Hospital nurse staffing models and patient and staff-related outcomes (Review)

Butler M, Collins R, Drennan J, Halligan P, O'Mathúna DP, Schultz TJ, Sheridan A, Vilis E

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[Intervention Review]

Hospital nurse staffing models and patient and staff-related outcomes

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ABSTRACT

Background

Nurse staffing interventions have been introduced across countries in recent years in response to changing patient requirements, developments in patient care, and shortages of qualified nursing staff. These include changes in skill mix, grade mix or qualification mix, staffing levels, nursing shifts or nurses' work patterns. Nurse staffing has been closely linked to patient outcomes, organisational outcomes such as costs, and staff-related outcomes.

Objectives

Our aim was to explore the effect of hospital nurse staffing models on patient and staff-related outcomes.

Search methods

We searched the following databases from inception through to May 2009: Cochrane/EPOC resources (DARE, CENTRAL, the EPOC Specialised Register), PubMed, EMBASE, CINAHL Plus, CAB Health, Virginia Henderson International Nursing Library, the Joanna Briggs Institute database, the British Library, international theses databases, as well as generic search engines.

Selection criteria

Randomised control trials, controlled clinical trials, controlled before and after studies and interrupted time series analyses of interventions relating to hospital nurse staffing models. Participants were patients and nursing staff working in hospital settings. We included any objective measure of patient or staff-related outcome.

Data collection and analysis

Seven reviewers working in pairs independently extracted data from each potentially relevant study and assessed risk of bias.

Main results

We identified 6,202 studies that were potentially relevant to our review. Following detailed examination of each study, we included 15 studies in the review. Despite the number of studies conducted on this topic, the quality of evidence overall was very limited. We found no evidence that the addition of specialist nurses to nursing staff reduces patient death rates, attendance at the emergency department, or readmission rates, but it is likely to result in shorter patient hospital stays, and reductions in pressure ulcers. The evidence in relation to the impact of replacing Registered Nurses with unqualified nursing assistants on patient outcomes is very limited. However, it is suggested that specialist support staff, such as dietary assistants, may have an important impact on patient outcomes. Self-scheduling and primary nursing may reduce staff turnover. The introduction of team midwifery (versus standard care) may reduce medical procedures in labour and result in a shorter length of stay without compromising maternal or perinatal safety. We found no eligible studies of educational interventions, grade mix interventions, or staffing levels and therefore we are unable to draw conclusions in relation to these interventions.

Authors' conclusions

The findings suggest interventions relating to hospital nurse staffing models may improve some patient outcomes, particularly the addition of specialist nursing and specialist support roles to the nursing workforce. Interventions relating to hospital nurse staffing models may also improve staff-related outcomes, particularly the introduction of primary nursing and self-scheduling. However, these findings should be treated with extreme caution due to the limited evidence available from the research conducted to date.

PLAIN LANGUAGE SUMMARY

Hospital nurse staffing models and patient and staff-related outcomes

Many countries have introduced new models for staffing hospital units with nursing staff in response to shortages of qualified nurses and changes in patient care needs. These include changes in the mix of qualified and unqualified nurses within the hospital workforce, the mix of nurses with different qualifications and different levels of experience, and the way in which nursing staff are allocated to hospital units and to individual patients receiving care on each hospital unit. We identified 15 relevant studies that were considered to be of an appropriate design to be included in this review.

It appears that certain changes to hospital nurse staffing, particularly the introduction of specialist nursing roles and specialist support staff, may improve patient outcomes. The introduction of staffing models such as primary nursing and self-scheduling may reduce the number of staff resignations. However, the research in relation to these topics is limited and the findings should be treated with caution.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON *[Explanation]*

The effect of adding a specialist nursing post(s) to nurse staffing compared to usual nurse staffing on patient outcomes

Patient or population: patients with patient outcomes
Settings: Hospital
Intervention: the addition of a specialist nursing post(s) to staffing
Comparison: usual nurse staffing

Outcomes[$]	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Usual nurse staffing	The addition of a specialist nursing post(s) to staffing				
In-hospital mortality	Study population		RR 0.96 (0.59 to 1.56)	612 (1 study)	⊕⊕⊕◯ **moderate**[1]	
	97 per 1000	93 per 1000 (57 to 151)				
	Medium risk population					
	97 per 1000	93 per 1000 (57 to 151)				
Length of stay		The mean length of stay in the intervention groups was **1.35 lower** (1.92 to 0.78 lower)		235 (2 studies)	⊕⊕⊕◯ **moderate**[2]	Analysis only includes data from 2 of 6 studies (Dawes 2007;Feddersen 1994). 3 studies reported Median values only (Davies 2001; Einstadter 1996; Forster 2005) and 1 study reported mean values but not SD (Talley 1990).

Readmission	**Study population**		**RR 1.15** (0.88 to 1.52)	878 (3 studies)	⊕⊕⊕○ **moderate**[2]	Analysis does not include data from 1 study (Forbes 2006) as data were reported as the range of readmission rates over the three time periods rather than actual values
	174 per 1000	**200 per 1000** (153 to 264)				
	Medium risk population					
	144 per 1000	**166 per 1000** (127 to 219)				
Attendance at ED within 30 days	**Study population**		**RR 1.14** (0.79 to 1.62)	472 (1 study)	⊕⊕⊕○ **moderate**[3]	
	192 per 1000	**219 per 1000** (152 to 311)				
	Medium risk population					
	192 per 1000	**219 per 1000** (152 to 311)				
Post-discharge admission, ED visit or death	**Study population**		**RR 1.33** (0.93 to 1.91)	328 (1 study)	⊕⊕⊕○ **moderate**[1]	
	234 per 1000	**311 per 1000** (218 to 447)				
	Medium risk population					
	234 per 1000	**311 per 1000** (218 to 447)				
Post-discharge adverse events	**Study population**		**RR 1.03** (0.7 to 1.53)	328 (1 study)	⊕⊕⊕○ **moderate**[1]	
	228 per 1000	**235 per 1000** (160 to 349)				
	Medium risk population					

	228 per 1000	**235 per 1000** (160 to 349)		
Glycosylated haemoglobin		The mean Glycosylated haemoglobin in the intervention groups was **0.5 lower** (1.9 lower to 0.9 higher)	88 (1 study)	⊕⊕◯◯ **low**[3,4]

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[$] A range of outcomes were included across studies relating to this intervention. In some cases, an outcome may have been included in one study only. Therefore the number of studies per outcome varies considerably.
[1] Differences noted in baseline characteristics of control and intervention groups
[2] One study was a CCT - therefore not randomly allocated
[3] CCT study - therefore not randomly allocated
[4] Results reported only for 88/129 patients - no explanation given

BACKGROUND

A range of nurse staffing model interventions has been introduced across countries in recent years to address nursing shortages. These include changes to nurse staffing levels, the nursing skill mix, the educational preparation of nurses, staff allocation models, shift patterns, and the use of overtime and agency staff. It is suggested that nurse staffing is closely associated with the quality of care that patients receive and with patient outcomes.

Description of the condition

Currently there is a shortage of nurses across many countries (Buchan 2005; Buchan 2009; Potempa 2009) which is likely to continue in the coming decade (Potempa 2009; Preston 2009). At the same time, hospitalised patients have become more acutely ill, requiring more intensive nursing time and care (Buerhaus 2000; Lang 2004) and ageing populations are likely to require additional nursing resources (Preston 2009). In addition, the numbers of patients receiving hospital care has increased in many countries (e.g. Australia (AIHW 2006)). The International Council of Nurses reported that "a common challenge facing HR managers is determining the most effective mix of staff and skills needed to deliver quality and cost-effective patient care" in the light of "rising demand for health services, cost containment and shortages of nurses and other health workers" (ICN 2006).

Description of the intervention

Models of hospital nurse staffing dictate the allocation of nursing resources to meet patient care needs. The numbers of nurses available in a hospital or hospital unit (staffing levels) can be quantified in relation to numbers of patients in that hospital or hospital unit (nurse per patient ratio). Numbers of nurses can also be quantified in terms of hours of nursing care and nurse full time equivalents (FTE) or whole time equivalents (WTE). Currently, one WTE/FTE is equivalent to 37.5 hours per week in Australia, Canada and Ireland. Mandatory nurse to patient ratios have been introduced in California, USA and in the state of Victoria in Australia in response to concerns about staffing levels. Several countries have resorted to overseas recruiting in order to address the shortfall of nurses (e.g. Humphries 2008).

The mix of nurses can be quantified in terms of skill mix, grade mix or qualification mix. Skill mix may refer to the mix of "licensed" and "unlicensed" staff in the case of the US nursing workforce (Kane 2007) or registered or unregistered staff in the case of the Irish, Australian and the UK workforce, or "the proportion of different nursing grades, and levels of qualification, expertise and experience" (Ayre 2007; Buchan 2002; Spilsbury 2001). Grade mix refers to the proportion of nursing grades in the nursing workforce. These are occupational grades that are assigned to posts rather than individuals, and the grading models vary within and across countries. Grade may be used as a proxy for skill (Carr-Hill 1995), but skill mix is more than grade mix - it relates to qualifications, experience and competencies. Qualification mix refers to the proportion of different nursing qualifications in the work force. Changes in the mix of nurses with different educational qualifications may also result in a change in skill mix in relation to the proportion of nurses with or without additional or more advanced skills and knowledge. Skill mix, grade mix or qualification mix may refer to the mix of nurses in a hospital, in a hospital unit or on a hospital ward.

Internationally, the education and training of nurses has rapidly evolved to attempt to address issues of shortage of supply, increased demand, and expansion of the role of nurses. Examples include the introduction of a shorter programme (often of two years duration instead of three), the introduction of degree programmes, and the introduction of post registration education programmes.

New models of nurse staffing have also been introduced in different countries which relate to how patients are assigned to nurses working on a hospital ward or unit. One example of this is primary nursing. In primary nursing, one nurse (the primary nurse) is responsible for total care of a number of patients 24 hours a day, seven days a week, aimed at providing "comprehensive, individualised and consistent care" (Kozier 2008, p133). The primary nurse assesses and prioritises each patient's needs, and plans and evaluates the patient's care. The primary nurse co-ordinates the patient's care and is their "first line manager ... with all its inherent accountabilities and responsibilities". However, other nursing staff may also be involved in the patient's care (Kozier 2008, p134).

Changes have also been made to nursing shifts or nurses' work patterns and there is a greater reliance on the use of overtime and agency staff to cover nursing shifts (Rogers 2004).

How the intervention might work

It is suggested that nurse staffing is closely related to the quality of the nursing practice environment, and subsequently to patient outcomes (Leiter 2006). Further it is suggested that nurse staffing and the practice environment together influence patient outcomes directly and indirectly through "nurse job outcomes" (Lake 2006). It has been argued that nurse staffing and nursing skill mix are "directly linked" to quality of care, with a lower proportion of registered nurses in the nursing workforce being associated with increased patient length of stay, incidence of hospital acquired infections, and prevalence of pressure ulcers (Currie 2005). The evidence base in the area of skill mix is limited. Some studies report improvements in cost effectiveness and quality improvements following the introduction of care assistants, but other studies report decreases in quality of care, higher workload for registered nurses, and higher turnover or absence rates. Increases in costs to cover time on call, sick leave and overtime have also been reported (Buchan 2005). The evidence is also limited in relation to changes in nursing shifts or nurses' work patterns. A recent systematic re-

view reported equivocal results when the effects of shift length on quality of patient care was examined (Estabrooks 2009).

Why it is important to do this review

Although the effects of changes to nurse staffing have important implications for healthcare provision, the bulk of the public policy driving these changes is not evidence-based because of "an insufficient body of credible evidence linking changes in the hospital nurse work force to potentially adverse effects on patient outcomes" (Buerhaus 2000). Further, it is suggested that the "considerable research" capable of informing the debate about the relationship between the nursing work force and patient outcomes is often "selectively quoted to support arguments" (Lankshear 2005). Several reviews of nurse staffing and patient outcomes have been conducted previously but are limited in relation to the scope of the literature search. For example, Lankshear 2005's systematic review of nurse staffing and healthcare outcomes was limited to studies published between 1990 and 2004. The method used by Spilsbury 2001 to examine nursing outcomes, skill mix, and changing roles included a literature review and use of an expert panel to inform debate. Their review of the literature was limited to studies conducted in the UK between 1992 and 1998. Lang 2004 conducted a systematic review of the effects of nurse staffing on patient, employee, and hospital outcomes. Their study was limited to studies conducted in the United States and published between 1980 and 2003. It is not possible to assess the breadth and depth of McKenna 1995's study of skill mix substitutions and quality of care, as details of the search are not outlined within the published work available.

