republic of Ireland; Australia, Canada, New Zealand and USA). Date limits were restricted to the time period 2010 onwards in order to optimise both currency and feasibility. This means that reviews compiled between 2010 and 2018 would be examined in order to find only included primary studies conducted between these dates. When the review was updated (to include primary papers published between 2000-2009) the original included reviews were rescreened but no new database search for reviews was conducted.

The search strategy for Review Questions 1 and 2 is depicted in tabular format, providing the definitive search terms and the number of hits for each database source.

Nursing Skill Mix and Safety Search strategies (Scoping Review)

		Safety		
		Core	Probable	Possible
Skill Mix	Core	((Nursing Staff/ OR Nursing Staff, Hospital/ OR exp Nurses/ OR Nurses' Aides/ OR Nursing Administration Research/ OR Nursing Audit/ OR Models Nursing/ OR Nursing Service Hospital/) OR (Nurse or nurses or nursing).tw. OR ("healthcare assistant*" OR "health care assistant*").tw.) AND (Personnel Staffing and Scheduling/ OR Nurses Role/ OR Workload/ OR Health Manpower/) AND (Patient Safety/ OR Safety Management/ OR Medical Errors/ OR Fatigue/ OR Work Schedule Tolerance/ OR safety) **23 items (no geog limiters)** **388 CINAHL**	((Nursing Staff/ OR Nursing Staff, Hospital/ OR exp Nurses/ OR Nurses' Aides/ OR Nursing Administration Research/ OR Nursing Audit/ OR Models Nursing/ OR Nursing Service Hospital/) OR ((Nurse or nurses or nursing).tw. OR ("healthcare assistant*" OR "health care assistant*").tw.)) AND (Personnel Staffing and Scheduling/ OR Nurses Role/ OR Workload/ OR Health Manpower/) AND (Quality of Health Care/ OR Nursing/standards OR safe) **Same 23 items as previous** **265 CINAHL**	((Nursing Staff/ OR Nursing Staff, Hospital/ OR exp Nurses/ OR Nurses' Aides/ OR Nursing Administration Research/ OR Nursing Audit/ OR Models Nursing/ OR Nursing Service Hospital/ OR ((Nurse or nurses or nursing).tw. OR ("healthcare assistant*" OR "health care assistant*").tw.) AND (Personnel Staffing and Scheduling/ OR Nurses Role/ OR Workload/ OR Health Manpower/) AND (Health Planning Guidelines OR Economics, Nursing) **35 items (30 new)** **29 CINAHL**
	Probable	Nursing Staff/ OR Nursing Staff, Hospital/ OR exp Nurses/ OR Nurses' Aides/ OR Nursing Administration Research/ OR	Nursing Staff/ OR Nursing Staff, Hospital/ OR exp Nurses/ OR Nurses' Aides/ OR Nursing Administration Research/ OR	Hospital/ OR exp Nurses/ OR Nurses' Aides/ OR Nursing Administration Research/ OR Nursing Audit/ OR Models Nursing/ OR Nursing Service

		Nursing Audit/ OR Models Nursing/ OR Nursing Service Hospital/ OR (Nurse or nurses or nursing).tw. OR ("healthcare assistant*" OR "health care assistant*").tw. AND workforce OR manpower OR personnel OR (skill* adj1 mix*).tw. OR skillmix*.tw. OR ("skill shortage*" OR "nursing shortage*.tw.) OR (staffmix* or "staff mix*").tw. OR staffing.tw. OR understaff*.tw. OR "under staff*".tw. AND Patient Safety/ OR Safety Management/ OR Medical Errors/ OR Fatigue/ OR Work Schedule Tolerance/ OR safety **14 items (10 new) 450 CINAHL**	Nursing Audit/ OR Models Nursing/ OR Nursing Service Hospital/ OR (Nurse or nurses or nursing).tw. OR ("healthcare assistant*" OR "health care assistant*").tw. AND workforce OR manpower OR personnel OR (skill* adj1 mix*).tw. OR skillmix*.tw. OR ("skill shortage*" OR "nursing shortage*.tw.) OR (staffmix* or "staff mix*").tw. OR staffing.tw. OR understaff*.tw. OR "under staff*".tw. AND Quality of Health Care/ OR Nursing/standards OR safe **28 items (10 new) 348 CINAHL**	Hospital/ OR (Nurse or nurses or nursing).tw. OR ("healthcare assistant*" OR "health care assistant*").tw. AND workforce OR manpower OR personnel OR (skill* adj1 mix*).tw. OR skillmix*.tw. OR ("skill shortage*" OR "nursing shortage*.tw.) OR (staffmix* or "staff mix*").tw. OR staffing.tw. OR understaff*.tw. OR "under staff*".tw. AND Health Planning Guidelines OR Economics, Nursing **182 items 42 CINAHL**
	Possible	Nursing Staff/ OR Nursing Staff, Hospital/ OR exp Nurses/ OR Nurses' Aides/ OR Nursing Administration Research/ OR Nursing Audit/ OR Models Nursing/ OR Nursing Service Hospital/ OR (Nurse or nurses	(Nursing Staff/ OR Nursing Staff, Hospital/ OR exp Nurses/ OR Nurses' Aides/ OR Nursing Administration Research/ OR Nursing Audit/ OR Models Nursing/ OR Nursing Service Hospital/ OR (Nurse or nurses or	(Nursing Staff/ OR Nursing Staff, Hospital/ OR exp Nurses/ OR Nurses' Aides/ OR Nursing Administration Research/ OR Nursing Audit/ OR Models Nursing/ OR Nursing Service Hospital/ OR (Nurse or nurses or nursing).tw. OR

		or nursing).tw. OR ("healthcare assistant*" OR "health care assistant*").tw. AND (staff* adj3 (level* or ratio* or resourc* or model* or number* or mix* or rota* or rosta* or roster* or schedul* or overtime or supervision or supervisory)).tw. OR (staff* adj3 (sufficient* or sufficiency or adequate* or adequac* or target* or insufficient* or insufficienc* or inadequate* or inadequac* or short or shortage or efficient* or efficienc* or inefficien*)).ti. OR (workload* or shift or shiftwork* or shifts or overtime or capacity).tw. AND Patient Safety/ OR Safety Management/ OR Medical Errors/ OR Fatigue/ OR Work Schedule Tolerance/ OR safety 0 hits CINAHL 547 hits	nursing).tw. OR ("healthcare assistant*" OR "health care assistant*").tw.) AND ((staff* adj3 (level* or ratio* or resourc* or model* or number* or mix* or rota* or rosta* or roster* or schedul* or overtime or supervision or supervisory)).tw. OR (staff* adj3 (sufficient* or sufficiency or adequate* or adequac* or target* or insufficient* or insufficienc* or inadequate* or inadequac* or short or shortage or efficient* or efficienc* or inefficien*)).ti. OR (workload* or shift or shiftwork* or shifts or overtime or capacity).tw.) AND (Quality of Health Care/ OR Nursing/standards OR safe) 0 hits CINAHL 311	("healthcare assistant*" OR "health care assistant*").tw.) AND ((staff* adj3 (level* or ratio* or resourc* or model* or number* or mix* or rota* or rosta* or roster* or schedul* or overtime or supervision or supervisory)).tw. OR (staff* adj3 (sufficient* or sufficiency or adequate* or adequac* or target* or insufficient* or insufficienc* or inadequate* or inadequac* or short or shortage or efficient* or efficienc* or inefficien*)).ti. OR (workload* or shift or shiftwork* or shifts or overtime or capacity).tw.) AND (Health Planning Guidelines OR Economics, Nursing) 0 hits CINAHL 28

		(Nursing Staff/ OR Nursing Staff, Hospital/ OR exp Nurses/ OR Nurses' Aides/ OR Nursing Administration Research/ OR Nursing Audit/ OR Models Nursing/ OR Nursing Service Hospital/ OR (Nurse or nurses or nursing).tw. OR ("healthcare assistant*" OR "health care assistant*").tw.) AND ((staff* adj3 (level* or ratio* or resourc* or model* or number* or mix* or rota* or rosta* or roster* or schedul* or overtime or supervision or supervisory)).tw. OR (staff* adj3 (sufficient* or sufficiency or adequate* or adequac* or target* or insufficient* or insufficienc* or inadequate* or inadequac* or short or shortage or efficient* or efficienc* or inefficien*)).ti. OR (workload* or shift or shiftwork* or shifts or overtime or capacity).tw.) 337 Refs
All Combined with: Great Britain/ OR UK OR United Kingdom OR England OR Scotland OR Scottish OR Wales OR Welsh OR London OR Leeds OR Liverpool OR Manchester OR Birmingham OR Sheffield OR Portsmouth OR Southampton OR Glasgow OR Edinburgh OR Aberdeen OR Dundee OR Ireland OR Irish OR Belfast OR Dublin OR Australia OR Australian OR Canada OR Canadian OR “New Zealand” OR “United States” AND English Language Only AND 2010 to 2018		

Study selection and quality assessment

Inclusion and exclusion criteria are documented in the accompanying protocol. Study selection of primary studies was undertaken by the Research Associate (KS). Items were prioritised for selection by searching for keywords associated with the review question and research design types that were strongly indicative of an empirical study (e.g, cross-sectional; design). Clarification was sought from the systematic review methodologist (AB) in cases where inclusion/exclusion was unclear or where the initial scope required further refinement.

Study selection of systematic reviews was split between the Research Associate (KS) and the systematic review methodologist (AB). Reviews were included if they were published between 2010 and 2018, if at least one of their included studies was published within the same period, if they addressed issues relating to nurse staffing (optimally nursing skill mix) and included at least one outcome that was directly related to patient safety (e.g. medication errors, falls, pressure ulcers, missed care etcetera). There was no additional database search specifically for reviews published between 2000-2009. The included reviews were re-screened. The update database search for primary studies (2000-2009) was screened for relevant reviews. The additional Google Scholar search was also screened for relevant reviews.

No quality assessment was performed for the scoping review. Reviews and primary studies will be assessed once the future direction of the planned systematic review is determined so that only items that address the specific review question are assessed.