Other reviews have included studies that are outside of the focus of this review in relation to the methods or outcomes. For example, Numata 2006 conducted a literature review and meta-analysis of nurse staffing levels and hospital mortality in critical care settings. This review involved a comprehensive search for studies going back to 1966 (MEDLINE) and was last updated in October 2005. All nine studies included were observational and did not include interventions. Kane 2007's systematic review of nurse staffing and the quality of patient care was limited to observational studies conducted in the United States and Canada between 1990 and 2006. Observational studies did not meet the inclusion criteria for our review. The concept of quality and relationship with staffing levels and skill mix was the focus of Currie 2005's literature review, which involved a 'comprehensive search' of the literature. Currie's study discussed the literature but did not weigh evidence to support associations between nurse staffing and patient outcomes. Crossan 2005's 'descriptive review' of nursing skill mix is very broad in nature with little reference to patient outcomes or scrutiny of the quality of the identified research.

A small number of reviews have been conducted that focus on a single aspect of the review presented here. De Broe 2001's rapid review of the role of specialist nurses in multiple sclerosis involved a detailed and comprehensive search strategy across electronic databases. Their review also included a less extensive review of the role of the specialist nurse in diabetes, epilepsy and Parkinson's disease. Estabrooks 2009 conducted a systematic review of shift length on patient and health provider outcomes. Some of these very specific reviews have also been limited in relation to the scope of the search strategy. For example, Carter 2007's study of the impact of nurse practitioners working in the emergency department was limited to studies published in English listed in MEDLINE and CINAHL before November 2006. Lookinland 2005's study of non-traditional practice models in nursing and patient outcomes was limited to studies listed in CINAHL, MEDLINE and PubMed between 1998 and April 2004.

This study aimed to address the limitations identified in this comprehensive list of related studies through an inclusive systematic review of the current research evidence in relation to the effect of hospital nurse staffing models on patient and staff-related outcomes.

OBJECTIVES

The purpose of this review was to explore the effect of hospital nurse staffing models on patient and staff-related outcomes, specifically:

1. To identify which staffing model(s) are associated with better outcomes for patients in the hospital setting.

2. To identify which staffing model(s) are associated with better staff-related outcomes in the hospital setting.

To address these aims, the effects of hospital nurse staffing model interventions were compared with the effects of controls (previously existing hospital nurse staffing models) using the criteria found in evaluations of nurse staffing models.

METHODS

Criteria for considering studies for this review

Types of studies

We sought all relevant published and unpublished randomised controlled trials (RCTs), controlled clinical trials (CCTs), controlled before and after studies (CBAs), or interrupted time series studies (ITSs) that met the EPOC eligibility criteria. There were no restrictions on time period, jurisdiction, or language. Relevant studies which did not use one of the previously mentioned designs were excluded. We assessed the risk of bias of all included studies using the EPOC criteria (EPOC 2009).

Types of participants

Participants were hospital nursing staff and hospital patients. Hospitals included acute and non-acute, small, medium and large, teaching and non-teaching, and public and private. Staff were registered nurses or their international equivalents (e.g. registered general nurse, staff nurse, professional nurse), licensed practical nurses or their international equivalents (e.g. licensed vocational nurse, enrolled nurse), and unlicensed assistive personnel or their international equivalents (e.g. nurses' aide, auxiliary nurse, nursing assistant). We excluded studies of nurse staffing outside of hospitals (e.g. community, nursing homes). Staffing models in residential/nursing home/extended care settings are the focus of a separate Cochrane Review (Haesler 2007).

Types of interventions

We considered all studies of hospital nurse staffing model interventions. These included interventions of staffing models, staffing levels, skill mix, grade mix, or qualification mix. Staffing models are models used to identify and allocate nursing staff, shift patterns, use of overtime, or use of non-core staff. Staffing levels include nurse to patient ratios, hours of nursing care, nurse full time equivalents (FTEs), or nurse whole time equivalents (WTEs). Skill mix refers to the proportion of total hours of nursing care provided by registered nurses, number of registered nurse hours per day, proportion of registered nurses in the work force, or proportion of advanced nurse practitioners. Grade mix refers to the proportion of nursing grades in the work force. Qualification mix refers to the proportion of graduate nurses in the nursing work force, the proportion of nurses with a post-registration qualification (obtained following registration as a nurse), or the proportion of nurses with a post-graduate qualification. We excluded studies of the substitution of doctors by nurses. Such substitution is the focus of a separate Cochrane Review (Laurant 2004). Studies of ratios between nurses and other professionals were also beyond the scope of this review.

Types of outcome measures

The primary outcomes of interest to this review were any objective measures of patient or staff-related outcomes (using the methodological inclusion criteria for an EPOC review (EPOC 2002)). These included patient mortality, risk-adjusted patient mortality, in-hospital death, length of patient's stay, staff sick leave rates, and staff turnover rates.

Other objective outcome measures included "nursing-sensitive patient outcomes" which are defined as "variable patient or family caregiver states, behaviours, or perceptions at a low level of abstraction that are responsive to nursing interventions and used for determining a patient outcome" (Gordon 1998). Doran 2003 defines nursing-sensitive outcomes as "those that are relevant, based on nurses' scope and domain of practice, and for which there is empirical evidence linking nursing inputs and interventions to the outcomes." Several measures of nurse-sensitive or nursing-sensitive patient outcomes can be found in the literature (Kane 2007; Doran 2006). Examples of objective nursing-sensitive outcomes include infections, falls, pressure/decubitus ulcer, complications, or medication errors.

Studies focusing on outcomes that were not considered to be objective were excluded from this review (as is required for EPOC reviews EPOC 2002). Examples found in studies of nurse staffing included patient satisfaction, staff satisfaction, quality of life, disease impact, staff stress, and staff burnout.

Search methods for identification of studies

The following databases were searched through to May 2009 to identify primary studies: 1) Cochrane databases (DARE, CENTRAL) and the EPOC Specialised Register; 2) Bibliographic databases including CINAHL (Ebsco) Medline (OVID), EMBASE (OVID), Cochrane Library (Wiley), CAB Health (OVID) and the Joanna Briggs database; 3) the British Library and British and Irish Theses database, University of Michigan database of US Theses and Dissertations and other international theses databases; and 4) generic search engines (Google, Yahoo) for government or nursing organisation reports. In addition, the following were used to identify primary studies: handsearches of high-yield journals and conference proceedings not already handsearched on behalf of the Cochrane Collaboration; searches of reference lists of all papers and relevant reviews identified; contacting authors of relevant papers and other related reviews seeking information on any further published or unpublished work; and a search of the ISI Web of Science for papers which cite studies included in the review.

We searched electronic databases using a strategy incorporating the methodological component of EPOC search terms with selected MeSH terms and free text terms relating to hospital nurse staffing. The search strategies used for each electronic database are included in Appendix One.

Data collection and analysis

Two authors (MB and one assigned author) independently assessed each potentially relevant study for inclusion using pre-established inclusion criteria. We excluded studies if they were not of the appropriate design (i.e. RCT, CCT, CBA with at least two control and two intervention groups, or ITS with at least three data points pre- and post-intervention), did not relate to hospital staff or hospital patients, did not relate to one of the interventions specified (i.e. staffing models, staffing levels, skill mix, grade mix or qualification mix), or included only secondary outcomes or outcomes that were not considered to be objective. We catalogued all excluded studies along with their reason for exclusion. We retrieved and stored electronically full text copies of all potentially relevant studies. Two authors independently extracted data

using a modified version of the EPOC data collection checklist. We resolved any disagreement in the screening or data extraction process by discussion between authors. Two authors assessed the risk of bias of all eligible studies.

Analysis

Effects of interventions were measured based on changes in absolute numbers or mean values and data were used to calculate risk ratios, mean differences and confidence intervals for some outcomes. In order to provide a visual presentation of findings, where data were available for outcomes from two or more similar studies, these were entered into Revman to produce forest plots. However, our meta-analysis is limited because of the small number of eligible studies identified for each intervention.

In accordance with EPOC guidelines, where possible, results from CBA studies are presented in terms of: (1) absolute difference (mean or proportion in intervention group minus control); (2) relative percentage difference (absolute difference divided by post-intervention score in the control group); (3) absolute change from baseline (pre to post changes in both groups); and (4) difference in absolute change from baseline. In studies without baseline data, only absolute difference and relative percentage difference were calculated.

On-going studies

We have reported on-going studies detailing the primary author, research question(s), methods and outcome measures. Analysis of these studies will be included in future updates of the review.

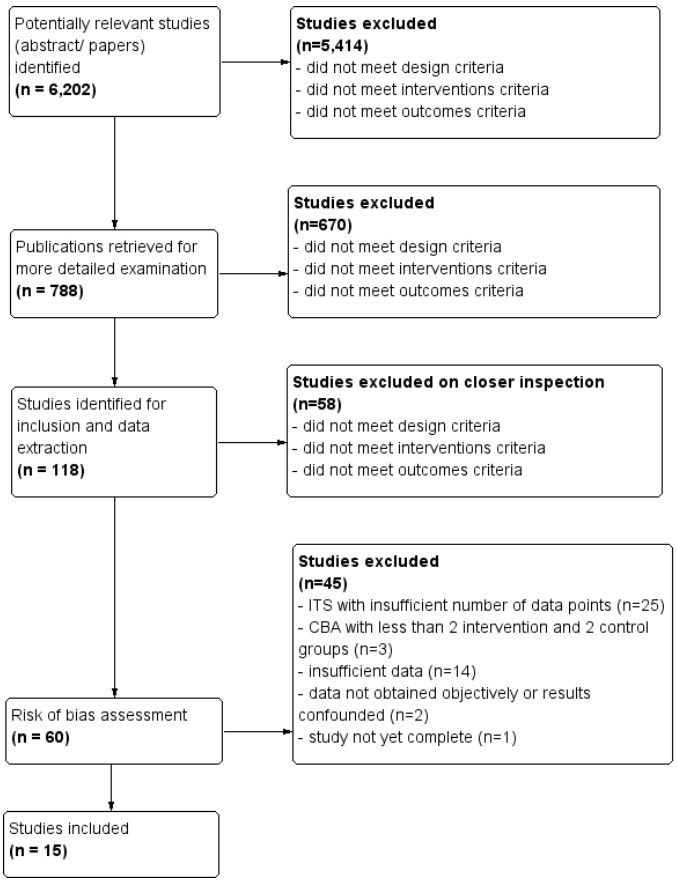
RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of ongoing studies.

The search resulted in the identification of 6,202 potentially relevant studies. Further assessment of these studies resulted in the inclusion of 15 eligible studies. The process for study inclusion and exclusion is represented in Figure 1.

Figure 1. Identification and screening of relevant studies



Results of the search

We conducted two searches for this review: an initial search in November 2007 and a second search in May 2009. The two searches yielded a total of 6,202 studies, 486 of which were identified as potentially relevant to our study. The search included electonic databases, generic search engines, hand searches, reference lists, information from authors about other studies and a search of the ISI web of science. Table 1 provides further information on the sources of included studies.

Included studies

Following closer examination of studies through the data extraction and risk of bias assessment process, 15 studies were identified for inclusion in this study. There were four studies of staffing models which included interventions relating to primary nursing, self-scheduling and team midwifery. There were 11 studies relating to nursing skill-mix. We identified two types of nurse staffing interventions in relation to staffing skill mix: 1) the addition of specialist nurse(s) to usual staffing (nine studies), and 2) increasing the proportion of support staff versus usual nurse staffing (two studies).

Of the 15 studies included, eight were randomised controlled trials (Biro 2000; Davies 2001; Dawes 2007; Duncan 2006; Forster 2005; Pozen 1977; Ritz 2000; Talley 1990), two were controlled clinical trials (Einstadter 1996; Feddersen 1994), and five were controlled before and after studies (Boumans 1999; Forbes 2006; Melchoir 1996; Neidlinger 1993; O'Connor 1992).

A range of different patient and staff-related outcomes was found across studies. Most studies of staffing models focused on staff-related outcomes such as absenteeism, staff retention and staff turnover. However, one study also included patient outcomes (patient falls, medication errors and adverse incidents) and costs. Studies relating to nursing skill-mix focused on patient outcomes and costs. Patient outcomes included length of stay, patient mortality, readmission and attendance at the emergency department post-discharge, and several other clinical outcomes (seeTable 2). Biro 2000's study of the effect of team midwifery examined delivery outcomes including procedures in labour, mode of delivery and perinatal outcomes.