Charting data

Data from primary research studies were extracted using a "light touch" data extraction form. This form was designed to provide sufficient detail to inform decisions on the quantity and nature of the identified evidence but without meeting the specific requirements of a systematic review. Extracted data will then be supplemented with additional fields once the specific review question has been determined.

Data extracted from systematic reviews consisted of two types. First, the team mapped the authors and total numbers of eligible included studies from the review to enable an assessment of coverage and overlap. Then the team mapped each review against the specific safety outcomes included in that review in order to develop a picture of the most common safety outcomes.

Summarising and reporting results

Data were described in narrative and tabular form, including study characteristics and frequencies. No attempt was made to capture the results of the identified

studies as this would be a feature of the full systematic review and might contribute to selection bias when the final review question was being determined.

Consultation exercise

This report is prepared for the University of Sheffield (UoS) School of Nursing team in the first instance with a subsequent version to be shared with the Royal College of Nursing. A brief oral presentation of the principal findings of the report prior to the update was shared with the Advisory Group. Both the UoS School of Nursing team and the RCN team had the opportunity to feed into the final direction of the systematic review,

Appendix 2 – Included Reviews N=22

NB: To be included as "relevant" studies must be published from 2000 onwards, involve aspects of nurse staffing connected to safety outcomes and not be conducted within one of the settings excluded by Griffiths et al (2016).

Casey (2017)

Casey M, O'Connor L, Cashin A, Smith R, O'Brien D, Nicholson E, O'Leary D, Fealy G, McNamara M, Glasgow ME, Stokes D. An overview of the outcomes and impact of specialist and advanced nursing and midwifery practice, on quality of care, cost and access to services: A narrative review. *Nurse Education Today*. 2017 Sep 1;56:35-40.

Clendon and Gibbons (2015)

Clendon, J., & Gibbons, V. (2015). 12 h shifts and rates of error among nurses: A systematic review. *International journal of nursing studies, 52*(7), 1231-1242.

Drennan et al (2014)

Jonathan Drennan, Alejandra Recio-Saucedo, Catherine Pope, Rob Crouch, Jeremy Jones, Chiara Dall'Ora and Peter Griffiths (2014) Safe Staffing for Nursing in Accident and Emergency Departments. Draft evidence review report. 26th November 2016. Produced for NICE. https://www.nice.org.uk/guidance/gid-sgwave0762/documents/safe-staffing-guidelines-accident-and-emergency-departments-evidence-review2

Driscoll (2018)

Driscoll A, Grant MJ, Carroll D, Dalton S, Deaton C, Jones I, Lehwaldt D, McKee G, Munyombwe T, Astin F. The effect of nurse-to-patient ratios on nurse-sensitive patient outcomes in acute specialist units: a systematic review and meta-analysis. *European Journal of Cardiovascular Nursing*. 2018 Jan;17(1):6-22.

Gaffney (2016)

Gaffney TA, Hatcher BJ, Milligan R. Nurses' role in medical error recovery: an integrative review. *Journal of Clinical Nursing*. 2016 Apr;25(7-8):906-17.

Griffiths (2014)

Griffiths, P., Ball, J., Drennan, J., James, L., Jones, J., Recio, A., & Simon, M. (2014). The association between patient safety outcomes and nurse/healthcare assistant skill mix and staffing levels and factors that may influence staffing requirements.

Griffiths (2016)

Griffiths P, Ball J, Drennan J, Dall'Ora C, Jones J, Maruotti A, Pope C, Saucedo AR, Simon M. Nurse staffing and patient outcomes: strengths and limitations of the evidence to inform policy and practice. A review and discussion paper based on evidence reviewed for the National Institute for Health and Care Excellence Safe Staffing guideline development. *International Journal of Nursing Studies*. 2016 Nov 1;63:213-25.

Griffiths (2018)

Griffiths P, Recio-Saucedo A, Dall'Ora C, Briggs J, Maruotti A, Meredith P, Smith GB, Ball J, Missed Care Study Group. The association between nurse staffing and omissions in nursing care: a systematic review. *Journal of Advanced Nursing*. 2018 Mar 8.

Jennings (2015)

Jennings N, Clifford S, Fox AR, O'Connell J, Gardner G. The impact of nurse practitioner services on cost, quality of care, satisfaction and waiting times in the emergency department: a systematic review. *International Journal of Nursing Studies.* 2015 Jan 1;52(1):421-35.

Johnston (2014) possible 9 other relevant to factors affecting escalation of care

Johnston MJ, Arora S, King D, Bouras G, Almoudaris AM, Davis R, Darzi A. A systematic review to identify the factors that affect failure to rescue and escalation of care in surgery. *Surgery*. 2015 Apr 1;157(4):752-63.

Jones (2015)

Jones TL, Hamilton P, Murry N. Unfinished nursing care, missed care, and implicitly rationed care: State of the science review. *International Journal of Nursing Studies*. 2015 Jun 1;52(6):1121-37.

Kallisch (2014)

Kalisch BJ, Xie B. Errors of omission: missed nursing care. *Western Journal of Nursing Research*. 2014 Aug;36(7):875-90.

Kenward et al (2017)

Kenward, L., Whiffin, C., & Spalek, B. (2017). Feeling unsafe in the healthcare setting: patients' perspectives. *British Journal of Nursing, 26*(3), 143-149.

Kim (2015)

Kim L, Lyder CH, McNeese-Smith D, Leach LS, Needleman J. Defining attributes of patient safety through a concept analysis. *Journal of Advanced Nursing*. 2015 Nov;71(11):2490-503.

Lobo (2014)

Lobo V, Fisher A, Peachey G, Ploeg J, Akhtar-Danesh N. Integrative review: an evaluation of the methods used to explore the relationship between overtime and patient outcomes. *Journal of Advanced Nursing*. 2015 May;71(5):961-74.

Papastavrou (2014)

Papastavrou E, Andreou P, Efstathiou G. Rationing of nursing care and nurse–patient outcomes: a systematic review of quantitative studies. *The International Journal of Health Planning and Management.* 2014 Jan;29(1):3-25.

Recio-Saucedo (2018)

Recio-Saucedo A, Dall'Ora C, Maruotti A, Ball J, Briggs J, Meredith P, Redfern OC, Kovacs C, Prytherch D, Smith GB, Griffiths P. What impact does nursing care left undone have on patient outcomes? Review of the literature. *Journal of Clinical Nursing.* 2018 Jun;27(11-12):2248-59.

Shekelle (2013)

Shekelle PG. Nurse–patient ratios as a patient safety strategy: a systematic review. *Annals of Internal Medicine*. 2013 Mar 5;158(5_Part_2):404-9.

Shin (2018)

Shin S, Park JH, Bae SH. Nurse staffing and nurse outcomes: A systematic review and meta-analysis. *Nursing Outlook*. 2018 Feb 26.

Stalpers (2015)

Stalpers D, de Brouwer BJ, Kaljouw MJ, Schuurmans MJ. Associations between characteristics of the nurse work environment and five nurse-sensitive patient outcomes in hospitals: a systematic review of literature*. International Journal of Nursing Studies*. 2015 Apr 1;52(4):817-35.

Swiger (2017)

Swiger PA, Patrician PA, Miltner RS, Raju D, Breckenridge-Sproat S, Loan LA. The Practice Environment Scale of the Nursing Work Index: an updated review and recommendations for use. *International Journal of Nursing Studies*. 2017 Sep 1;74:76-84.

Twigg (2015)

Twigg DE, Myers H, Duffield C, Giles M, Evans G. Is there an economic case for investing in nursing care–what does the literature tell us? *Journal of Advanced Nursing*. 2015 May;71(5):975-90.

Appendix 3 – Included Studies from Reviews

Original Studies	Casey et al 2017 - 3 relevant	Clendon et al., 2015- 2 relevant	Driscoll 2018- 7 relevant	Drennan 2014 -4 relevant	Gaffney et al 2016- 2 relevant	Griffiths et al 2014- 29 relevant	Griffiths 2016 – 3 relevant	Griffiths 2018 - 10 relevant	Jennings et al 2015- 9 relevant	Johnston et al 2014- 4 relevant)	Jones et al 2015 - 18 relevant	Kalisch et al 2014 -5 relevant	Kenward et al 2017- 2 relevant	Kim (2015- 1 relevant)	Lobo et al 2014- 5 relevant	Papastavrou et al 2014 - 6 relevant	Recio-Saucedo et al 2017 -8 relevant	Shekelle et al 2013 -10 relevant	Shin et al 2018- 7 relevant	Stalpers et al 2015-21 relevant	Swiger et al 2017- 11 relevant	Twigg et al 2015-6 relevant
Aiken (2002)																			✓			
Aiken (2008)																			✓		✓	
Aiken (2010)																		✓				
Aiken (2011)																						
Aiken (2012)											✓								✓			
Aiken (2013)																						
Ausserhofer (2013)						✓																
Ausserhofer (2014)								✓			✓						✓					
Bae et al., 2010a																				✓		
Bae et al., 2010b																				✓		
Ball (2014)						✓		✓			✓						✓					
Begley (2010	✓																					
Bernsey and Needleman (2006)															✓							
Blegen (2008)						✓																

Blegen (2011)						✓																
Bobay (2011)															✓							
Breckenridge Sproat et al., 2012,																				✓		
Bruyneel (2015)								✓									✓					
Burnes (2007)																				✓		
Carthon (2015)																	✓					
Castner et al (2015)											✓											
Chang & Mark (2011)						✓																
Chang (2006)																				✓		
Cho (2003)						✓																
Clarke (2002)																			✓			
Colligan (2011)									✓													
Considine (2010)									✓													
Considine (2006)									✓													
Cook et al (2012)																		✓				
Dabney and Kallish (2015)								✓														
Dall (2009)						✓	✓															
Dinh (2012)									✓													
Donaldson (2005)																				✓		
Donaldson et al (2004)						✓																
Duffield et al (2011)						✓																
Estabrooks (2005)						✓																
Friese et al (2005)																					✓	
Friese (2013)								✓			✓							✓				