Excluded studies

Several other potentially relevant studies were identified for these and other interventions (staffing levels, grade mix, partnership models, qualification mix) but they were excluded because they did not meet other inclusion criteria (e.g. design, outcomes). Twenty-five studies were classified as interrupted time series studies (Armstrong 2004; Arts 2000; Burnes Bolton 2007; Cavan 2001; Donaldson 2005; Eck 1999; Gardner 1991; Grillo-Peck 1995; Hinshaw 1981; Jansen 1994; Lea 2003; Lee 2005; Lewis 1994; Brett 1990; O'Hare 2006; Pratt 1993; Rideout 2007; Sarkissan 1999; Sheill 1993; Smith 2006; Strayer 2008; Vaska 1993; Williams 2000; Yong 2002; Zidek 2003). However, none of these studies met the EPOC criterion for inclusion which is the collection of data at three or more data points pre- and post-intervention. Most studies had just one or two data points before or after the intervention. The EPOC inclusion criteria for ITS studies are quite strict in order to minimise the threats to internal validity that may arise in ITS studies due to history, maturation, instrumentation bias and selection bias (EPOC 1998).

Eight relevant CBA studies were identified but three of these studies (Hanneman 1993; Lengacher 1994; Tourangeau 1999) were excluded because they did not have the minimum number of intervention and control groups (four groups) required in the EPOC minimum criteria for CBA studies (EPOC 2002).

A further 16 relevant studies were identified but not included because results were not reported adequately (Benson 2008; Campolo 1998; Chavigny 1984; Choi 1986; Ciske 1974; Counsell 1999; Danello 2008; Davis 1997; Eriksen 1992; Heinemann 1996; Kenney 2001; McPhail 1990; Ringerman 2000; Sullivan 2002) or because of problems with the results (in one, the results were confounded (Barkell 2002)); in another, data were not obtained objectively (Sinclair 2006).

Risk of bias in included studies

The risk of bias of all studies was assessed using criteria set out in the EPOC risk of bias tool. RCT and CCT studies were also assessed using the GRADE Working Group Grades of Evidence criteria (Guyatt 2008). The risk of bias of included studies is described in the following section by study type.

A. Randomised controlled trials

Of the eight RCTs, three were assessed to be of low risk of bias (Biro 2000; Dawes 2007; Duncan 2006). Three studies were assessed to be of moderate risk of bias (Davies 2001; Forster 2005; Talley 1990) and the remaining two were assessed to be of high risk of bias. Only four RCT studies provided sufficient information to demonstrate that the sequence had been adequately generated and that allocation was concealed (Biro 2000; Dawes 2007; Duncan 2006; Forster 2005). Blinding of the participants or clinicians was only done or feasible in three studies (Biro 2000; Dawes 2007; Forster 2005) and outcomes assessment was blinded in three of the eight studies (Dawes 2007; Duncan 2006; Forster 2005). With the exception of one study (Ritz 2000), outcome reporting appeared complete across RCTs. Seven studies conducted a baseline assessment of groups. In the remaining study, the results reported

are of differences between sub-groups rather than between the intervention and the control group (Talley 1990). In seven studies the control group appeared to be similar but some differences were noted between groups in the remaining study (Forster 2005).

B. Clinical controlled trials

Both CCT studies were assessed to be of moderate risk of bias (Einstadter 1996; Feddersen 1994). In both cases blinding of participants/clinicians and blinding of outcome assessment was not done.

C. Controlled before and after studies

Five studies were CBAs (Boumans 1999; Forbes 2006; Melchoir 1996; Neidlinger 1993; O'Connor 1992) and all were assessed to be of moderate risk of bias. All five studies fulfilled the criteria for pre-specification of the features to be assessed, adequate recording of what happened in the study and prospective collection of data pre- and post-intervention. None of the studies blinded participants/clinicians or outcome assessment. Data were incomplete in two studies (Forbes 2006; Melchoir 1996). In only three studies was it possible to determine that the study was free of selective outcome reporting (Boumans 1999; Neidlinger 1993; O'Connor 1992). Only two studies provided sufficient detail to show that the control group was similar to the study group (Boumans 1999; O'Connor 1992). Two studies reported specific sources of bias (Boumans 1999; Melchoir 1996).

Effects of interventions

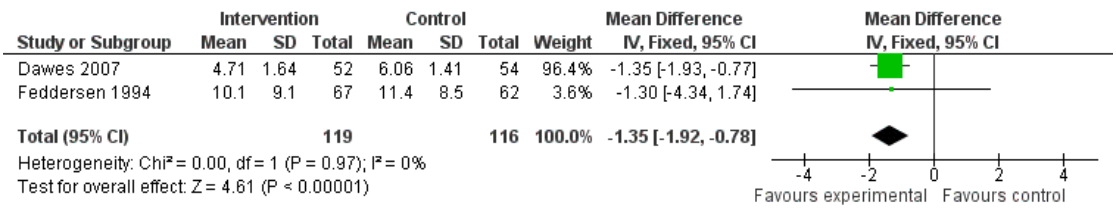
See: **Summary of findings for the main comparison** The effect of adding a specialist nursing post(s) to nurse staffing compared to usual nurse staffing on patient outcomes; **Summary of findings 2** Effect of adding dietary assistants to nurse staffing compared to usual nurse staffing on patient outcomes; **Summary of findings 3** The effect of team midwifery compared to usual midwifery staffing on maternity care outcomes

A. Addition of a specialist nursing post to nurse staffing versus usual nurse staffing

Patient outcomes were assessed in eight studies (Davies 2001; Dawes 2007; Einstadter 1996; Feddersen 1994; Forbes 2006; Forster 2005; Pozen 1977; Talley 1990). Specialist nurse roles varied from study to study but all were focused around the needs of specific groups of patients, such as patients with diabetes, multiple sclerosis, myocardial infarction, mental health problems, or gynaecology patients. The specialist nurse was usually educated to master's degree level. The role of the specialist nurse usually involved co-ordinating care including arranging tests and procedures, assessing patients, planning their care and reviewing their progress, undertaking or prescribing specific interventions based on assessed needs, and educating patients, nurses, and other staff. Five studies were RCTs (Forster 2005; Davies 2001; Dawes 2007; Pozen 1977; Talley 1990), and the remainder were either CCTs or CBAs. One study examined the impact of this intervention on patient mortality and concluded that the intervention had no impact on in-hospital patient mortality (Forster 2005). Our analysis of Forster 2005's data identified a risk ratio (RR) of 0.96 (95% CI 0.59 to 1.56; Z = 0.17, p = 0.86), indicating no effect.

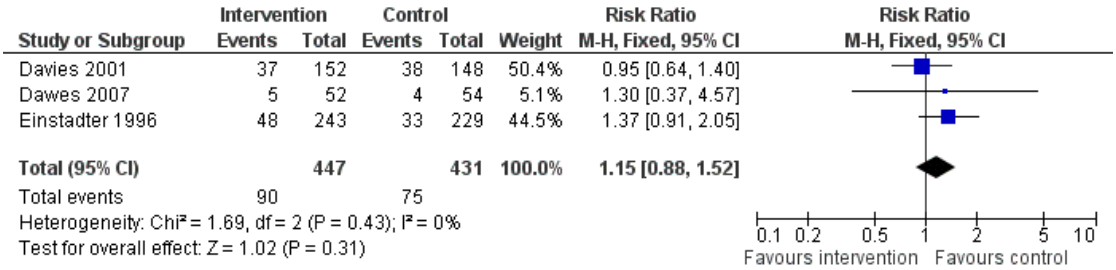
Six studies examined the impact on length of stay (Davies 2001; Dawes 2007; Einstadter 1996; Feddersen 1994; Forster 2005; Talley 1990). Two RCTs identified the potential for the introduction of a specialist nursing position to reduce patient length of stay (Davies 2001; Dawes 2007), whereas a third Forster 2005 found the intervention had no impact on length of stay. Dawes 2007 reported that the savings made due to reduction in patient length of stay offset the costs of employing the additional nurse specialist. Davies 2001 found no evidence of adverse effects from the reduced length of stay in terms of readmission rates, use of community resources or patient perceptions of quality of care. Talley 1990 examined the impact of a Psychiatric Liaison Nurse Specialist consultation for acute medical-surgical patients requiring constant observation and found the intervention had no impact on length of stay. Of the two other studies, Feddersen 1994 associated the intervention with a reduction in length of stay (p<0.001), whereas Einstadter 1996 found no effect on length of stay. A meta-analysis of the data provided by Dawes 2007 and Feddersen 1994 suggests an impact (reduction) on length of stay (RR -1.35, 95% CI -1.92 to 0.78; Z = 4.61, p<0.00001) (see Figure 2). (Note: median values were reported only or SD not reported in remaining four studies, therefore not included in the analysis).

Figure 2. Forest plot of comparison: 1 Addition of specialist nursing post to staffing versus standard staffing, outcome: 1.5 Length of stay (days).



Four studies examined the impact of the intervention on readmission rates (Davies 2001; Dawes 2007; Einstadter 1996; Forbes 2006). All four studies concluded that there was no impact on readmission rates. Our meta-analysis of the data from the three RCT/CCT studies supports this conclusion of no effect (RR 1.15, 95% CI 0.88, 1.52; Z = 1.02, p = 0.31) (see Figure 3).

Figure 3. Forest plot of comparison using RCTs and CCTs: 1 Addition of specialist nursing post to staffing versus standard staffing, outcome: 1.3 Readmission.

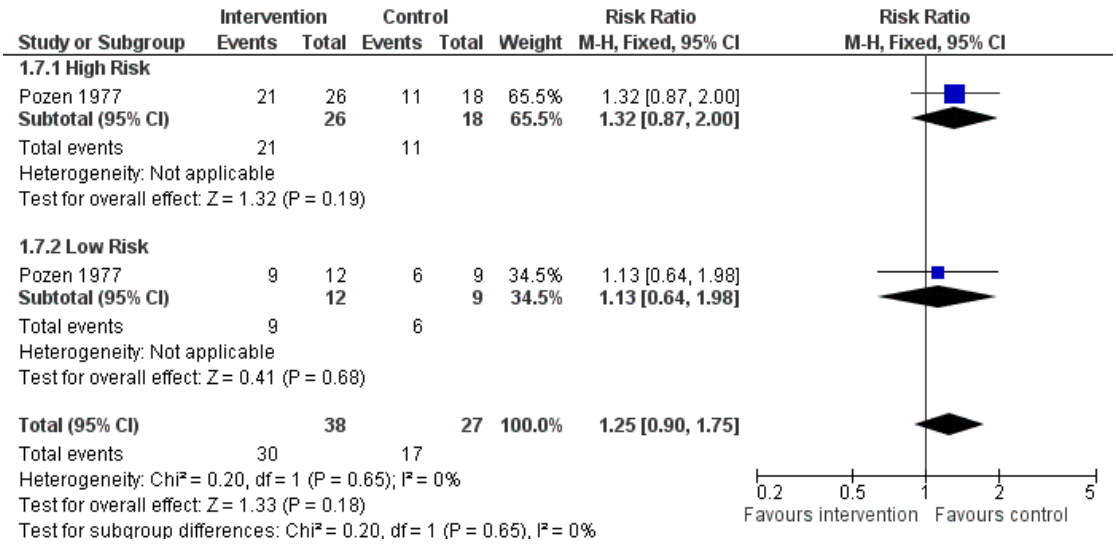


Einstadter 1996 also examined the impact of the intervention on attendance at the emergency department within 30 days of admission and found no effect. Forster 2005 examined the effect on post-discharge adverse events and found no significant effect but reported a trend towards an increased risk of emergency room visit, readmission or death post discharge (all three measures combined) for the CNS group.

In relation to adverse events or complications in hospital, Forbes 2006 examined the impact of a specialist nursing post on pressure ulcer rates and identified a statistically significant improvement in the incidence of pressure ulcers (p=0.001) (Table 3).

One study looked at the impact of a diabetes nurse specialist on blood glucose control and found no significant differences in metabolic control (Feddersen 1994). Another study examined the impact of a CCU-based nurse rehabilitator on patients' employment status at six months post myocardial infarction and reported that the intervention was effective in increasing patients' return to work (Pozen 1977). Pozen 1977 reports that the difference between the intervention and control group for high risk patients was significant (81% intervention group, 61% control group, p<.05). However, further analysis of the study data suggests there was no significant impact (RR 1.32, 95% CI 0.87 to 2.00; Z = 1.32, p = 0.19) (see Figure 4).

Figure 4. Forest plot of comparison: 1 Addition of specialist nursing post to staffing versus standard staffing, outcome: 1.9 Employment status 6 months post-discharge (of patients previously employed).



In relation to staff-related outcomes, two RCTs examined the costs associated with the introduction of specialist nursing posts versus usual nurse staffing (Dawes 2007; Ritz 2000). Ritz 2000 found no significant differences between the intervention and control groups. However, cost data was only complete for 141 of 211 participants. Dawes 2007 identified cost savings arising from the significant reduction in patient length of stay and found they offset the costs of employing the specialist nurse.

The results for this group of interventions for RCTs and CCTs are presented in the summary of findings table in Summary of findings for the main comparison.

B. Increasing the proportion of support staff versus usual nurse staffing

Patient outcomes were assessed in two studies in relation to this intervention. One study was an RCT (Duncan 2006), and one was a CBA (Neidlinger 1993). Looking at patient mortality, Duncan 2006 found the additional support of dietetic assistants led to a 6% reduction in trauma ward mortality (p = 0.048). Using Duncan 2006's data, we calculated a RR of 0.41 (95% CI 0.16 to 1.01; Z = 1.94, p = 0.05), which supports this finding. Duncan 2006 also identified significantly lower incidences of deaths in hospital (total hospital stay, including trauma ward) and at four months after discharge. We calculated a RR of 0.56 (95% CI 0.29 to1.09; Z = 1.69, p = 0.09) for deaths in hospital and a RR of 0.57 (95% CI 0.34 to 0.95; Z = 2.16, p = 0.03) for deaths at four months. Duncan 2006 also examined the impact of this intervention on length of stay and found no significant effect. A summary of findings table for Duncan's study is presented in Summary of findings 2.

In relation to staff-related outcomes, Neidlinger 1993 examined the effect of introducting nursing assistive personnel into the existing "professional pratice model" of staffing on costs and found unit personnel costs associated with patient care increased on the intervention units (reduced skill mix) 'for undetermined reasons'. The results from Neidlinger's study are presented in Table 4.

C. New rosters or shifts versus usual shifts

One study examined the effect of introducing a self-scheduling system on staff-related outcomes and reported a reduction in turnover (O'Connor 1992, Table 5).

D. Primary nursing versus usual model of nursing

Two studies (both CBAs) (see Table 6) examined the effect of introducing primary nursing on staff-related outcomes. Boumans 1999 found the intervention had no significant effect on absenteeism. Melchoir 1996 reported strong indications that the intervention reduced turnover rates.

E. Team midwifery versus standard care

One RCT was identified that examined the impact of introducing team midwifery (versus standard care) on maternity care outcomes (Biro 2000, Summary of findings 3). Team midwifery is defined by Biro 2000 as: "a new model of maternity care characterised by continuity of midwifery care from early pregnancy to the postnatal period". Continuity of midwifery care refers to care being provided by the same midwife who plans most of the care for the woman from the beginning of her care to the end of the postnatal period. The authors concluded that the intervention resulted in a reduction in medical procedures during labour and a shorter length of stay without compromising maternal or perinatal safety. Our analysis of the results for length of stay in hospital (RR -0.30, 95% CI -0.54, -0.06; Z = 2.41, p = 0.02) and length of stay in

special care nursery (SCN) (RR -2.00, 95% CI -2.07, -1.93; Z = 59.46, p < 0.00001) support Biro 2000's findings.

ADDITIONAL SUMMARY OF FINDINGS *[Explanation]*

Effect of adding dietary assistants to nurse staffing compared to usual nurse staffing on patient outcomes

Patient or population: patients with patient outcomes
Settings: hospital
Intervention: adding dietary assistants to nurse staffing
Comparison: usual nurse staffing

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Usual nurse staffing	Adding dietary assistants to nurse staffing				
Mortality - Deaths in trauma unit	Study population		RR 0.41 (0.16 to 1.01)	302 (1 study)	⊕⊕⊕◯ moderate	
	102 per 1000	42 per 1000 (16 to 103)				
	Medium risk population					
	102 per 1000	42 per 1000 (16 to 103)				
Mortality - Deaths in hospital	Study population		RR 0.56 (0.29 to 1.09)	302 (1 study)	⊕⊕⊕◯ moderate	
	146 per 1000	82 per 1000 (42 to 159)				
	Medium risk population					

	147 per 1000	**82 per 1000** (43 to 160)			
Mortality - Deaths at 4 months	**Study population**		**RR 0.57** (0.34 to 0.95)	302 (1 study)	⊕⊕⊕○ moderate
	229 per 1000	**131 per 1000** (78 to 218)			
	Medium risk population				
	229 per 1000	**131 per 1000** (78 to 218)			

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

The effect of team midwifery compared to usual midwifery staffing on maternity care outcomes

Patient or population: patients with maternity care outcomes
Settings: hospital
Intervention: team midwifery
Comparison: usual midwifery staffing

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Usual midwifery staffing	Team midwifery				
Perinatal death	Study population		RR 1.22 (0.33 to 4.5)	884 (1 study)	⊕⊕⊕⊕ high	
	9 per 1000	11 per 1000 (3 to 40)				
	Medium risk population					
	9 per 1000	11 per 1000 (3 to 40)				
Length of stay in hospital (days)		The mean Length of stay in hospital (days) in the intervention groups was **0.3 lower** (0.54 to 0.06 lower)		884 (1 study)	⊕⊕⊕⊕ high	
Length of stay in special care nursery (days)		The mean Length of stay in SCN (days) in the intervention groups was **2 lower** (2.07 to 1.93 lower)		884 (1 study)	⊕⊕⊕⊕ high	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

DISCUSSION

This review set out to identify which staffing models are associated with improved outcomes for patients in the hospital setting and which staffing models are associated with improved staff-related outcomes in the hospital setting. The scope of this review was broad and included a wide range of interventions relating to nurse staffing models. It also sought to identify relevant studies conducted across all jurisdictions and in all languages. As such, this was a very comprehensive review.

Summary of main results

We found no evidence that the addition of specialist nurses to nursing staff reduces patient death rates, attendance at the emergency department, or readmission rates, but it is likely to result in shorter patient hospital stays and reductions in pressure ulcers. Only two studies included costs in the outcomes measured and one of these studies was missing a significant amount of data.

Only two studies examined the effect of adding support staff to the nursing staff complement and therefore the evidence is weak in relation to this type of intervention. However, Duncan 2006's study demonstrated the potential of such interventions to make real improvements in patient outcomes where support staff are trained to meet the particular needs of patients; in this case, the dietary needs of patients on trauma wards.

Only a small number of studies relating to primary nursing or nurse rostering were identified and as a result the evidence is very limited. However, it does suggest that there may be some improvement in relation to nursing staff turnover.

One study of team midwifery (versus standard care) identified a reduction in medical procedures during labour, and a shorter length of stay without compromising maternal or perinatal safety.

Overall completeness and applicability of evidence

Our review failed to identify any studies of interventions relating to nurse staffing levels, education mix, or grade mix that met our inclusion criteria. This is despite the range of developments that have occurred across countries over recent decades in relation to nurse education and the introduction of mandatory staffing levels in some states in the US and Australia.

Quality of the evidence

Our review identified a large number of papers written around the topic. However, many papers were commentaries or literature reviews. Over 145 studies were identified which were relevant in terms of the nurse staffing interventions included in the research and the outcomes measured but which did not use an appropriate design to be included in this review. Most of these studies were observational studies and used secondary or administrative data. Despite the shortcomings of such designs, many of these studies are often cited as evidence that the skill mix, grade mix, or educational mix of nursing staff makes a difference to patient outcomes.

The quality of evidence in relation to the impact of hospital nurse staffing based on the final set of studies included in this review is mixed and the findings should be treated with caution. Although the use of strict inclusion criteria reduced the amount of evidence available for review, systematic reviews can be very useful in identifying areas where there is insufficient evidence and where further research is required (Egger 2001). Although this review did not include more detailed analyses (e.g. an overall meta-analysis, subgroup analysis), the findings from the included studies allow some tentative conclusions which can inform further research on this topic. Particularly, it highlights topics around which findings are limited and where priorities may lie (e.g. the impact of nurse education interventions on patient outcomes), or where knowledge is developing and can be further enhanced through research (e.g. the impact of specialist nurse roles on patient outcomes; the impact of specialist support staff on patient outcomes). It also highlights the types of outcome measures used to date in studies of nurse staffing and how different researchers have operationalised such measures in individual studies.

Potential biases in the review process

The particular limitations of this review relate to the small number of studies identified around each of the interventions which did not permit more detailed analysis. In addition, no relevant studies were identified of interventions relating to staffing levels, education mix, or grade mix. Moreover, the scope of the review did not include outcomes that were not considered to be objective measures of patient or staff-related outcomes. As such, the large volume of published studies that focus on outcomes such as nurse or patient satisfaction, quality of life, burnout, or staff stress was not included.

Agreements and disagreements with other studies or reviews

We have already identified the limitations of the systematic and literature reviews previously conducted of hospital nurse staffing. Only one of these reviews identified studies using RCTs in their review of Nurse Practitioners in the Emergency Department study (Carter 2007). Several studies used secondary or administrative data.

Although this review only included studies that used RCTs, CCTs, CBAs and ITSs, all of the existing reviews identified above also include observational and even qualitative studies. On that basis, several reviews support the association between higher staffing levels and better patient outcomes (Crossan 2005; Currie 2005; Kane 2007; Lankshear 2005) and better staff-related outcomes (Currie 2005), and between the higher proportion of RNs and better patient outcomes (Currie 2005). However, Lankshear 2005 identified one study that did not support an association between

staffing levels and patient outcomes. Lang 2004 suggests the literature offers minimal support for specific minimum nurse: patient ratios in the acute hospital setting but suggests there are other factors involved in the quality of care that should be considered in addition to nurse staffing ratios. In relation to the evidence to support these suggestions, our review failed to identify any eligible studies of staffing levels.

The impact of specialist nursing roles is also explored in other reviews. Carter 2007 looked at the impact of nurse practitioners (NPs) in the emergency department. Once again, Carter 2007's review included qualitative and observational studies in its analysis in addition to the three RCTs identified. They concluded that NPs could reduce waiting times in the emergency department and had similar or better outcomes to medical residents in relation to the accuracy of x-ray examinations, physical examinations, appropriateness of urgent referrals and patient satisfaction. De Broe 2001's rapid and systematic review failed to find support, other than that based on expert opinion and anecdotal evidence, for the benefits of specialist nurses for patients with multiple sclerosis, diabetes and epilepsy. Our review identified eight eligible studies of the impact of specialist nurse roles on patient outcomes and suggests such interventions can reduce length of stay for patients but found no evidence of an impact on patient mortality or readmission rates. There is some evidence also to suggest that there may be an impact on the incidence of pressure ulcers.

In relation to replacing the proportion of registered nurses with licensed practical nurses, licensed vocational nurses, or nursing assistants, some authors (Crossan 2005; Currie 2005) suggest there is no or little evidence to suggest that it compromises the quality of patient care. Lankshear 2005 found one study which associated higher levels of Licenced Practical Nurses/Licensed Vocational Nurses (LPN/LVNs) with higher rates of patient complications. Spilsbury 2001 suggests the evidence shows RNs do make a difference but the research fails to offer guidance in relation to the most effective skill mix to provide the "best" patient care. We only identified one eligible study relating to the impact of replacing RNs with less qualified staff support staff and could not draw conclusions. However, we did find one study which showed that the addition of trained support staff could enhance patient outcomes.

In relation to nursing shifts, Estabrooks 2009 states there is insufficient evidence to suggest that shift length affects patient or provider outcomes. Although we did identify studies of nursing shifts, none were eligible for inclusion. We only identified one such eligible study which suggested self-scheduling may reduce nursing staff turnover.

A review of non-traditional staffing models (Lookinland 2005) did not draw conclusions overall. We found two studies of primary nursing and concluded that there may be an impact on nursing staff turnover.

Kane 2007, drawing again on observational studies, identifies a significant negative correlation between the proportion of Bachelor Degree (BSN) nurses in nursing staff and the incidence of patient deaths. We found no eligible studies in relation to education mix.

However, several review authors (Crossan 2005; Currie 2005; Estabrooks 2009; McKenna 1995) highlight the limitations in the evidence base due to the small numbers of studies conducted, and an overall lack of rigour due to design issues such as sample size, methodology and measurement issues. In addition, Spilsbury 2001 identifies a tendency for researchers to measure grade mix rather than skill mix and a difficulty comparing studies around the same intervention. Our review supports this finding in relation to the quality of evidence. Further, the restriction of our review to studies only which can provide the highest level of evidence to support the impact of interventions on patient and staff-related outcomes (RCTs,CCTs, CBAs and ITSs) helps to demonstrate the lack of high quality evidence around this broad topic and the need for more robust research.