Friese et al., 2016																					✓	
Frith et al., 2010						✓														✓		
Frith et al., 2012						✓																
Fry (2011)									✓													
Gabriel (2013)																					✓	
Glance (2012)										✓												
Goode et al., 2011																				✓		
Griffiths (2014)		✓			✓			✓														
Gunningberg et al., 2012,																				✓		
Harless & Mark (2010)																		✓				
Harris (2010)				✓																		
Hart and Davis (2011)			✓			✓																
He (2013)						✓																
Hennenmen (2006)					✓																	
Hoxhaj et al (2004)				✓																		
Jennings (2008)									✓													
Jessie & Rutledge (2012)	✓																					
Jiang (2006)																				✓		
Johansen et al., (2015)			✓																			
Kalisch (2010) b												✓										
Kalisch (2011)a								✓			✓					✓						
Kalisch 2011)b								✓			✓					✓						
Kalisch (2012)											✓	✓				✓						
Kalisch et al (2012) b																						

Kalisch et al (2013)											✓											
Kalisch (2014)											✓					✓						
Kalisch (2009a)											✓											
Kalisch (2009b)											✓	✓				✓						
Kalisch and Lee (2012)											✓											
Kendall-Gallagher (2011)										✓												
Kirwan et al., 2013																				✓		
Kutney-Lee et al (2009)																				✓		
Kutney-Lee (2013)						✓																
Lake (2010)						✓																
Lake et al., (2016)																				✓		
Li et al (2011)																					✓	
Lucero (2010)											✓					✓	✓					
Mallidou et al., 2011,																			✓			
Manojlovich et al., 2011,						✓													✓			
Mark (2004)																			✓			
McCloskey and Diers (2005)																			✓			
McGillis Hall (2004)						✓													✓			
McHugh (2014)											✓							✓				
McHugh (2016)			✓																			
McClellan (2012)									✓													
McClellan (2013)									✓													
Mollon (2014)													✓									

Nash (2006)									✓													
Needleman et al (2011)						✓												✓				
Needleman et al (2006)						✓	✓															✓
Newbold (2008)																						✓
O'Brien-Pallas (2010a)			✓																			
O'Brien-Pallas (2010b)						✓																
Olds and Clarke (2010)															✓							
Orique (2015)								✓														
Ozdemir (2016)																						
Papastavrou (2014)											✓						✓					
Park (2012)						✓																
Patrician et al., 2011						✓														✓		
Peebles (2014)										✓												
Potter (2003)																						
Raferty (2007)																			✓			
Rathert (2012)													✓									
Rathlev et al 2012)				✓																		
Roche et al (2010)																					✓	
Roche (2016)																					✓	
Rogers (2004)															✓							
Rothberg (2005)																						✓
Schilling et al (2010)																		✓		✓		
Saego (2006)					✓																	
Sermeus (2011)											✓											

Shamliyan (2009)						✓																✓
Shang (2013)																					✓	
Sheetz (2016)			✓																			
Sheward (2005)																			✓			
Shuldham et al., 2009			✓																	✓		
Sochalski (2004)						✓										✓	✓					
Socalski (2008)																						
Spetz (2013)						✓																
Stewart (2005)																						
Thompson (2014)																	✓					
Thompson and Meskell (2012)	✓																					
Titler et al., 2011,																				✓		
Tourangeau et al., 2007			✓																			
Trinkoff (2011)														✓								
Tschannen (2010)						✓					✓											
Tschannen (2012)												✓										
Twigg (2011)																		✓		✓		
Twigg (2013)						✓	✓															✓
Unruh & Zhang (2012)																		✓		✓		
Unruh (2007)																						
Walker (2010)																					✓	
Weichenthal (2011)				✓																		
Weiss (2011)						✓		✓														

Aiken, L.H., Cimiotti, J.P., Sloane, D.M., Smith, H.L., Flynn, L., Neff, D.F., (2011). Effects of nurse staffing and nurse education on patient deaths in hospitals with different nurse work environments. Med Care 49 (12), 1047–1053. http://dx.doi.org/10.1097/MLR.0b013e3182330b6e

Aiken, L.H., Sloane, D.M., Cimiotti, J.P., Clarke, S.P., Flynn, L., Seago, J.A., Spetz, J. and Smith, H.L., 2010. Implications of the California nurse staffing mandate for other states. *Health services research*, *45*(4), pp.904-921.

Aiken, L.H., Sermeus, W., Van den Heede, K., Sloane, D.M., Busse, R., McKee, M., Bruyneel, L., Rafferty, A.M., Griffiths, P., Moreno-Casbas, M.T. and Tishelman, C., (2012). Patient safety, satisfaction, and quality of hospital care: cross sectional surveys of nurses and patients in 12 countries in Europe and the United States. *Bmj*, *344*, p.e1717.

Aiken, H. L., Clarke, P. S., Sloane, M. D., Lake, T. E., & Cheney, T. T. (2008). Effects of Hospital Care Environment on Patient Mortality and Nurse Outcomes. *JONA: The Journal of Nursing Administration, 38*(5), 223-229. doi:10.1097/01.NNA.0000312773.42352.d7

Aiken, L. H., Clarke, S. P., & Sloane, D. M. (2002). Hospital staffing, organization, and quality of care: cross-national findings. *International Journal for Quality in Health Care, 14*(1), 5-14. doi:10.1093/intqhc/14.1.5

Aiken, L. H., Sloane, D. M., Bruyneel, L., Van den Heede, K., Sermeus, W., & Rn4cast Consortium. (2013). Nurses' reports of working conditions and hospital quality of care in 12 countries in Europe. *International journal of nursing studies*, *50*(2), 143-153.

Ausserhofer, D., Zander, B., Busse, R., Schubert, M., De Geest, S., Rafferty, A. M., . . . Schwendimann, R. (2014). Prevalence, patterns and predictors of nursing care left undone in European hospitals: results from the multicountry cross-sectional RN4CAST study. *BMJ Quality & Safety, 23*(2), 126. doi:10.1136/bmjqs-2013-002318

Ausserhofer, D., Schubert, M., Desmedt, M., Blegen, M. A., De Geest, S., & Schwendimann, R. (2013). The association of patient safety climate and nurse-related organizational factors with selected patient outcomes: A cross-sectional survey. *International Journal of Nursing Studies, 50*(2), 240-252. doi:10.1016/j.ijnurstu.2012.04.007

Bae, S.H., Mark, B., Fried, B., (2010)a. Use of temporary nurses and nurse and patient safety outcomes in acute care hospital units. *Health Care Manage. Rev*. 35 (4), 333–344.

Bae, S.-H., Mark, B., & Fried, B. (2010b). Impact of Nursing Unit Turnover on Patient Outcomes in Hospitals. *Journal of Nursing Scholarship, 42*(1), 40-49. doi:10.1111/j.1547-5069.2009.01319.x

Ball, J. E., Murrells, T., Rafferty, A. M., Morrow, E., & Griffiths, P. (2014). 'Care left undone'during nursing shifts: associations with workload and perceived quality of care. *BMJ Qual Saf*, *23*(2), 116-125.

Begley C, K. Murphy, A. Higgins, N. Elliott, J. Lalor, F. Sheerin, I. Coyne, C. Comiskey, C. Normand, D. Casey, M. Dowling, D. Devane, A. Cooney, F. Farrelly, M. Brennan, P. Meskell, P. MacNeela, (2010) SCAPE Evaluation of Clinical Nurse and Midwife Specialist and Advanced Nurse and Midwife Practitioner Roles in Ireland (SCAPE) Report. National Council for the Professional Development of Nursing and Midwifery in Ireland, Dublin.

Berney B., Needleman J. & Kovner C. (2005) Factors influencing the use of registered nurse overtime in hospitals, 1995-2000. *Journal of Nursing Scholarship* 37(2), 165–172.

Blegen, M. A., Goode, C., Spetz, J., Vaughn, T. & Park, S. H. (2011). Nurse Staffing effects on patient outcomes: safety-net and non-safety net hospitals. *Medical Care*, 49, 406-414.

Blegen, M. A., Vaughn, T., & Vojir, C. P. (2008). Nurse Staffing Levels: Impact of Organizational Characteristics and Registered Nurse Supply. *Health Services Research, 43*(1p1), 154-173. doi:10.1111/j.1475-6773.2007.00749.x

Bobay KL, Yakusheva O, Weiss ME. Outcomes and cost analysis of the impact of unit-level nurse staffing on post-discharge utilization. *Nurs Econ.* 2011 Mar-Apr;29(2):69-78, 87.

Breckenridge-Sproat, S., Johantgen, M., & Patrician, P. (2012). Influence of unit-level staffing on medication errors and falls in military hospitals. *Western journal of nursing research*, *34*(4), 455-474.

Bruyneel, L., Li, B., Ausserhofer, D., Lesaffre, E., Dumitrescu, I., Smith, H.L., Sloane, D.M., Aiken, L.H. and Sermeus, W., (2015). Organization of hospital nursing, provision of nursing care, and patient experiences with care in Europe. *Medical Care Research and Review*, *72*(6), pp.643-664.

Burnes Bolton, L., Aydin, C. E., Donaldson, N., Storer Brown, D., Sandhu, M., Fridman, M., & Udin Aronow, H. (2007). Mandated Nurse Staffing Ratios in California: A Comparison of Staffing and Nursing-Sensitive Outcomes Pre- and Postregulation. *Policy, Politics, & Nursing Practice, 8*(4), 238-250. doi:10.1177/1527154407312737

Carthon, J. M. B., Lasater, K. B., Sloane, D. M., & Kutney-Lee, A. (2015). The quality of hospital work environments and missed nursing care is linked to heart failure readmissions: A cross-sectional study of US hospitals. *BMJ Quality and Safety*, 24(4), 255–263. https://doi.org/10.1136/bmjqs-2014-003346

Castner, J., Wu, Y.-W. B., & Dean-Baar, S. (2015). Multi-Level Model of Missed Nursing Care in the Context of Hospital Merger. *Western Journal of Nursing Research, 37*(4), 441-461. doi:10.1177/0193945914535670

Chang, C. Y.-K., Hughes, C. L., & Mark, C. B. (2006). Fitting In or Standing Out: Nursing Workgroup Diversity and Unit-level Outcomes. *Nursing Research, 55*(6), 373-380. doi:10.1097/MCP.0b013e328012e270

Chang, Y., & Mark, B. (2011). Moderating effects of learning climate on the impact of RN staffing on medication errors. *Nursing research, 60*(1), 32.