AUTHORS' CONCLUSIONS

Implications for practice

The findings suggest the addition of specialist nurses to nursing staff is likely to result in shorter patient hospital stays and reductions in pressure ulcers. Limited research suggests this intervention to be cost-effective.

The evidence in relation to the impact that replacing Registered Nurses with unqualified nursing assistants has on patient outcomes is very limited. However, it is suggested that specialist support staff, such as dietary assistants, may have an important impact on certain patient outcomes.

The evidence relating to primary nursing and nurse rostering systems is very limited. However, it is suggested that self-scheduling and primary nursing may reduce staff turnover.

Team midwifery may reduce the number of medical procedures during labour, and may result in a shorter length of stay without compromising maternal or perinatal safety.

No studies of educational interventions, grade mix interventions, or staffing levels met the criteria for inclusion in this study and therefore we are unable to draw conclusions in relation to the impact of these interventions on patient or staff-related outcomes.

Implications for research

This review highlights the limited nature of research conducted on this topic. More specifically, it highlights the large number of studies conducted in the area that are not of an appropriate design to be considered an adequate source of evidence on the impact of nurse staffing models on patient and staff-related outcomes.

The limitations of the studies included highlight the need for larger studies, preferably using an RCT, CCT or CBA design, and for ITS studies that use several data points pre- and post-intervention, and that draw on primary data. Funders of potential studies of hospital nurse staffing should ensure that further research around hospital nurse staffing includes such designs.

While this review highlights the inadequacies of research conducted across nurse staffing interventions generally, it particularly highlights the need for research in relation to educational, grade mix and staffing level interventions.

Finally, the range of studies being conducted in different countries in isolation from each other suggests there may be particular merit in international collaboration in conducting research in this area.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Biro 2000

Methods	RCT
Participants	1,000 eligible women who booked for care at the Monasch Medical Centre (Clayton Campus), Melbourne, Australia, were recruited between March 1996 and January 1998. 502 women allocated to team midwifery and 498 allocated to standard care 888 women participated (449 intervention (team), 439 control (standard)), 112 missing participants 14 team and 18 standard care were lost to follow up, 30 team and 36 standard had a miscarriage or termination, 9 team and 5 standard were inadvertently re-recruited when they returned for a successive pregnancy after a miscarriage and were eliminated. 5% of women assigned to team care elected other care models
Interventions	Care provided for low-risk women by a team midwife at each visit except for 3 scheduled visits with obstetric staff at 12 to 16, 28 and 36 weeks' gestation. Women not yet delivered at 41 weeks also had an additional visit with obstetric staff. High risk women had an individualised care plan developed in consultation with a senior consultant. Women attending consultant visits also saw a team midwife. In most cases, intrapartum and postnatal care was also provided by a team midwife
Outcomes	Procedures in labour Mode of delivery Perineal status Admission to special care nursery Pre-term Birthweight Apgar Perinatal death Length of stay
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Allocations were computer generated" (p169)
Allocation concealment (selection bias)	Low risk	Quote: Allocations were "processed onto paper strips with the text "standard care" or "team care". The paper strips were inserted into opaque envelopes, which were then placed in a lockable box kept by medical records staff, who were not associated with the project". "Midwives involved in the assessment clinic were asked to present the team midwifery project briefly to each woman. If a woman was interested and met the inclusion cri-

Biro 2000 (*Continued*)

		teria, a member of the research team was contacted to speak with her. Once the woman had consented to recruitment, the research team member telephoned the medical records staff and asked them to select an envelope with the randomized treatment allocation" (p169)
Incomplete outcome data (attrition bias) All outcomes	Low risk	Some outcome results missing but in all cases total number for which data was available is provided. Analysis was on an intention to treat basis
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	No evidence of any other sources of bias.
Baseline assessment?	Low risk	Participants completed a questionnaire prior to randomisation
Baseline characteristics similar for intervention group and control?	Low risk	It is reported that no statistical differences were found between the groups for gestation at booking, parity, marital status, country of birth, and educational level
Blinding of outcome assessment?	Unclear risk	Baseline data collected before randomisation and clinical outcome data recorded from medical records but it is not clear if allocation was concealed from those recording outcomes from medical records
Adequately protected against contamination?	Low risk	No evidence of contamination.

Boumans 1999

Methods	CBA
Participants	Nurses working on 5 units in a 850-bed hospital in The Netherlands. 5 units were: 2 surgical units (units A and C), 2 internal medicine units (units B and D) and 1 orthopaedic unit (unit E). Units A and B made up the experimental group (group 1); units C, D and E the control group (group 2) (see Fig. 1). The units were selected on the basis of comparable size, staff structure, bed capacity and patient population. Before the implementation of Primary Nursing, all 5 units used a Functional Nursing system The sample comprised 145 nurses at t1, 131 nurses at t2 and 119 nurses at t3. A total of 59 nurses (57 females and 2 males) participated at all 3 measuring moments; 23 in group 1 and 36 in group 2. These 59 nurses were included in the analyses
Interventions	Dutch version of primary nursing introduced to 2 units (1 surgical and 1 medical) in a Dutch hospital. This comprised the following: - each unit was divided into 2 teams - in each team 2 RNs were responsible for a specific - group of about 6 patients - this patient allocation lasted 8 hours a day (1 work shift) - 5 days a week

Boumans 1999 (*Continued*)

	RNs used the nursing process as the basis for practice.
Outcomes	Absence Job satisfaction Experience of job significance Health complaints
Notes	Absence is the only outcome relevant to this review

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Incomplete outcome data (attrition bias) All outcomes	Low risk	Outcome data were reported for all three time periods
Selective reporting (reporting bias)	Low risk	Results were reported for all outcomes
Other bias	High risk	The following "Methodological flaws" were identified by authors: Quote: "... several scores in group 2 changed even before the actual intervention in this group (i.e. between t1 and t2) and/or changed in the same direction as those in group 1. There are several possible explanations for this result. First, the problem of contamination must be considered. Group 1 may have served as a model for group 2 between t1 and t2. As a result, it is quite possible that the nursing units of group 2 had already started to introduce some elements of Primary Nursing in the period between t1and t2. A second explanation might be that changes were not so much caused by the intervention itself, but rather by external variables such as changes in general hospital policy. A final explanation might be found in the already mentioned 'Hawthorne effect' which entails 'the effect on the dependent variable caused by subjects' awareness that they are 'special' participants under study' (20). Furthermore, it is possible that the non-response led to biased results such that the 'responders' differed significantly from the 'non-responders' on certain characteristics (for example, motivation for the study)" (p120) Comment: Also, absence data were obtained by self-reporting rather than recorded absence. There is a risk relating to self-reporting as an objective source of data
Baseline assessment?	Low risk	Quote: "There were no differences between groups 1 and 2 in sex, age, employment rate, and number of years in service as a nurse, in either the hospital or the unit" (p119)
Baseline characteristics similar for intervention group and control?	Low risk	3 similar units using the traditional "functional nursing system" were selected on the basis of comparable size, staff structure, bed capacity and patient population. As reported above, there

Boumans 1999 (*Continued*)

		were no differences between intervention and control groups in baseline characteristics
Blinding of outcome assessment?	High risk	Data were collected via self-completion questionnaire at all 3 data collection points
Adequately protected against contamination?	Unclear risk	Authors report that contamination was possible - see "*Free of other bias?*" above.

Davies 2001

Methods	RCT
Participants	300 patients admitted to the medical and surgical wards at UHW, Cardiff with type 1 or 2 diabetes (n=148 intervention group) (n=152 control group) 14 patients missing from primary outcomes, 153 from questionnaire (focusing on patient knowledge, diabetes quality of life, post-discharge events, subsequent attendances, contacts with primary and social care and time away from normal activities) sent 1 month post discharge
Interventions	Care and advice from a Diabetes Specialist Nurse (DSN) in addition to standard care. DSN care was individual structured patient education appropriate to need, practical management advice including verbal and written case-note feedback to ward-based medical and nursing staff. DSN care began on randomisation until discharge
Outcomes	Length of stay Readmission Time to readmission Quality of life Patient knowledge Patient satisfaction
Notes	Only length of stay and readmission outcomes relevant to this review

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Quote: "Sequential, unselected referrals of in-patients to the DSN service (with either Type 1 or Type 2 diabetes) were randomized prior to clinical review into two groups" (p302) Comment: No details of sequence generation provided
Allocation concealment (selection bias)	Unclear risk	Not reported, therefore it is not clear if patients/clinicians/assessors were aware of allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: Poor response to post-discharge questionnaire explained: Quote: "...129 were unable to complete the questionnaires be-

Davies 2001 (*Continued*)

		cause they were either visually impaired, non-English speaking, confused, or had reduced consciousness. A further 24 failed to return the 1-week post-discharge questionnaires, and 14 patients died (control group eight, intervention group six). The overall questionnaire response rate was therefore 47% (66 control vs. 67 intervention)" (p303)
Selective reporting (reporting bias)	High risk	Glucose control outcomes not included
Other bias	Unclear risk	There may be some bias in relation to allocation
Baseline assessment?	Low risk	Age, gender, dependency on admission, diabetes status, and specialty of admission measured in both groups
Baseline characteristics similar for intervention group and control?	Low risk	Quote: "Patient characteristics in the two study groups were generally similar, although there is evidence of a greater proportion of patients with Type 1 diabetes in the intervention group (Table 1)" (p303)
Blinding of outcome assessment?	Unclear risk	Not reported if outcome assessors were aware of group allocation
Adequately protected against contamination?	Low risk	No evidence of contamination

Dawes 2007

Methods	RCT
Participants	111 women scheduled for major abdominal or pelvic surgery for benign gynaecological disease recruited 5 women withdrew - reasons provided 106 women randomly allocated - 52 intervention group and 54 control group 96% response rate to questionnaire (50 intervention and 52 control); 102 participated
Interventions	In addition to usual care, participants met with specialist nurse who supplemented advice, developed discharge plan, planned discharge on day 3 (subject to satisfactory assessment and provided fit for discharge)
Outcomes	Health status Length of stay Readmission Information on discharge Satisfaction Costs
Notes	Only length of stay, readmission and cost outcomes relevant to this review
Risk of bias	

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote:"The study design was a randomised controlled trial with randomisation to intervention or routine care... Randomisation numbers were generated using Excel software before the start of the trial" (p264)
Allocation concealment (selection bias)	Low risk	Quote: "Allocation was by sealed envelopes, which were kept by the ward clerk and opened in numerical sequence on the day of admission by the research nurse" (p264)
Incomplete outcome data (attrition bias) All outcomes	Low risk	Results reported fully
Selective reporting (reporting bias)	Low risk	Results reported for all outcomes
Other bias	Low risk	Comment: Authors note small sample size as a limitation to the study but this appears to have been the result of a concern to prevent bias due to women expressing a preference for the intervention model as the study progressed:
Baseline assessment?	Low risk	The SF-36 health survey questionnaire was used to measure women's evaluations of their health status before surgery. Demographic data also collected using a questionnaire
Baseline characteristics similar for intervention group and control?	Low risk	Quote: "The baseline characteristics of women randomly allocated to specialist nurse care (mean age 46.8) when compared to women randomised to routine care (mean age 46.4) were very similar (Table 1). The groups were balanced for all variables. There was no significant difference in general demographic characteristics of the women" (p265)
Blinding of outcome assessment?	Low risk	An independent research nurse, who was blinded to treatment allocation, administered the questionnaires at discharge from hospital and at 6 weeks follow-up. Women in either arm of the study had no identifying marks on their case notes
Adequately protected against contamination?	Low risk	Quote: "Recruitment for the study reached 54 in the control group and 52 in the intervention and the study was stopped because of potential contamination of the control group and staff who appeared to have accepted the earlier hospital discharge" (p268) Comment: This action is likely to have prevented a potential source of bias

Duncan 2006

Methods	RCT
Participants	318 women aged over 65 admitted to a single trauma ward with hip fracture from normal place of residence (165 control, 153 intervention)
Interventions	Addition of 2 part-time Dietetic Assistants (DAs), with 14 days orientation and training to provide presence for 6 hours per day, 7 days per week DAs were asked to try to ensure that patients allocated to them received appropriate help in meeting their nutritional needs. They did this in many ways, including: • checking personal and cultural food preference; • co-ordinating appropriate meal orders with catering staff; • ordering nutritional supplements when necessary; • provision of appropriate feeding aids; • assisting with food choice, portion size and positioning at mealtimes; • sitting with, encouraging and feeding the frailest patients at mealtimes and • collecting information to aid nutritional assessment by the dietician.
Outcomes	Mortality Length of stay Patient satisfaction Complication rate Nutritional status Energy intake
Notes	Only mortality and length of stay relevant to this review