Cho, H. S.-H., Ketefian, G. S., Barkauskas, G. V., & Smith, G. D. (2003). The Effects of Nurse Staffing on Adverse Events, Morbidity, Mortality, and Medical Costs. *Nursing Research, 52*(2), 71-79. doi:10.1097/00006199-200303000-00003

Clarke, S. P., Rockett, J. L., Sloane, D. M., & Aiken, L. H. (2002). Organizational climate, staffing, and safety equipment as predictors of needlestick injuries and near-misses in hospital nurses. *American Journal of Infection Control, 30*(4), 207-216.

Colligan, M. Collins, C. Foley, B. Jones, P. Miles, J. & Zeng I. (2011). Emergency nurse practitioners: do they provide an effective service in managing minor injuries, compared to emergency medicine registrars? *N. Z. Med. J.*, 124: 74-80.

Considine, J., Martin, R., Smit, D., Winter, C., & Jenkins, J. (2006). Emergency nurse practitioner care and emergency department patient flow: Case–control study. *Emergency Medicine Australasia, 18*(4), 385-390. doi:doi:10.1111/j.1742-6723.2006.00870.x

Considine, J., Kropman, M., & Stergiou, H. E. (2010). Effect of clinician designation on emergency department fast track performance. *Emergency Medicine Journal,* 27(11), 838-842.

Cook, A., Gaynor, M., Stephens Jr, M., & Taylor, L. (2012). The effect of a hospital nurse staffing mandate on patient health outcomes: Evidence from California's minimum staffing regulation. *Journal of Health Economics*, 31(2), 340-348.

Dall, M. T., Chen, J. Y., Seifert, F. R., Maddox, J. P., & Hogan, F. P. (2009). The Economic Value of Professional Nursing. *Medical care, 47*(1), 97-104. doi:10.1097/MLR.0b013e3181844da8

Dabney, B. W., & Kalisch, B. J. (2015). Nurse staffing levels and patient-reported missed nursing care. *Journal of nursing care quality*, *30*(4), 306-312. doi: 10.1097/NCQ.0000000000000123.

Dinh, M. Walker, A. Parameswaran, A. Enright N. (2012). Evaluating the quality of care delivered by an emergency department fast track unit with both nurse practitioners and doctors. *Aust. Emerg. Nurs. J.*, 15: 188-194

Donaldson, N., Bolton, L. B., Aydin, C., Brown, D., Elashoff, J. D., & Sandhu, M. (2005). Impact of California's licensed nurse-patient ratios on unit-level nurse staffing and patient outcomes. *Policy, Politics, & Nursing Practice*, *6*(3), 198-210.

Downey, W. A., Quach, L. J., Haase, L. M., Haase-Fielitz, L. A., Jones, L. D., & Bellomo, L. R. (2008). Characteristics and outcomes of patients receiving a medical emergency team review for acute change in conscious state or arrhythmias. *Critical care medicine, 36*(2), 477-481. doi:10.1097/01.CCM.0000300277.41113.46

Duffield, C., Diers, D., O'Brien-Pallas, L., Aisbett, C., Roche, M., King, M., & Aisbett, K. (2011). Nursing staffing, nursing workload, the work environment and patient outcomes. *Applied nursing research*, *24*(4), 244-255.

Estabrooks, A. C., Midodzi, K. W., Cummings, G. G., Ricker, L. K., & Giovannetti, L. P. (2005). The Impact of Hospital Nursing Characteristics on 30-Day Mortality. *Nursing Research, 54*(2), 74-84. doi:10.1097/00006199-200503000-00002

Friese, C.R., Siefert, M.L., Thomas-Frost, K., Walker, S., Ponte, P.R., (2016). Using data to strengthen ambulatory oncology nursing practice. Cancer Nurs. 39 (1), 74–79. http://dx.doi.org/10.1097/ncc.0000000000000240.

Friese, C. R., Kalisch, B. J., & Lee, K. H. (2013). Patterns and Correlates of Missed Nursing Care in Inpatient Oncology Units. *Cancer Nursing*, *36*(6), E51–E57. http://doi.org/10.1097/NCC.0b013e318275f552

Friese, C.R., (2005). Nurse practice environments and outcomes: implications for oncology nursing. *Oncol. Nurs. Forum* 32 (4), 765–772

Frith, K. H., Anderson, E. F., Tseng, F., & Fong, E. A. (2012). Nurse staffing is an important strategy to prevent medication errors in community hospitals. *Nursing Economics, 30*(5), 288.

Frith, K. H., Anderson, E. F., Caspers, B., Tseng, F., Sanford, K., Hoyt, N. G., & Moore, K. (2010). Effects of nurse staffing on hospital-acquired conditions and length of stay in community hospitals. *Quality Management in Healthcare*, *19*(2), 147-155.

Fry, M., Fong, J., Asha, S., & Arendts, G. (2011). A 12-month evaluation of the impact of Transitional Emergency Nurse Practitioners in one metropolitan Emergency Department. *Australasian Emergency Nursing Journal*, *14*(1), 4-8.

Gabriel, A. S., Erickson, R. J., Moran, C. M., Diefendorff, J. M., & Bromley, G. E. (2013). A Multilevel Analysis of the Effects of the Practice Environment Scale of the Nursing Work Index on Nurse Outcomes. *Research in Nursing & Health, 36*(6), 567-581. doi:10.1002/nur.21562

Glance, L. G., Dick, A. W., Osler, T. M., Mukamel, D. B., Li, Y., & Stone, P. W. (2012). The association between nurse staffing and hospital outcomes in injured patients. *BMC health services research*, *12*(1), 247.

Goode, C.J., Blegen, M.A., Park, S.H., Vaughn, T., Spetz, J., (2011_. Comparison of patient outcomes in magnet and non-magnet hospitals. *J. Nurs. Adm.* 41 (12), 517–523

Griffiths, P., Dall'Ora, C., Simon, M., Ball, J., Lindqvist, R., Rafferty, A.M., Schoonhoven, L., Tishelman, C., Aiken, L.H., RN4Cast Consortium, 2014. Nurses' shift length and overtime working in 12 European countries: the association with perceived quality of care and patient safety. *Medical care*, *52*(11), 975.

Gunningberg, L., Donaldson, N., Aydin, C., & Idvall, E. (2012). Exploring variation in pressure ulcer prevalence in Sweden and the USA: benchmarking in action. *Journal of evaluation in clinical practice*, *18*(4), 904-910. care and patient safety. Med. Care 52 (11), 975–981. [RN4CAST]

Hall, M. L., Doran, H. D., & Pink, H. G. (2004). Nurse Staffing Models, Nursing Hours, and Patient Safety Outcomes. *JONA: The Journal of Nursing Administration, 34*(1), 41-45. doi:10.1097/00005110-200401000-00009

Harless, D. W., & Mark, B. A. (2010). Nurse staffing and quality of care with direct measurement of inpatient staffing. *Medical care*, 659-663.

Harris, A., & Sharma, A. (2010). Access block and overcrowding in emergency departments: an empirical analysis. *Emergency Medicine Journal*, *27*(7), 508-511.

Hart, P., & Davis, N. (2011). Effects of nursing care and staff skill mix on patient outcomes within acute care nursing units. *Journal of Nursing Care Quality, 26*(2), 161-168. doi:10.1097/NCQ.0b013e3181efc9cb

He, J., Almenoff, P. L., Keighley, J., & Li, Y.-F. (2013). Impact of patient-level risk adjustment on the findings about nurse staffing and 30-day mortality in Veterans Affairs acute care hospitals. *Nursing research, 62*(4), 226-232.

Henneman, E. A., Blank, F. S. J., Gawlinski, A., & Henneman, P. L. (2006). Strategies used by nurses to recover medical errors in an academic emergency department

setting. *Applied Nursing Research, 19*(2), 70-77. doi:https://doi.org/10.1016/j.apnr.2005.05.006

Hoxhaj, S., M. G. Moseley and C. L. Reese (2004). "Nurse staffing levels affect the number of emergency department patients who leave without treatment." Academic Emergency Medicine 11(5): 459.

Jennings, N., O'Reilly, G., Lee, G., Cameron, P., Free, B., & Bailey, M. (2008). Evaluating outcomes of the emergency nurse practitioner role in a major urban emergency department, Melbourne, Australia. *Journal of Clinical Nursing, 17*(8), 1044-1050. doi:doi:10.1111/j.1365-2702.2007.02038.x

Jessee, B. T., & Rutledge, C. M. (2012). Effectiveness of nurse practitioner coordinated team group visits for type 2 diabetes in medically underserved Appalachia. *Journal of the American Academy of Nurse Practitioners*, *24*(12), 735-743.

Jiang, H. J., Stocks, C., & Wong, C. J. (2006). Disparities Between Two Common Data Sources on Hospital Nurse Staffing. *Journal of Nursing Scholarship, 38*(2), 187-193. doi:10.1111/j.1547-5069.2006.00099.x

Johansen, De Cordova, Duan, Martinez, & Cimiotti. (2015). The Implications of Nurse Resources on Cardiac Care in the Emergency Department. Applied Nursing Research, 28(2), 210-212.

Kalisch B, Lee KH. Staffing and job satisfaction: nurses and nursing assistants. J Nurs Manag. 2014 May;22(4):465-71. doi: 10.1111/jonm.12012. Epub 2012 Nov 2.

Kalisch B., J. (2009b). Nurse and Nurse Assistant Perceptions of Missed Nursing Care: What Does It Tell Us About Teamwork? *JONA: The Journal of Nursing Administration, 39*(11), 485-493. doi:10.1097/NNA.0b013e3181bd61ac

Kalisch, & Lee. (2012). Missed nursing care: Magnet versus non-Magnet hospitals. *Nursing Outlook, 60*(5), E32-E39**.**

Kalisch, B. J., Landstrom, G., & Williams, R. A. (2009a). Missed nursing care: Errors of omission. *Nursing Outlook, 57*(1), 3-9. doi:https://doi.org/10.1016/j.outlook.2008.05.007

Kalisch, B. J., Tschannen, D., & Lee, K. H. (2011b). Do staffing levels predict missed nursing care? International Journal of Quality in Health Care, 23(3), 302–308. https://doi.org/10.1093/intqhc/mzr009

Kalisch, B. J., Tschannen, D., & Lee, K. H. (2012). Missed nursing care, staffing, and patient falls. *Journal of nursing care quality*, *27*(1), 6-12.

Kalisch, B. J., Tschannen, D., Lee, H., & Friese, C. R. (2011a). Hospital variation in missed nursing care. American Journal of Medical Quality, 26 (4), 291–299. https://doi.org/10.1177/1062860610395929

Kalisch, B. J., Xie, B., & Ronis, D. L. (2013). Train-the-trainer intervention to increase nursing teamwork and decrease missed nursing care in acute care patient units. *Nursing Research*, *62*(6), 405-413.

Kalisch, B., & Lee, K. (2010). The impact of teamwork on missed nursing care. Nursing Outlook, 58, 233-241.

Kendall-Gallagher, D., Aiken, L. H., Sloane, D. M., & Cimiotti, J. P. (2011). Nurse specialty certification, inpatient mortality, and failure to rescue. *Journal of Nursing Scholarship*, *43*(2), 188-194.

Kirwan, M., Matthews, A., Scott, P.A., 2013. The impact of the work environment of nurses on patient safety outcomes: a multi-level modelling approach. Int. J. Nurs. Stud. 50 (2), 253–263. http://dx.doi.org/10.1016/j.ijnurstu.2012.08.020 [RN4CAST]

Kutney-Lee, A., Sloane, D. M., & Aiken, L. H. (2013). An increase in the number of nurses with baccalaureate degrees is linked to lower rates of postsurgery mortality. *Health Affairs, 32*(3), 579-586.

Kutney-Lee, A., Lake, E.T., Aiken, L.H., (2009). Development of the hospital nurse surveillance capacity profile. *Res. Nurs. Health* 32 (2), 217–228.

Lake, E., Sanders, J., Rui, D., & Yong, C. J. A., Boston, MA. (2016). A Meta-Analysis of the Assoications Between the Nursing Work Envionment in Hospitals and Five Sets of Outcomes.

Lake, E. T., Shang, J., Klaus, S., & Dunton, N. E. (2010). Patient falls: Association with hospital Magnet status and nursing unit staffing. *Research in nursing & health, 33*(5), 413-425.

Li Y., Wong E.S., Sales A.E., Sharp N.D., Needleman J., Maciejewski M.L., Lowy E., Alt-White A.C. & Liu C. (2011) Nurse staffing and patient care costs in acute inpatient nursing units. Medical Care 49, 708–715. doi:10.1097/MLR.0b013e318223a9f1"

Lucero, R. J., Lake, E. T., & Aiken, L. H. (2010). Nursing care quality and adverse events in US hospitals. *Journal of Clinical Nursing*, 19(15–16), 2185–2195.

Mallidou, A. A., Cummings, G. G., Estabrooks, C. A., & Giovannetti, P. B. (2011). Nurse specialty subcultures and patient outcomes in acute care hospitals: A multiple-group structural equation modeling. *International Journal of Nursing Studies*, *48*(1), 81-93.

Manojlovich, M., Sidani, S., Covell, C.L., Antonakos, C.L., (2011). Nurse dose: linking staffing variables to adverse patient outcomes. *Nurs. Res.* 60 (4), 214–220

Mark, B. A., Harless, D. W., McCue, M., & Xu, Y. (2004). A Longitudinal Examination of Hospital Registered Nurse Staffing and Quality of Care. *Health Services Research, 39*(2), 279-300. doi:doi:10.1111/j.1475-6773.2004.00228.x

McCloskey, A. B., & Diers, K. D. (2005). Effects of New Zealand's Health Reengineering on Nursing and Patient Outcomes. *Medical care, 43*(11), 1140-1146. doi:10.1097/01.mlr.0000182549.85761.cd

McHugh, M. D., Berez, J., & Small, D. S. (2013). Hospitals with higher nurse staffing had lower odds of readmissions penalties than hospitals with lower staffing. *Health Affairs*, *32*(10), 1740-1747.

McHugh, M. D., Rochman, M. F., Sloane, D. M., Berg, R. A., Mancini, M. E., Nadkarni, V. M., Merchant, R.M., Aiken, L.H& American Heart Association's Get With The Guidelines-Resuscitation Investigators. (2016). Better nurse staffing and nurse work environments associated with increased survival of in-hospital cardiac arrest patients. *Medical care*, *54*(1), 74.

McClellan, C. M., Cramp, F., Powell, J., & Benger, J. R. (2012). A randomised trial comparing the clinical effectiveness of different emergency department healthcare professionals in soft tissue injury management. *BMJ open*, *2*(6), e001092.

McClellan, C. M., Cramp, F., Powell, J., & Benger, J. R. (2013). A randomised trial comparing the cost effectiveness of different emergency department healthcare professionals in soft tissue injury management. *BMJ open*, *3*(1), e001116.

Merchant, R. M., Berg, R. A., Yang, L., Becker, L. B., Groeneveld, P. W., Chan, P. S., & for the American Heart Association' s Get With the Guidelines - Resuscitation Investigators. (2014). Hospital Variation in Survival After In - hospital Cardiac Arrest. Journal of the American Heart Association: Cardiovascular and Cerebrovascular Disease, 3(1), e000400. http://doi.org/10.1161/JAHA.113.000400

Mollon, D., (2014). Feeling safe during an inpatient hospitalization: a concept analysis. *Journal of Advanced Nursing*, 70(8), 1727–1737

Nash, K., Zachariah, B., Nitschmann, J., & Psencik, B. (2007). Evaluation of the Fast Track Unit of a University Emergency Department. *Journal of Emergency Nursing, 33*(1), 14-20. doi:https://doi.org/10.1016/j.jen.2006.08.003

Needleman, J., Buerhaus, P., Pankratz, V. S., Leibson, C. L., Stevens, S. R., & Harris, M. (2011). Nurse staffing and inpatient hospital mortality. *New England Journal of Medicine*, *364*(11), 1037-1045.

Needleman, J., Buerhaus, P. I., Stewart, M., Zelevinsky, K., & Mattke, S. (2006). Nurse staffing in hospitals: Is there a business case for quality? *Health affairs, 25*(1), 204-211. doi:10.1377/hlthaff.25.1.204

Newbold, D. (2008). The production economics of nursing: A discussion paper. *International Journal of Nursing Studies, 45*(1), 120-128. doi:https://doi.org/10.1016/j.ijnurstu.2007.01.007

O'Brien-Pallas, L., Li, X. M., Wang, S., Meyer, R. M. & Thomson, D. (2010a). Evaluation of a patient care delivery model: system outcomes in acute cardiac care. *Canadian Journal of Nursing Research,* 42**,** 98-120.

O'Brien-Pallas, L., Murphy, G. T., Shamian, J., Li, X. & Hayes, L. J. 2010b. Impact and determinants of nurse turnover: a pan-Canadian study. *Journal of Nursing Management,* 18**,** 1073-1086.

Olds, D. M., & Clarke, S. P. (2010). The effect of work hours on adverse events and errors in health care. *Journal of safety research*, *41*(2), 153-162. Available from: http://dx.doi.org/10.1016/j.jsr.2010.02.002

Orique, S. B., Patty, C. M., & Woods, E. (2016). Missed nursing care and unit-level nurse workload in the acute and post-acute settings. *Journal of nursing care quality*, *31*(1), 84-89.

Ozdemir, B., Sinha, S., Karthikesalingam, A., Poloniecki, J., Pearse, R., Grocott, M., Thompson, M.M. and Holt, P. (2015). Mortality of emergency general surgical patients and associations with hospital structures and processes. *BJA: British Journal of Anaesthesia, 116*(1), 54-62.

Papastavrou, E., Andreou, P., & Efstathiou, G. (2014). Rationing of nursing care and nurse-patient outcomes: A systematic review of quantitative studies. International *Journal of Health Planning and Management,* 29 (1), 3–25. https://doi.org/10.1002/hpm.2160

Park, S. H., Blegen, M. A., Spetz, J., Chapman, S. A., & De Groot, H. (2012). Patient turnover and the relationship between nurse staffing and patient outcomes. *Research in nursing & health, 35*(3), 277-288.

Patrician, P.A., Loan, L., McCarthy, M., Fridman, M., Donaldson, N., Bingham, M., Brosch, L.R., (2011). The association of shift-level nurse staffing with adverse patient events. *J. Nurs. Adm*. 41 (2), 64–70.

Peebles, E., Subbe, C. P., Hughes, P., & Gemmell, L. (2012). Timing and teamwork—an observational pilot study of patients referred to a rapid response team with the aim of identifying factors amenable to re-design of a rapid response system. *Resuscitation*, *83*(6), 782-787.

Potter, P., Barr, N., Mcsweeney, M. & Sledge, J. 2003. Identifying Nurse Staffing And Patient Outcome Relationships: a guide for change in care delivery. Nurs Econ, 21, 158-66.

Rafferty, A. M., Clarke, S. P., Coles, J., Ball, J., James, P., McKee, M., & Aiken, L. H. (2007). Outcomes of variation in hospital nurse staffing in English hospitals: Cross-

sectional analysis of survey data and discharge records. *International Journal of Nursing Studies, 44*(2), 175-182. doi:https://doi.org/10.1016/j.ijnurstu.2006.08.003

Rathert, C., Brandt, J. & Williams, E.S., (2012). Putting the 'patient' in patient safety: a qualitative study of consumer experiences. *Health Expectations*, 15(3), pp.327–336

Rathlev, N. K., D. Obendorfer, L. F. White, C. Rebholz, B. Magauran, W. Baker, A. Ulrich, L. Fisher and J. Olshaker (2012). Time series analysis of emergency department length of stay per 8-hour shift. *Western Journal of Emergency Medicine*, *13*(2), 163.