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: Stated that subjects were randomised Quote: "Subjects were randomised either to receive the conventional pattern of nurse- and dietitian-led care, normally provided on the trauma unit (which included the routine provision of oral nutritional supplements to all patients) or to receive the additional personal attention of the DAs" (p149). Comment: However, method of sequence generation not clear
Allocation concealment (selection bias)	Low risk	Quote: "Randomisation was by sequentially numbered, opaque, sealed envelope method in blocks of 10, prepared by a member of staff not directly involved in the trial. The DAs or the dietitian would approach those suitable for inclusion, and if consent or assent was obtained would open the next numbered envelope" (p150)
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: Results reported fully and supplementary data also provided Some attrition: Quote: "Four participants were moved out of the base trauma

Duncan 2006 (*Continued*)

		ward, prior to theatre, to a high-dependency unit, and since this precluded their receiving DA support were ineligible for inclusion in the study. A further seven patients were excluded as they died preoperatively, and five because they were treated conservatively" (p151). Adequately accounted for
Selective reporting (reporting bias)	Low risk	Results reported for all outcomes
Other bias	Low risk	No evidence of bias
Baseline assessment?	Low risk	Admission - SAHFE protocol, Waterlow score and Abbreviated Mental Test, medical record data on complications and satisfaction
Baseline characteristics similar for intervention group and control?	Low risk	Comment: Control group was comprised of patients receiving conventional (nursing/ nurse-led) care, and had similar relevant characteristics Quote: "Patients in the two arms of the trial were comparable in respect of age, and the presence of medical, nutritional and psychiatric factors known to be predictive of poor outcome. 56.9% of participants had an Abrreviated Mental Test (AMT) score <8, suggestive of cognitive impairment (54.2% of the DA support arm and 59.2% of the conventional care arm)" (p151)
Blinding of outcome assessment?	Low risk	Quote: "Assessments were based on the protocol of the Standardised Audit of Hip Fractures in Europe (SAHFE) and performed on admission, at discharge from the acute trauma ward and at 4-month follow-up. This allowed a member of the trial team, blind to patient allocation and independent of the dietitian and DAs, to profile subjects' progress through rehabilitation ... We approached the 4 month follow-up assessment using a postal questionnaire. If no response was received, the participant or their carer was telephoned. Date of death was confirmed with medical records or the audit department" (p149)
Adequately protected against contamination?	Low risk	No evidence of contamination

Einstadter 1996

Methods	CCT (Prospective Cohort Trial)
Participants	472 medical patients admitted to resident physicians of a particular firm at a tertiary referral centre in Ohio, over a 6 month period 243 were admitted to nurse case manager team and 229 to the control team
Interventions	A master's prepared nurse practitioner and nurse case manager (also assigned part-time to work in the medical clinic) was assigned to work with one team in the selected medical firm

Einstadter 1996 (*Continued*)

Outcomes	Appointment within 3 days One documented visit within 30 days Readmission within 30 days Attendance at the emergency department (ED) within 30 days
Notes	Only readmission within 30 days and attendance at ED within 30 days relevant to this study

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Incomplete outcome data (attrition bias) All outcomes	Low risk	Results reported fully
Selective reporting (reporting bias)	Low risk	Results provided for all outcomes
Other bias	Unclear risk	Used secondary data obtained from the computerised hospital system but reports that data were collected for all patients admitted to the medical service during the study period and data files were obtained for all subsequent outpatient medical activity up to 30 days post discharge
Baseline assessment?	Low risk	Demographics, Diagnosis Related Group (DRG) data
Baseline characteristics similar for intervention group and control?	Low risk	Comment: The other team in the firm acted as the control. They received usual care Quote:"There were no statistically significant differences between the two groups in age, gender, race, median length of stay, median DRG weight, insurance status, or admission source" (p686)
Blinding of outcome assessment?	High risk	Data collected for each patient admitted during study period from computerised hospital systems
Adequately protected against contamination?	Low risk	No evidence of contamination

Feddersen 1994

Methods	CCT
Participants	129 patients with diabetes admitted to one of 4 units (2 experimental, 2 control) at Strong Memorial Hospital, Rochester, New York

Feddersen 1994 (*Continued*)

Interventions	Employment of a Certified Diabetes Educator for 20 hours per week on the experimental units to provide in-service training for nursing staff and to co-ordinate diabetes education for all insulin-requiring patients with diabetes
Outcomes	Length of stay Glycosylated haemoglobin Patient knowledge Nurse knowledge
Notes	Only length of stay and gylcosylated haemoglobin relevant to this review

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Results are reported for length of stay for 129 patients but only reported for glycosylated haemoglobin for 88 patients. No explanation given for this
Selective reporting (reporting bias)	Unclear risk	Results not reported for complications associated with diabetes
Other bias	Low risk	Appears free of bias other than concerns raised above
Baseline assessment?	Low risk	Demographics, duration of diabetes and gylcosylated haemoglobin levels
Baseline characteristics similar for intervention group and control?	Low risk	Similar units, separated geographically to minimise contract between units Reported that there were no significant differences between intervention and control groups in relation to race, sex, duration of diabetes, or initial gylcosylated haemoglobin levels
Blinding of outcome assessment?	High risk	Lab tests to measure Glycosylated Haemoglobin, length of stay recorded in patient records
Adequately protected against contamination?	Low risk	No evidence of contamination

Forbes 2006

Methods	CBA
Participants	753 patients with MS attending 6 neurological services in 4 English regions. 616 patients (82%) completed follow-up
Interventions	Skill mix: addition of MS Specialist Nurse to usual care Appointment of a MS specialist nurse to services. Intervention not specifically described

	but refers to 4 dimensions to role described by Forbes (2003) in background section, as follows: psychological assessment and intervention, social assessment and intervention, physical assessment and intervention, co-ordination and care management, specialist MS assessment and intervention, education and support, and research and audit
Outcomes	Hospital admissions within 12 months Pressure sores Experience and severity of MS-related problems Health-related quality of life
Notes	Only hospital admissions and pressure sores relevant to this review

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Incomplete outcome data (attrition bias) All outcomes	High risk	Not all data provided on readmission within 1 month
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Unclear risk	Comment: Some concerns about differences in process measures were noted Quote: "Baseline comparisons of the process measures between the intervention and control groups revealed significant differences in some variables. A higher proportion of people in the intervention group: received information (78% (n = 193) compared to 65% (n = 171)); had a named professional coordinating their care (48% (n = 96) compared to 27% (n = 57)); had details of an MS contact person (55% (n =124) compared to 44% (n = 102)); felt able to get help in an MS emergency (66% (n = 118) compared to 52% (n =90)); and felt more involved in their care (only 18% (n =42) of the intervention group felt 'not at all' involved in their care compared to 31% (n = 71) in the control group) (p<0.001, in all cases). This difference was largely contributed by site I4 where the specialist nurse was established in the area prior to their appointment within the programme. No differences were noted in any of the outcome variables except for hospital admission (17% admitted in the intervention group and 27% in the control, X^2 = 8.2, df=1, p = 0:004). These differences did not prejudice the comparison as the analysis was focused on the group time effects which are independent of starting point, although the potential for improvement in the intervention group may have been prejudiced by the relatively higher starting point (ceiling effect)" (p991)
Baseline assessment?	Low risk	Data were collected prospectively before the appointment of the MS nurses and then at 12 and 24 months. Data were collected via a postal questionnaire

Forbes 2006 (*Continued*)

Baseline characteristics similar for intervention group and control?	Unclear risk	Comment: Significant differences were identified between the intervention and control groups in relation to age, disease duration and relapse rates. Some account was made for this in the analyses Quote: "The intervention group was younger and had less disease duration compared to the control group. Therefore these variables were also considered as covariates in the multivariate modelling. However, as age and time of onset and diagnosis were highly correlated (Pearson r40.8, po0.001), only age was used to reduce the risk of multicollinearity. Post hoc site level analysis (Tukey HSD) showed that this difference was attributable to one site (I4)" (p991) Comment: Control units described by authors and appear similar to intervention units - 2 control units, 1 with a low level of development and 1 with a moderate level. Authors note that there was a major change of personnel at one of the control units during the study. Unclear what impact this may have had on outcomes
Blinding of outcome assessment?	High risk	Data collected using a self-report questionnaire
Adequately protected against contamination?	Unclear risk	See concerns noted in "*Free from other bias?*" section above.

Forster 2005

Methods	RCT
Participants	Patients admitted to 1 of 4 general medicine teams at the Ottawa Hospital between January 21 and April 28 2002 620 randomised, 361 discharged to community, 328 completed study, 290 completed satisfaction survey Missing participants: 33 to completion, 71 to satisfaction survey
Interventions	Skill mix: addition of Clinical Nurse Specialist (CNS) to usual care In addition to usual care, patients received care from a CNS added to 1 of 4 general medicine teams. CNS's activities prioritised to: retrieving information collected by family physicians and consultants before admission; arranging in-hospital imaging, procedures and consultations; facilitating patient education; and telephoning patients early after discharge from hospital (average 3 days) to answer questions and address early problems
Outcomes	In-hospital mortality Transfer home or transfer Time to discharge or patient transfer Emergency room visit, readmission, or death Time to emergency room visit, readmission, or death Adverse events post-discharge Patient satisfaction

Notes	Only in-hospital mortality, emergency room visit, readmission, or death, and adverse events post-discharge relevant to this review

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation was stratified by team in blocks of 4 with varying random order; unit of randomisation was the patient so that physicians had patients from both study arms in their team
Allocation concealment (selection bias)	Low risk	Once baseline screening was conducted, nurse registered patients with study co-ordinator who then randomised patients to study groups using sequentially numbered opaque envelopes
Incomplete outcome data (attrition bias) All outcomes	Low risk	All outcomes data appears complete
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	No evidence of bias
Baseline assessment?	Low risk	Baseline and functional data collected on all participants prior to randomisation The clinical nurse specialist conducted baseline interviews or chart reviews for all patients admitted during the study period before assignment to study groups. Patients were unaware to which group they were randomised. Before randomisation, patients (or their caregivers) were interviewed to determine the patient's disability score. The medical record was reviewed by study physicians who were not involved in the patient's care and who were unaware of the treatment group. Chart review recorded chronic medical illnesses (the burden of which was measured with the Charlson Comorbidity Index), number of acute in-hospital diagnoses, and number of consultations
Baseline characteristics similar for intervention group and control?	Unclear risk	Comment: Description is inadequate, just that patients received "usual care", Comment: Analysis of group characteristics identified some differences: Quote: "Overall, the control group appeared slightly sicker ... It was more likely to have a higher Charlson Comorbidity Index and disability score. The control group also had a greater number of acute diagnoses and was more likely to have congestive heart failure. In contrast, clinical nurse specialist patients had a greater number of consultations during their visit. With the exception of disability score, these differences were similar to the patients discharged to the community" (p1151)

Forster 2005 (*Continued*)

Blinding of outcome assessment?	Low risk	Quote: "At least 2 physicians (who were blinded to the patient group) reviewed all post discharge symptoms to determine if the patient had experienced an adverse event" (p1150) Comment: Data on post-discharge outcomes and satisfaction were collected via telephone interview. The telephone interviewer was blinded to which group the patient had been assigned
Adequately protected against contamination?	Low risk	No evidence of contamination

Melchoir 1996

Methods	CBA
Participants	492 nurses (psychiatric nurses, practical nurses, nurses' aides) providing direct care on 1 of 35 long-stay psychiatric wards at 5 hospitals in the Netherlands randomly selected to participate High attrition reported over 3 times due to staff turnover 366 (74.3%) participated at time 1, 161 (32.7%) at time 3
Interventions	Staffing models: primary nursing The intervention was based on the general principles of primary nursing. Both psychiatric and practical nurses were assigned to patients as primary nurses based on the complexity of care needed Nurse managers or quality care co-ordinators provided the primary nurse with the feedback and support needed. They also gave advice on skills needed and promoted communication between the primary nurses and other health care providers. A special support meeting between primary nurses and other health care specialists was planned. Primary nurses followed a training programme that emphasized communication skills. The interventions were fully described in an intervention book. The process of implementing the intervention was supported by a group and was evaluated monthly
Outcomes	Staff turnover Burnout
Notes	Staff turnover only relevant outcome

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Incomplete outcome data (attrition bias) All outcomes	High risk	High attrition - turnover data incomplete at time 3
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	High risk	2 major problems described by authors - high drop out due to turnover and contamination of control units

Melchoir 1996 (*Continued*)

Baseline assessment?	Low risk	Demographics, burnout questionnaire - pre-test measurement x 2
Baseline characteristics similar for intervention group and control?	Unclear risk	Comment: 21 comparable (long-stay psychiatric) wards where intervention was not introduced Quote: "major differences in the pretest scores between the intervention group and the control group" (p697)
Blinding of outcome assessment?	High risk	
Adequately protected against contamination?	Unclear risk	Comment: Possibility of contamination described by authors. Quote:"During the study it became apparent that some parts of the intervention were introduced to some control wards through information leakage and through nursing students who switched wards. This led to the assumption that the control group could be seen as an intervention group except for the fact that it did not receive support from the support group" (p698)

Neidlinger 1993

Methods	CBA
Participants	6769 patients admitted to 1 of 4 units at a 560-bed hospital in San Francisco between January and June 1990 (pre-intervention) and January and June 1991 (post-intervention)
Interventions	Staffing model & skill mix: incorporating Nursing Assistive Personnel (NAP) into nursing professional practice model Senior nurses and managers met to agree on the role of the NAP and to agree on the educational needs of staff and other resources required for the intervention. 3 NAPs were recruited to each unit and received a 2-day didactic preparation and a 2-week orientation programme. Each NAP assigned to work with 2 to 3 registered nurses, assisting in the care of 12 to 18 patients
Outcomes	Costs Care quality Patient satisfaction Staff satisfaction
Notes	Only costs relevant to this review

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Incomplete outcome data (attrition bias) All outcomes	Low risk	Results reported fully

Neidlinger 1993 (*Continued*)

Selective reporting (reporting bias)	Low risk	Results provided for all outcomes
Other bias	Low risk	No evidence of bias
Baseline assessment?	Unclear risk	No discussion of group characteristics
Baseline characteristics similar for intervention group and control?	Unclear risk	Stated that units were selected because of perceived similarities in patient acuity and length of shift to experimental units but not described
Blinding of outcome assessment?	High risk	Data taken from hospital records and through chart audit
Adequately protected against contamination?	Low risk	No evidence of contamination

O'Connor 1992

Methods	CBA
Participants	647 nurses working on one of 21 units over study period
Interventions	Self-staffing - in order to meet patient care demands, units would use only their own nursing staff. The central staffing office did not supply additional help even if there were increased patient care demands, staff from other units could not be moved around to help. Therefore the unit took more responsibility for scheduling and staff had input into policies and procedures concerning staffing on the units
Outcomes	Turnover rate
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Incomplete outcome data (attrition bias) All outcomes	Low risk	Results reported fully
Selective reporting (reporting bias)	Low risk	Results provided for all outcomes
Other bias	Low risk	No evidence of bias
Baseline assessment?	Unclear risk	Baseline characteristics of groups not measured
Baseline characteristics similar for intervention group and control?	Unclear risk	2 control sites: 1 where intervention was not introduced and 1 where intervention was implemented before the study began
Blinding of outcome assessment?	High risk	

O'Connor 1992 (*Continued*)

Adequately protected against contamination?	Low risk	No evidence of contamination

Pozen 1977

Methods	RCT
Participants	313 patients admitted to the CCU of Baltimore City Hospitals during a 16 month period who had MI (documented by history, serial enzymes and typical ECG changes) and were willing to participate in the study and follow-up
Interventions	In addition to routine care, patients had access to a CCU-based nurse rehabilitator. Objectives were to 1) optimise patients' long-term work and rehabilitation through an aggressive programme of psychological support and education, 2) to improve patients' knowledge and compliance to medical therapy by teaching them about MI, risk factors, basic physiology, rationale for therapy, and the appropriate convalescent programme, and 3) reduce anxiety by assisting the patient in understanding and coping with MI
Outcomes	Anxiety Functional status Complications Knowledge Smoking and weight regimes Employment status at 6 months (previously employed)
Notes	Employment status only outcome relevant to this study

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	States that once classified as low or high risk 24 hours post admission; patients were randomised to study or control group. High risk patients were randomly assigned in equal proportions. Low risk patients assigned using a 2:1 ratio to study and control groups respectively, rationale or further details not reported. Also stated that rotational admission policy resulted in a similar distribution of patients among all house officers
Allocation concealment (selection bias)	Unclear risk	Not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	Results reported fully
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	No evidence of bias

Pozen 1977 (*Continued*)

Baseline assessment?	Low risk	Patient questionnaire to assess demographic and clinical characteristics, and risk
Baseline characteristics similar for intervention group and control?	Low risk	Comment: Traditional MD/RN care. Quote: "Distributions of patients' age, race, sex, income, employment, education and clinical characteristics were similar in the study and control groups for both the high risk and low risk categories" (p831)
Blinding of outcome assessment?	High risk	Data collected using a self-completion questionnaire.
Adequately protected against contamination?	Low risk	No evidence of contamination

Ritz 2000

Methods	RCT
Participants	211 women 21 years and older diagnosed with breast cancer between 1995 & 1997, able to read and write English and give informed consent. Also required physician referral, care within the system and consent within 2 weeks of diagnosis
Interventions	Standard medical care plus Advanced Practice Nurse (APN) care APN contact within 2 weeks of diagnosis, written and verbal information about breast cancer, what to expect in consultations with physicians, decision-making support, answering questions and presence for support. Subsequent contacts at scheduled clinic visits, by telephone, home visits or patient initiated visits. Contacts based on need as determined by patient, family and APNs. 1 of 2 APNs was on call 8am to 8pm Monday to Friday and 8am to 12 noon on weekends
Outcomes	Quality of life Costs
Notes	Only costs data relevant to this study

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	It is stated that women were assigned randomly to 1 of 2 groups but method is not described
Allocation concealment (selection bias)	Unclear risk	Not discussed
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Comment: Cost data complete only for 141/211 participants. States those not included in the cost analysis were missing: Quote: "substantial amounts of data on costs [lost] either because they were referred for only oncology care or because they

Ritz 2000 (*Continued*)

		moved, changed insurance, or transferred care to non system facilities" (p925)
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	No evidence of bias
Baseline assessment?	Low risk	Demographics, histology and treatment
Baseline characteristics similar for intervention group and control?	Low risk	Comment: Standard medical care Quote: "The randomization process produced intervention and control groups that were similar demographically and in characteristics of disease at diagnosis and treatment .. with two exceptions: women in the intervention group were significantly more likely to have a lower histology (p=0.04) and to receive adjuvant hormone therapy (p=0.03) than women in the control group" (p925)
Blinding of outcome assessment?	High risk	Data obtained from hospital records or through self-completion questionnaire
Adequately protected against contamination?	Low risk	No evidence of contamination.

Talley 1990

Methods	RCT
Participants	107 patients (85 non-suicidal and 22 suicidal) admitted to an adult medical, surgical, obstetrical or gynaecological unit in a large northeastern university hospital in the US and assigned a sitter for at least 1 shift on 2 consecutive days between 4th January and 31st March 1988
Interventions	Consultation with a Psychiatric Liaison Nurse Specialist (PLNS) Seen by PLNS for the duration of the sitter order. Consultation initiated as soon as possible after the second sitter day by one of the hospitals 2 PNLSs. Consultation was based on modified version of PLNS consultation (Lewis and Lewis 1982). Consultation was individualised to the particular patient situation and typically began with the reason for the sitter request, a review of the chart, and exploration of the staff nurse's view of the patient problem. Patient then assessed and interventions based on identified problems with approaches targeted to nursing staff, patients and sitters. Patients received ongoing, direct PLNS interventions based on their potential for co-operation and the nature of the problem necessitation sitters
Outcomes	Length of stay Number of sitter shifts Number of charted observations of mood, behaviour and mental status Number of patient incident reports during the time with sitters

Talley 1990 (*Continued*)

	Number of incidents of sitter refusal or walk-offs
Notes	Only length of stay relevant to this review

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	All patients with sitters who met study inclusion criteria were assigned to suicidal or non-suicidal group. Patients in each group then assigned randomly to either treatment or control group. Method to generate sequence not described
Allocation concealment (selection bias)	Unclear risk	Not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	All outcomes reported fully
Selective reporting (reporting bias)	Unclear risk	Not clear which group 3 reported episodes relate to
Other bias	Low risk	No evidence of bias
Baseline assessment?	Unclear risk	Demographics, diagnosis and history Comparisons made between suicidal and non-suicidal groups rather than intervention and control and no reference to significance of differences
Baseline characteristics similar for intervention group and control?	Low risk	Similar patients who received no intervention
Blinding of outcome assessment?	High risk	Information collected using template or taken from hospital incident reports and sitter service records
Adequately protected against contamination?	Low risk	No evidence of contamination

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Armstrong 2004	Insufficient data points pre- and post-intervention
Arts 2000	Insufficient data points pre- and post-intervention
Barkell 2002	Results confounded

(*Continued*)

Benson 2008	Insufficient data reported
Brett 1990	Insufficient data points pre- and post-intervention
Burnes Bolton 2007	Insufficient data points pre- and post-intervention
Campolo 1998	Insufficient data reported
Cavan 2001	Insufficient data points pre- and post-intervention
Chavigny 1984	Insufficient data reported
Choi 1986	Insufficient data reported
Ciske 1974	Insufficient data reported
Counsell 1999	Insufficient data reported
Danello 2008	Insufficient data reported
Davis 1997	Insufficient data reported
Donaldson 2005	Insufficient data points pre- and post-intervention
Eck 1999	Insufficient data points pre- and post-intervention
Eriksen 1992	Insufficient data reported
Gardner 1991	Insufficient data points pre- and post-intervention
Grillo-Peck 1995	Insufficient data points pre- and post-intervention
Hanneman 1993	Did not meet the EPOC minimum requirement for CBA studies of 2 intervention groups and 2 control groups
Heinemann 1996	Insufficient data reported
Hinshaw 1981	Insufficient data points pre- and post-intervention
Jansen 1994	Insufficient data points pre- and post-intervention
Kenney 2001	Insufficient data reported
Lea 2003	Insufficient data points pre- and post-intervention
Lee 2005	Insufficient data points pre- and post-intervention

(*Continued*)

Lengacher 1994	Did not meet the EPOC minimum requirement for CBA studies of 2 intervention groups and 2 control groups
Lewis 1994	Insufficient data points pre- and post-intervention
McPhail 1990	Insufficient data reported
O'Hare 2006	Insufficient data points pre- and post-intervention
Pratt 1993	Insufficient data points pre- and post-intervention
Rideout 2007	Insufficient data points pre- and post-intervention
Ringerman 2000	Insufficient data reported
Sarkissan 1999	Insufficient data points pre- and post-intervention
Sheill 1993	Insufficient data points pre- and post-intervention
Sinclair 2006	Data not obtained objectively
Smith 2006	Insufficient data points pre- and post-intervention
Strayer 2008	Insufficient data points pre- and post-intervention
Sullivan 2002	Insufficient data reported
Tourangeau 1999	Did not meet the EPOC minimum requirement for CBA studies of 2 intervention groups and 2 control groups
Vaska 1993	Insufficient data points pre- and post-intervention
Williams 2000	Insufficient data points pre- and post-intervention
Yong 2002	Insufficient data points pre- and post-intervention
Zidek 2003	Insufficient data points pre- and post-intervention

Characteristics of ongoing studies *[ordered by study ID]*

Valentine 2008

Trial name or title	Achieving effective staffing through a shared decision-making approach to open shift management
Methods	ITS
Participants	Hospital nurses at three magnet-designated acute care hospitals in Pennsylvania
Interventions	Staffing models - open-shift management
Outcomes	Costs Nurse turnover Vacancy rates
Starting date	Not stated
Contact information	Dr. Valentine, Main Line Health, Ist Floor Gerhard Building, 130 Bryn Mawr, PA 19010, valentinen@mlhs.org
Notes	Descriptive report, reports plans to roll program out further

DATA AND ANALYSES

Comparison 1. Addition of specialist nursing post to staffing versus standard staffing

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 In-hospital mortality	1	612	Risk Ratio (M-H, Fixed, 95% CI)	0.96 [0.59, 1.56]
2 Length of stay	2	235	Mean Difference (IV, Fixed, 95% CI)	-1.35 [-1.92, -0.78]
3 Readmission	3	878	Risk Ratio (M-H, Fixed, 95% CI)	1.15 [0.88, 1.52]
4 Attendance at ED within 30 days	1	472	Risk Ratio (M-H, Fixed, 95% CI)	1.14 [0.79, 1.62]
5 Post-discharge admission, ED visit or death	1	328	Risk Ratio (M-H, Fixed, 95% CI)	1.33 [0.93, 1.91]
6 Post-discharge adverse events	1	328	Risk Ratio (M-H, Fixed, 95% CI)	1.03 [0.70, 1.53]
7 Employment status 6 months post-discharge (of patients previously employed)	1	65	Risk Ratio (M-H, Fixed, 95% CI)	1.25 [0.90, 1.75]
7.1 High Risk	1	44	Risk Ratio (M-H, Fixed, 95% CI)	1.32 [0.87, 2.00]
7.2 Low Risk	1	21	Risk Ratio (M-H, Fixed, 95% CI)	1.13 [0.64, 1.98]
8 Glycosylated haemoglobin	1	88	Mean Difference (IV, Fixed, 95% CI)	-0.5 [-1.90, 0.90]

Comparison 2. Increasing the proportion of support staff versus usual staffing

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Deaths in trauma unit	1	302	Risk Ratio (M-H, Fixed, 95% CI)	0.41 [0.16, 1.01]
2 Deaths in hospital	1	302	Risk Ratio (M-H, Fixed, 95% CI)	0.56 [0.29, 1.09]
3 Deaths at 4 months	1	302	Risk Ratio (M-H, Fixed, 95% CI)	0.57 [0.34, 0.95]

Comparison 3. Team midwifery versus standard care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Perinatal death	1	884	Risk Ratio (M-H, Fixed, 95% CI)	1.22 [0.33, 4.50]
2 Length of stay in hospital (days)	1	884	Mean Difference (IV, Fixed, 95% CI)	-0.30 [-0.54, -0.06]
3 Length of stay in SCN (days)	1	884	Mean Difference (IV, Fixed, 95% CI)	-2.00 [-2.07, -1.93]

Analysis 1.1. Comparison 1 Addition of specialist nursing post to staffing versus standard staffing, Outcome 1 In-hospital mortality.