Roche, M. A., Duffield, C., Friedman, S., Twigg, D., Dimitrelis, S., & Rowbotham, S. (2016). Changes to nurses' practice environment over time. *Journal of Nursing Management, 24*(5), 666-675. doi:10.1111/jonm.12371

Roche, M., & Duffield, C. (2010). A Comparison of the Nursing Practice Environment in Mental Health and Medical-Surgical Settings. *Journal of Nursing Scholarship, 42*(2), 195-206.

Rogers, A. E., Hwang, W., Scott, L., Aiken, L. H., & Dinges, D. (2004). The working hours of hospital staff nurses and patient safety. *Health Aff., 23*(4), 202-212. doi:10.1377/hlthaff.23.4.202

Rothberg, B. M., Abraham, K. I., Lindenauer, N. P., & Rose, N. D. (2005). Improving Nurse-to-Patient Staffing Ratios as a Cost-Effective Safety Intervention. *Medical care, 43*(8), 785-791. doi:10.1097/01.mlr.0000170408.35854.fa

Schilling, P. L., Campbell, D. A., Englesbe, M. J., & Davis, M. M. (2010). A comparison of in-hospital mortality risk conferred by high hospital occupancy, differences in nurse staffing levels, weekend admission, and seasonal influenza. *Medical care*, 224-232. -32.

Seago, J. A., Williamson, A., & Atwood, C. (2006). Longitudinal analyses of nurse staffing and patient outcomes: More about failure to rescue. *Journal of nursing administration, 36*(1), 13-21. doi:10.1097/00005110-200601000-00005

Sermeus W, Aiken LH, Van den Heede K, Rafferty AM, Griffiths P, Moreno-Casbas MT, Busse R, Lindqvist R, Scott AP, Bruyneel L, Brzostek T, Kinnunen J, Schubert M, Schoonhoven L, Zikos D; (2011). Nurse forecasting in Europe (RN4CAST): rationale, design and methodology. *BMC nursing*, *10*(1), 6.

Shamliyan, T. A., Kane, R. L., Mueller, C., Duval, S., & Wilt, T. J. (2009). Cost savings associated with increased RN staffing in acute care hospitals: simulation exercise. *Nursing economic$, 27*(5), 302-331. doi:10.1024/1012-5302.22.5.325

Sheetz, K. H., Dimick, J. B., & Ghaferi, A. A. (2016). Impact of Hospital Characteristics on Failure to Rescue Following Major Surgery. *Annals of Surgery*, *263*(4), 692–697. http://doi.org/10.1097/SLA.0000000000001414

Sheward, L., Hunt, J., Hagen, S., Macleod, M., & Ball, J. (2005). The relationship between UK hospital nurse staffing and emotional exhaustion and job dissatisfaction. *Journal of Nursing Management, 13*(1), 51-60. doi:10.1111/j.1365-2834.2004.00460.x

Shuldham, C., Parkin, C., Firouzi, A., Roughton, M., & Lau-Walker, M. (2009). The relationship between nurse staffing and patient outcomes: A case study. *International Journal of Nursing Studies, 46*(7), 986-992. doi:https://doi.org/10.1016/j.ijnurstu.2008.06.004

Sochalski, J. (2004). Is More Better?: The Relationship Between Nurse Staffing and the Quality of Nursing Care in Hospitals. *Medical care, 42*(2 Suppl), II-67-II-73. doi:10.1097/01.mlr.0000109127.76128.aa.

Sochalski, J., Konetzka, R. T., Zhu, J., & Volpp, K. (2008). Will mandated minimum nurse staffing ratios lead to better patient outcomes?. *Medical care*, *46*(6), 606-613.

Spetz, J., Harless, D. W., Herrera, C. N., & Mark, B. A. (2013). Using minimum nurse staffing regulations to measure the relationship between nursing and hospital quality of care. *Medical Care Research and Review*, *70*(4), 380-399. doi: 10.1177/1077558713475715. Epub 2013 Feb 11

Stimpfel, A., Sloane, D. & Aiken, L., (2012). The Longer The Shifts For Hospital Nurses, The Higher The Levels Of Burnout And Patient Dissatisfaction. *Health Affairs*, 31(11),2501–9.

Thompson, W., & Meskell, P. (2012). Evaluation of an advanced nurse practitioner (emergency care)—An Irish perspective. *The Journal for Nurse Practitioners*, *8*(3), 200-205. Available from: http://dx.doi.org/10.1016/j.nurpra.2011.09.002

Thompson, D. (2014). The examination of practice environment, burnout, and missed care on pressure ulcer prevalence rates using a complexity science framework. (Ph.D.), University of Kansas.

Titler, M.G., Shever, L.L., Kanak, M.F., Picone, D.M., Qin, R., (2011). Factors associated with falls during hospitalization in an older adult population. *Res. Theory Nurs. Pract.* 25 (2), 127–148"

Tourangeau, A. E., Doran, D. M., Hall, L. M., O'Brien Pallas, L., Pringle, D., Tu, J. V., & Cranley, L. A. (2007). Impact of hospital nursing care on 30-day mortality for acute medical patients. *Journal of Advanced Nursing, 57*(1), 32-44. doi:10.1111/j.1365-2648.2006.04084.x

Trinkoff, A. M., Johantgen, M., Storr, C. L., Gurses, A. P., Liang, Y., & Han, K. (2011). Nurses' work schedule characteristics, nurse staffing, and patient mortality. *Nursing research*, *60*(1), 1-8.

Tschannen, D., & Lee, E. (2012). The impact of nursing characteristics and the work environment on perceptions of communication. *Nursing research and practice*, *2012*.

Tschannen, D., Kalisch, B. J., & Lee, K. H. (2010). Missed nursing care: the impact on intention to leave and turnover. *CJNR (Canadian Journal of Nursing Research)*, *42*(4), 22-39.

Twigg, D., Duffield, C., Bremner, A., Rapley, P., & Finn, J. (2011). The impact of the nursing hours per patient day (NHPPD) staffing method on patient outcomes: a retrospective analysis of patient and staffing data. *International journal of nursing studies*, *48*(5), 540-548.

Twigg D.E., Geelhoed E.A., Bremner A.P. & Duffield C.M. (2013) The economic benefits of increased levels of nursing care in the hospital setting. *Journal of Advanced Nursing* 69, 2253–2261. doi:10.1111/jan.12109.

Unruh, L. Y., & Zhang, N. J. (2012). Nurse staffing and patient safety in hospitals: new variable and longitudinal approaches. *Nursing research*, *61*(1), 3-12.

Unruh, L., Joseph, L., & Strickland, M. (2007). Nurse absenteeism and workload: negative effect on restraint use, incident reports and mortality. *Journal of Advanced Nursing, 60*(6), 673-681. doi:10.1111/j.1365-2648.2007.04459.x

Walker, K., Middleton, S., Rolley, J., & Duff, J. (2010). Nurses report a healthy culture: Results of the Practice Environment Scale (Australia) in an Australian hospital seeking Magnet recognition. *International Journal of Nursing Practice, 16*(6), 616-623. doi:10.1111/j.1440-172X.2010.01890.x

Weichenthal, L., & Hendey, G. W. (2011). The effect of mandatory nurse ratios on patient care in an emergency department. *The Journal of emergency medicine*, *40*(1), 76-81.

Weiss, M. E., Yakusheva, O., & Bobay, K. L. (2011). Quality and cost analysis of nurse staffing, discharge preparation, and postdischarge utilization. *Health services research*, *46*(5), 1473-1494.Available from: http://dx.doi.org/10.1111/j.1475-6773.2011.01267.x

Appendix 4 – Included Primary Studies N=30

1. Adams, A., Lugsden, E., Chase, J., Arber, S., & Bond, S. (2000). Skill-mix changes and work intensification in nursing. Work, employment and society, 14(3), 541-555.

2. Aiken, L. H., et al. (2017). "Nursing skill mix in European hospitals: cross-sectional study of the association with mortality, patient ratings, and quality of care." BMJ Quality & Safety 26(7): 559-568. [RN4CAST].

3. Aiken, L., Clarke, S., & Sloane, D. (2002). Hospital staffing, organization, and quality of care: Crossnational findings. International Journal for Quality in Health Care, 14(1), 5-13

4. Aiken, L., Clarke, S., Sloane, D., & Sochalski, J. (2001). An International Perspective on Hospital Nurses' Work Environments: The Case for Reform. Policy, Politics, & Nursing Practice, 2(4), 255-263.

5. Attree, M. (2001). A study of the criteria used by healthcare professionals, managers and patients to represent and evaluate quality care. Journal of Nursing Management, 9(2), 67-78.

6. Bishop, A. C. and M. Macdonald (2017). "Patient Involvement in Patient Safety: A Qualitative Study of Nursing Staff and Patient Perceptions." Journal of patient safety 13(2): 82-87.

7. Blegen, M. A., et al. (2013). "Baccalaureate education in nursing and patient outcomes." Journal of Nursing Administration 43(2): 89-94.

8. Brooks Carthon, J. M., et al. (2012). "Nurse Staffing and Postsurgical Outcomes in Black Adults." Journal of the American Geriatrics Society 60(6): 1078-1084.

9. Carthon, J. M., et al. (2015). "The quality of hospital work environments and missed nursing care is linked to heart failure readmissions: a cross-sectional study of US hospitals." BMJ Quality & Safety 24(4): 255-263.

10. Dubois, C. A., et al. (2013). "Associations of patient safety outcomes with models of nursing care organization at unit level in hospitals." International Journal for Quality in Health Care 25(2): 110-117.

11. Flynn, L., Thomas-Hawkins, C., & Clarke, S. (2009). Organizational Traits, Care Processes, and Burnout Among Chronic Hemodialysis Nurses. Western Journal of Nursing Research, 31(5), 569-582.

12. Friese, C., Lake, E., Aiken, L., Silber, J., & Sochalski, J. (2008). Hospital Nurse Practice Environments and Outcomes for Surgical Oncology Patients. Health Services Research, 43(4), 1145-1163.

13. Griffiths, P., et al. (2014). "Nurses' shift length and overtime working in 12 European countries: the association with perceived quality of care and patient safety." Medical Care 52(11): 975-981. [RN4CAST]

14. Griffiths, P., et al. (2016). "Registered nurse, healthcare support worker, medical staffing levels and mortality in English hospital trusts: a cross-sectional study.[Erratum appears in BMJ Open. 2016 May 05;6(5):e008751corr1; PMID: 27150183]." BMJ Open 6(2): e008751.

15. Hegney, Desley, Ashley Plank, and Victoria Parker. "Nursing workloads: the results of a study of Queensland nurses." Journal of Nursing Management 11.5 (2003): 307-314.

16. Hurst, K. (2005). Relationships between patient dependency, nursing workload and quality. International journal of nursing studies, 42(1), 75-84.

17. Kalisch, B. J., et al. (2011). "Do staffing levels predict missed nursing care?" International Journal for Quality in Health Care 23(3): 302-308.

18. McCloskey, B. A., & Diers, D. K. (2005). Effects of New Zealand's health reengineering on nursing and patient outcomes. Medical Care, 43(11), 1140-1146.

19. McHugh, M. D., et al. (2016). "Better Nurse Staffing and Nurse Work Environments Associated With Increased Survival of In-Hospital Cardiac Arrest Patients." Medical Care 54(1): 74-80.

20. McIntosh, J., Moriarty, D., Lugton, J., & Carney, O. (2000). Evolutionary change in the use of skills within the district nursing team: a study in two Health Board areas in Scotland. Journal of advanced nursing, 32(4), 783-790.

21. Needleman, J., et al. (2011). "Nurse staffing and inpatient hospital mortality." New England Journal of Medicine 364(11): 1037-1045.

22. Pappas, S., et al. (2015). "Risk-Adjusted Staffing to Improve Patient Value." Nursing Economics 33(2): 73-78, 87; quiz 79.

23. Rafferty, Clarke, Coles, Ball, James, Mckee, & Aiken. (2007). Outcomes of variation in hospital nurse staffing in English hospitals: Cross-sectional analysis of survey data and discharge records. International Journal of Nursing Studies, 44(2), 175-182

24. Rathert, C., et al. (2012). "Putting the 'patient' in patient safety: a qualitative study of consumer experiences." Health Expectations 15(3): 327-336.

25. Roche MA, Friedman S, Duffield C, et al. A comparison of nursing tasks undertaken by regulated nurses and nursing support workers: a work sampling study. Journal of Advanced Nursing 2016;73:1421–32. doi:10.1111/jan.13224

26. Seago, J. A., Williamson, A., & Atwood, C. (2006). Longitudinal analyses of nurse staffing and patient outcomes: More about failure to rescue. Journal of Nursing Administration, 36(1), 13-21.

27. Saleh, A. M., (2008) The effect of nurse staffing on selected outcomes of care. Doctoral thesis. University of Wisconsin - Milwaukee. ISBN: 9780549843924

28. Schilling, P. L., et al. (2010). "A comparison of in-hospital mortality risk conferred by high hospital occupancy, differences in nurse staffing levels, weekend admission, and seasonal influenza." Medical Care 48(3): 224-232.

29. Spence Laschinger, H. K., & Leiter, M. P. (2006). The Impact of Nursing Work Environments on Patient Safety Outcomes: The Mediating Role of Burnout Engagement. JONA: The Journal of Nursing Administration, 36(5), 259-267.

30. Unruh, L. and R. Hofler (2016). "Predictors of Gaps in Patient Safety and Quality in U.S. Hospitals." Health Services Research 51(6): 2258-2281.

Appendix 5 – Review Protocol

Protocol for scoping review: patient safety outcomes and nursing skill mix interventions

Rationale

Developing policies to deliver safe and effective healthcare for an ageing and increasingly chronically ill population in the context of financial austerity requires evidence based decision-making. In any health care system, the nursing workforce is usually the largest. It is critically important in terms of its potential to avoid or reduce adverse patient outcomes such as mortality and morbidity[1] and in terms of overall health system productivity. The responsibility of nurses in patient care ranges beyond the narrow aspects of bedside care to co-ordination and integration of care delivered by other health care providers [2]. Although achieving the 'right' mix of nursing personnel to meet the needs of patients effectively and safely is a major focus of public and political attention[3], with laws on safe nurse staffing levels introduced in some countries[4], workforce interventions in nursing have rarely been strategically planned, implemented or evaluated[5]. This scoping review examines the quantity and distribution of evidence[6] on skill mix variations and interventions in nursing, seeking to understand the impact of these on patient safety outcomes in adult acute and community care, and to characterise types of skill mix intervention and the contexts of implementation where safety outcomes have been demonstrated. The review informs the work of the RCN-University of Sheffield Strategic Research Alliance, in policy-making and new research.

Definitions of terms

Skill mix: '...the mix of posts, grades or occupations in an organization ... [or] the combinations of activities or skills needed for each job within the organization' [7]p 575.

Nursing skill or staff mix: 'The proportion or percentage of hours provided by one category of caregiver divided by the total hours of care'[8] p 430

Nurse: Registered practitioner, including entry level nurses and up to advance practice nurses (variety of titles).

Nursing care provider: unregistered nursing assistant (variety of titles).

Nursing team (following Griffiths et al[14]): *...the group of workers delivering 'hands on' nursing care on wards (including 'basic' care to meet patients fundamental needs and technical care, including aspects of care generally undertaken only by registered staff, such as medication administration). This would include all necessary administrative assessment and planning work (e.g. documentation, discharge planning). Members of the nursing team may include both registered nurses and unregistered support workers or assistants, regardless of job titles.*

Safety: prevention of harm or adverse events in health care across a range of patient groups and care contexts (based on a definition of 'safety practice' in a US review of patient

safety practices[8]). An expanded definition of 'patient safety' could also be employed thus: *...prevention of medical errors and avoidable adverse events, protection of patients from harm or injury and collaborative efforts by individual healthcare providers and a strong, wellintegrated healthcare system* [9].

Methods

The purpose of a scoping review has been described as:

> "...to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available [they] can be undertaken as standalone projects in their own right, especially where an area is complex or has not been reviewed comprehensively before"[10]

When assessing the evidence base in nursing skill mix interventions and patient safety outcomes, we will seek to establish whether there are any previous reviews in the field and how much evidence and what type and quality exists from primary empirical comparative studies[1] [6, p.146]. We will also identify existing conceptual frameworks characterising skill mix interventions for practical and interpretive reasons. Frameworks offer a means of categorisation and data extraction, speed up the coding process, provide a structure for presentation of findings and add interpretative value by grounding identified data within a wider theoretical context.

We will base our approach to the review on a framework developed by Arksey and O'Malley (2005), and refined by Daudt et al (2013). The key steps in the review are:

- Identifying the research questions
- Identifying relevant studies
- Study selection and quality assessment
- Charting data
- Summarising and reporting results
- Consultation exercise

Identifying Research questions

Subject to refinement, these are the research questions:

- *What patient safety outcomes are associated with nursing skill mix interventions and variation?*
- *How do patient safety outcomes associated with nursing skill mix interventions and variations compare in acute and community care?*

[1] See: https://epoc.cochrane.org/sites/epoc.cochrane.org/files/public/uploads/EPOC%20Study%20Designs%20About.pdf

- *What theories or conceptual frameworks have been used to characterise nursing skill mix interventions and the contexts of implementation in which patient safety outcomes have been demonstrated?*

Identifying relevant studies

We will use a sensitive search strategy to scope the field across key electronic nursing, medical and allied health databases, key journals and cited references. Databases will include: the CEA registry, CDSR, CENTRAL, CINAHL, DARE, Econlit, Embase, HTA database, Medline including In-Process, NHS EED, HEED, British Nursing Index and King's Fund Library.

(The databases included in the final review were CINAHL, Medline/(Pubmed in update) and Google Scholar. This combination of sources were thought to fit the scope of the review and to yield the most relevant results).

Key search terms will be developed on the basis of seminal publications [12-14] and any other existing high quality systematic reviews.

The following study types will be included:

- Randomised controlled trials (RCTs)
- Non-randomised controlled trials (NRCTs)
- Controlled before-after CBA (studies)
- Interrupted time series (ITS) and repeated measures studies
- Qualitative studies
- Secondary analysis of statistical data
  *Secondary analysis of data e.g. surveys and qualitative forms of data were included given the shortage of evidence of higher empirical design. This need was identified during the course of the review

Study selection criteria and quality assessment

Inclusion and exclusion criteria will be developed using the PICOC framework: population, intervention, comparator, outcome and context. A draft of the inclusion criteria using this framework follows below:

Population: adult patients in acute or community care settings in comparable health service contexts: UK, Ireland, USA, Australia, Canada, New Zealand and the USA[2].

Interventions: skill mix interventions or variations relating to the nursing team and including nurses and nursing care providers, reported in comparative studies. Buchan and Dal Poz [7]p 576 suggest a matrix of possible interventions that will be used to refine the search for skill mix interventions and employed for coding purposes:

[2] The USA context is not directly comparable to the UK health care system but we include it because of the volume of research that comes from there.

Table 1. **Skill mix: determinants, requirements and possible interventions**[a]

Determinant	Requirement	Possible interventions
Skill shortages	Response to shortages of staff in particular occupations or professions	Undertake skill substitution; improve use of available skills
Cost containment	Improved management of organizational costs, specifically labour costs	Reduce unit labour costs or improve productivity by altering staff mix or level
Quality improvement	Improved quality of care	Improve use and deployment of staff skills to achieve best mix
Technological innovation; new medical interventions	Cost-effective use of new medical technology and interventions	Re-train staff in new skills; introduce different mix or new types of worker
New health sector programmes or initiatives (e.g. Roll Back Malaria)	Maximum health benefits of programme implementation, by having appropriately skilled workers in place	Determine the cost-effective mix of staff required; enhance skills of current staff; introduce new types of worker
Health sector reform	Cost containment, improvements in quality of care and performance, and responsiveness of health sector organizations	Adjust staff roles; introduce new roles and new types of worker
Changes in the legislative/regulatory environment (note: this is also a possible intervention)	Scope for changes in (or constraints on) role for different occupations, professions	Adjust staff roles; introduce new skills and new types of worker

Outcomes: patient safety outcomes including for example: medication errors, falls, mortality, morbidity, and patient or care reported outcomes related to harm such as distress or anxiety. In the context of acute care, Griffiths et al [14] suggest that the following are the most promising indicators: falls, medication administration errors, and missed nursing care. They note that pressure ulcers and infections may also have a role but direct comparison between units is unlikely to be valid.

Comparators: usual or current practice or care.

Contexts: all acute or community settings of care. We will exclude (following Griffiths et al [14]) studies exclusively in intensive care , maternity, paediatric or mental health care, out patients or long-term care

Time span: Searching will date from the onset of the coalition government in 2000 to May 2018.

Study selection will be conducted in two stages. First, all titles and abstracts will be screened for relevance by at least two reviewers. Those that report empirical results of nursing skill mix variations or interventions with a comparator and a corresponding impact on patient safety outcomes will be selected for consideration against inclusion criteria. Disagreement will be resolved by consensus. Second, studies that meet detailed inclusion criteria will be obtained. Reasons for exclusion will be documented. General discussion / news articles with no empirical data or without substantial literature review will be excluded.

EndNote will be used to manage references.

There is a debate about whether scoping reviews should include an assessment of methodological quality, however, since this review is focused on quantitative evidence we intend to include quality assessment for any comparative studies using validated tools used by the Cochrane Collaboration's Effective Practice & Organization of Care (EPOC) Group, the group most used to analysing evidence for this type of topic. Following Daudt et al[11], we will trial the approach to be used and then refine.

Charting data

We will use Excel to input data, chart and output the data.

Using the data from the Excel charts we will identify potential opportunities for a focused review. This will involve narrative synthesis and summary as a minimum and may or may not permit quantitative synthesis in the form of meta-analysis, depending on the homogeneity of the outcomes data. Options will be presented to the advisory group and discussed on 19th July 2018.

Summarising and reporting results (synthesis)

As documented above the review team will examine the outcome measures and measurement periods to establish the viability of quantitative synthesis (meta-analysis). Experience from comparable reviews by other authors suggests that opportunities for quantitative synthesis will be limited but the team will be cognizant of the appearance of more recent evidence and will factor this into their decision.

Data will be analysed as either ratios or differences, depending on the summary effect measures used. Subgroup analyses will be performed only on variables that have been predefined and discussed with the advisory group e.g. differences between acute and community settings etcetera. If quantitative synthesis is not appropriate, either for the substantive body of the evidence or for specific analyses, the team will present the data in narrative, tabular and possibly graphical form.

2.6 Consultation exercise

To include consultation with the RCN and our PPI and advisory groups.

Project timetable [pre review update]

Table Sample project timetable for six-month literature review project

Note: A six month timescale is most appropriate for a literature review that does not require significant appraisal, synthesis, and analysis (e.g. for a scoping review, a mapping review of a well-defined and focused area, or for a rapid evidence assessment). Mapping/scoping reviews are primarily descriptive (What does the literature look like? Where are the gaps?) rather than analytical (What does the literature tell us?). A rapid evidence assessment makes little claim to in-depth quality assessment. Similarly a wellcircumscribed conceptual analysis, perhaps to inform a subsequent framework analysis, may be achieved within six months.

Task	Timescale
First project team meeting	Months 0–1
Search	
Finalise scope	April 2018

Preliminary literature searches	May 2018
Identify and contact key organisations	Months 0–1
Second project team meeting/discussion	Months 1–2
Full literature searches and reference management	Months 1–2
Selection of articles	May-June 2018
Mapping from Abstracts	May-July 2018
Follow-up cited references	July 2018
Draft Mapping Report	July 2018
Discussion with Advisory Group	July 2018
Production of focused review protocol	July 2018
Registration of focused review protocol with PROSPERO	July 2018
AppraisaL	July-August 2018
Quality assessment and selective data extraction	
Fourth project team meeting/discussion	Month 4
Synthesis	
Data synthesis	Month 5
Analysis	
Data analysis	Month 5
Excel data sheets and Final Mapping Report	Month 5
Fifth project team meeting/discussion	Month 5
Report writing	Month 6
Draft report	Month 6
Sixth project team meeting/discussion	Month 6
Consultation exercise	October 2018
Final report (Mapping Review/Focused Review)	Month 6
Scoping Review Update final report (integrating scoping findings October 2018)	October 2018-March 2019

References

1. Aiken, L.H., et al., *Nursing skill mix in European hospitals: cross-sectional study of the association with mortality, patient ratings, and quality of care.* Bmj Quality & Safety, 2017. **26**(7): p. 559-568.
2. Mitchell, P.H., *Defining patient safety and quality care.* , in *Patient safety and quality: An evidence based handbook for nurses.* , R.G. Hughes, Editor. 2008, Agency for Healthcare Research and Quality (US): Rockville (MD).
3. House of Commons Health Committee, *The nursing workforce. Second report of session 2017-19. HC 353*. 2018.
4. Dean, E., *Wales adopts safe staffing laws while the rest of the UK watches.* Nursing standard (Royal College of Nursing (Great Britain) : 1987), 2018. **32**(30): p. 12-13.
5. Buchan, J., et al., *Policies to sustain the nursing workforce: an international perspective.* International Nursing Review, 2015. **62**(2): p. 162-170.
6. Booth, A., A. Sutton, and D. Papaioannou, *Systematic approaches to a successful literature review*. 2016, London: Sage.
7. Buchan, J. and M.R. Dal Poz, *Skill mix in the health care workforce: reviewing the evidence.* Bulletin of the World Health Organization, 2002. **80**(7): p. 575-580.
8. Shojania, K.G., et al., *Making healthcare safer: a critical analysis of patient safety practices. Evidence Report/ Technology Assessment Number 43* 2001, Prepared by the University of
   California at San Francisco-Stanford Evidence-based Practice Center under Contract No. 29097-0013
9. Kim, L., et al., *Defining attributes of patient safety through a concept analysis.* Journal of Advanced Nursing, 2015. **71**(11): p. 2490-2503.
10. Arksey, H. and L. O'Malley, *Scoping studies: towards a methodological framework.* International Journal of Social Research Methodology, 2005. **8**(1): p. 19-32.
11. Daudt, H.M., C. van Mossel, and S.J. Scott, *Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework.* BMC Med Res Methodol, 2013. **13**: p. 48.
12. Shekelle, P.G., *Nurse-Patient Ratios as a Patient Safety Strategy A Systematic Review.* Annals of Internal Medicine, 2013. **158**(5): p. 404-+.
13. Griffiths, P., et al., *Nurse staffing and patient outcomes: Strengths and limitations of the evidence to inform policy and practice. A review and discussion paper based on evidence reviewed for the National Institute for Health and Care Excellence Safe Staffing guideline development.* International Journal of Nursing Studies, 2016. **63**: p. 213-225.
14. Griffiths, P., et al., *The Association Between Patient Safety Outcomes and Nurse/Healthcare*
    Assistant Skill Mix and Staffing Levels and Factors That May Influence Staffing Requirements (NICE Evidence Review). 2014, University of Southampton Centre for Innovation and Leadership in Health Sciences.

Sample Search Strategy based on PubMED MEDLINE

Population: adult patients in acute or community care

settings Nursing Staff/ OR Nursing Staff, Hospital/ exp

Nurses/ (39956)

(nurse or nurses or nursing).tw. (166343)

Nurses' Aides/ (1986)

("healthcare assistant*" or "health care assistant*").tw. (296)

Nursing Administration Research/ (1905)

Nursing Audit/ (1798)

Models Nursing/ (8353)

Nursing Service Hospital/ (1383)

The following combined with nurse, nurses, nursing as

textword exp Hospitals/ exp Hospital Units/

hospital*.tw.

(acute adj3 (ward* or unit*)).tw.

(acute adj3 care).tw.

(medical adj3 (unit* or ward*)).tw.

(surgical adj3 (unit* or ward*)).tw.

Inpatients/

(inpatient* or "in-patient*").tw.

(patient* adj3 surgical).tw.

("medical-surgical" or "surgical-medical").tw.

(postsurgical or "post surgical").tw.

Interventions: skill mix interventions or variations relating to the nursing team and including nurses and nursing care providers

Personnel Staffing and Scheduling/ OR Nurses Role/ OR Workload/ OR Health Manpower/

OR workforce OR manpower or

personnel (skill* adj1 mix*).tw.

skillmix*.tw.

(staffmix* or "staff mix*").tw.

staffing.tw. understaff*.tw.

"under staff*".tw.

(staff* adj3 (level* or ratio* or resourc* or model* or number* or mix* or rota* or rosta* or roster* or schedul* or overtime or supervision or supervisory)).tw.

(staff* adj3 (sufficient* or sufficiency or adequate* or adequac* or target* or insufficient* or insufficienc* or inadequate* or inadequac* or short or shortage or efficient* or efficienc* or inefficien*)).ti.

(workload* or shift or shiftwork* or shifts or overtime or capacity).tw.

Context: UK, Ireland, USA, Australia, Canada, New Zealand and the USA

Great Britain/ OR UK OR United Kingdom OR England OR Scotland OR Scottish OR Wales OR Welsh OR London OR Leeds OR Liverpool OR Manchester OR Birmingham OR Sheffield OR Portsmouth OR Southampton OR Glasgow OR Edinburgh OR Aberdeen OR Dundee

OR Ireland OR Irish OR Belfast OR Dublin

OR Australia OR Australian OR Canada OR Canadian OR "New Zealand"

OR "United States"

Outcomes: Safety

Safety

OR Patient Safety/ OR Safety Management/ OR Medical Errors/ OR Fatigue/ OR Work Schedule Tolerance/ OR Quality of Health Care/ OR Health Planning Guidelines OR Nursing/standards OR Economics, Nursing

Study Type: Randomised trials, Non-randomised trials, Controlled before-after studies, Interrupted time series studies and repeated measures studies (Following EPOC classification)

COMPARATIVE STUDY OR META-ANALYSIS OR EVALUATION STUDIES OR REVIEW OR CLINICAL TRIAL OR RANDOMIZED CONTROLLED TRIAL OR CONTROLLED TRIAL OR CONTROLLED CLINICAL TRIAL OR OBSERVATIONAL STUDY OR MULTICENTER STUDY

Strategic
Research
Alliance

Knowledge Enhances Practice