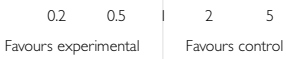
Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 1 Addition of specialist nursing post to staffing versus standard staffing

Outcome: 1 In-hospital mortality

Study or subgroup	Intervention n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Forster 2005	28/302	30/310		100.0 %	0.96 [0.59, 1.56]
Total (95% CI)	**302**	**310**		**100.0 %**	**0.96 [0.59, 1.56]**

Total events: 28 (Intervention), 30 (Control)
Heterogeneity: not applicable
Test for overall effect: Z = 0.17 (P = 0.86)
Test for subgroup differences: Not applicable



Analysis 1.2. Comparison 1 Addition of specialist nursing post to staffing versus standard staffing, Outcome 2 Length of stay.

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 1 Addition of specialist nursing post to staffing versus standard staffing

Outcome: 2 Length of stay

Study or subgroup	Intervention N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Dawes 2007	52	4.71 (1.64)	54	6.06 (1.41)		96.4 %	-1.35 [-1.93, -0.77]
Feddersen 1994	67	10.1 (9.1)	62	11.4 (8.5)		3.6 %	-1.30 [-4.34, 1.74]
Total (95% CI)	**119**		**116**			**100.0 %**	**-1.35 [-1.92, -0.78]**

Heterogeneity: Chi² = 0.00, df = 1 (P = 0.97); I² =0.0%
Test for overall effect: Z = 4.61 (P < 0.00001)
Test for subgroup differences: Not applicable

Analysis 1.3. Comparison 1 Addition of specialist nursing post to staffing versus standard staffing, Outcome 3 Readmission.

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 1 Addition of specialist nursing post to staffing versus standard staffing

Outcome: 3 Readmission

Study or subgroup	Intervention n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Davies 2001	37/152	38/148		50.4 %	0.95 [0.64, 1.40]
Dawes 2007	5/52	4/54		5.1 %	1.30 [0.37, 4.57]
Einstadter 1996	48/243	33/229		44.5 %	1.37 [0.91, 2.05]
Total (95% CI)	**447**	**431**		**100.0 %**	**1.15 [0.88, 1.52]**

Total events: 90 (Intervention), 75 (Control)

Heterogeneity: Chi^2 = 1.69, df = 2 (P = 0.43); I^2 =0.0%

Test for overall effect: Z = 1.02 (P = 0.31)

Test for subgroup differences: Not applicable

Analysis 1.4. Comparison 1 Addition of specialist nursing post to staffing versus standard staffing, Outcome 4 Attendance at ED within 30 days.

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 1 Addition of specialist nursing post to staffing versus standard staffing

Outcome: 4 Attendance at ED within 30 days

Study or subgroup	Intervention n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Einstadter 1996	53/243	44/229		100.0 %	1.14 [0.79, 1.62]
Total (95% CI)	**243**	**229**		**100.0 %**	**1.14 [0.79, 1.62]**

Total events: 53 (Intervention), 44 (Control)

Heterogeneity: not applicable

Test for overall effect: Z = 0.70 (P = 0.49)

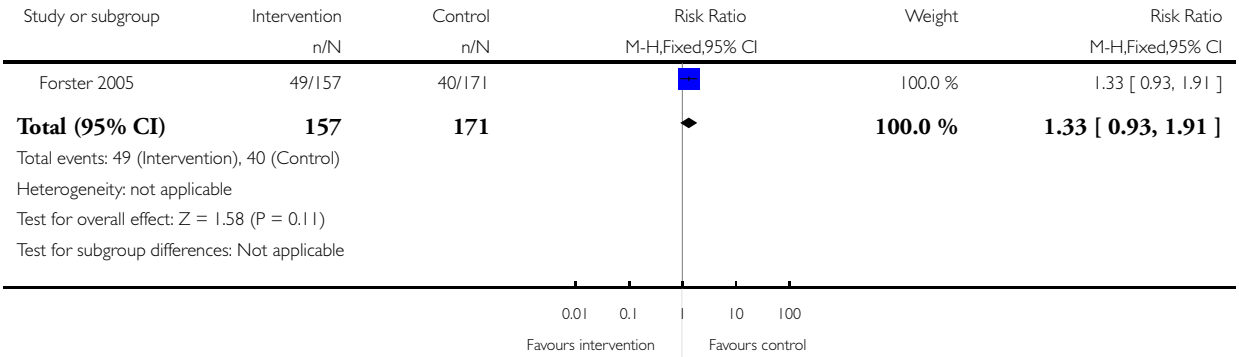
Test for subgroup differences: Not applicable

Analysis 1.5. Comparison 1 Addition of specialist nursing post to staffing versus standard staffing, Outcome 5 Post-discharge admission, ED visit or death.

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 1 Addition of specialist nursing post to staffing versus standard staffing

Outcome: 5 Post-discharge admission, ED visit or death



Analysis 1.6. Comparison 1 Addition of specialist nursing post to staffing versus standard staffing, Outcome 6 Post-discharge adverse events.

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 1 Addition of specialist nursing post to staffing versus standard staffing

Outcome: 6 Post-discharge adverse events

Study or subgroup	Intervention n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Forster 2005	37/157	39/171		100.0 %	1.03 [0.70, 1.53]
Total (95% CI)	**157**	**171**		**100.0 %**	**1.03 [0.70, 1.53]**
Total events: 37 (Intervention), 39 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.16 (P = 0.87)					
Test for subgroup differences: Not applicable					

Analysis 1.7. Comparison 1 Addition of specialist nursing post to staffing versus standard staffing, Outcome 7 Employment status 6 months post-discharge (of patients previously employed).

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 1 Addition of specialist nursing post to staffing versus standard staffing

Outcome: 7 Employment status 6 months post-discharge (of patients previously employed)

Study or subgroup	Intervention n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 High Risk					
Pozen 1977	21/26	11/18		65.5 %	1.32 [0.87, 2.00]
Subtotal (95% CI)	**26**	**18**		**65.5 %**	**1.32 [0.87, 2.00]**
Total events: 21 (Intervention), 11 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.32 (P = 0.19)					
2 Low Risk					
Pozen 1977	9/12	6/9		34.5 %	1.13 [0.64, 1.98]
Subtotal (95% CI)	**12**	**9**		**34.5 %**	**1.13 [0.64, 1.98]**
Total events: 9 (Intervention), 6 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.41 (P = 0.68)					
Total (95% CI)	**38**	**27**		**100.0 %**	**1.25 [0.90, 1.75]**
Total events: 30 (Intervention), 17 (Control)					
Heterogeneity: Chi^2 = 0.20, df = 1 (P = 0.65); I^2 =0.0%					
Test for overall effect: Z = 1.33 (P = 0.18)					
Test for subgroup differences: Chi^2 = 0.20, df = 1 (P = 0.65), I^2 =0.0%					

Analysis 1.8. Comparison 1 Addition of specialist nursing post to staffing versus standard staffing, Outcome 8 Glycosylated haemoglobin.

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 1 Addition of specialist nursing post to staffing versus standard staffing

Outcome: 8 Glycosylated haemoglobin

Study or subgroup	Intervention N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Feddersen 1994	44	10.8 (3.4)	44	11.3 (3.3)		100.0 %	-0.50 [-1.90, 0.90]
Total (95% CI)	**44**		**44**			**100.0 %**	**-0.50 [-1.90, 0.90]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.70 (P = 0.48)

Test for subgroup differences: Not applicable

Analysis 2.1. Comparison 2 Increasing the proportion of support staff versus usual staffing, Outcome 1 Deaths in trauma unit.

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 2 Increasing the proportion of support staff versus usual staffing

Outcome: 1 Deaths in trauma unit

Study or subgroup	Intervention n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Duncan 2006	6/145	16/157		100.0 %	0.41 [0.16, 1.01]
Total (95% CI)	**145**	**157**		**100.0 %**	**0.41 [0.16, 1.01]**

Total events: 6 (Intervention), 16 (Control)

Heterogeneity: not applicable

Test for overall effect: Z = 1.94 (P = 0.052)

Test for subgroup differences: Not applicable

Analysis 2.2. Comparison 2 Increasing the proportion of support staff versus usual staffing, Outcome 2 Deaths in hospital.

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 2 Increasing the proportion of support staff versus usual staffing

Outcome: 2 Deaths in hospital

Study or subgroup	Intervention n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Duncan 2006	12/145	23/157		100.0 %	0.56 [0.29, 1.09]
Total (95% CI)	**145**	**157**		**100.0 %**	**0.56 [0.29, 1.09]**

Total events: 12 (Intervention), 23 (Control)
Heterogeneity: not applicable
Test for overall effect: Z = 1.69 (P = 0.090)
Test for subgroup differences: Not applicable

Analysis 2.3. Comparison 2 Increasing the proportion of support staff versus usual staffing, Outcome 3 Deaths at 4 months.

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 2 Increasing the proportion of support staff versus usual staffing

Outcome: 3 Deaths at 4 months

Study or subgroup	Intervention n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Duncan 2006	19/145	36/157		100.0 %	0.57 [0.34, 0.95]
Total (95% CI)	**145**	**157**		**100.0 %**	**0.57 [0.34, 0.95]**

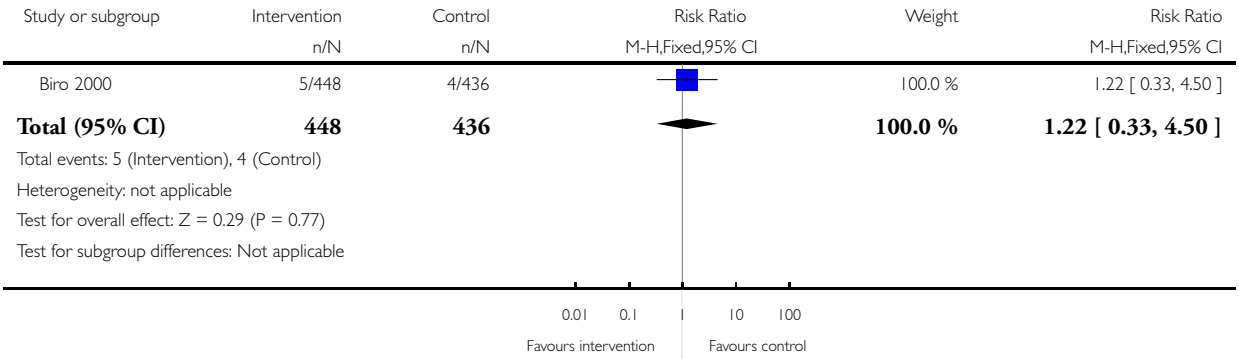
Total events: 19 (Intervention), 36 (Control)
Heterogeneity: not applicable
Test for overall effect: Z = 2.16 (P = 0.031)
Test for subgroup differences: Not applicable

Analysis 3.1. Comparison 3 Team midwifery versus standard care, Outcome 1 Perinatal death.

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 3 Team midwifery versus standard care

Outcome: 1 Perinatal death

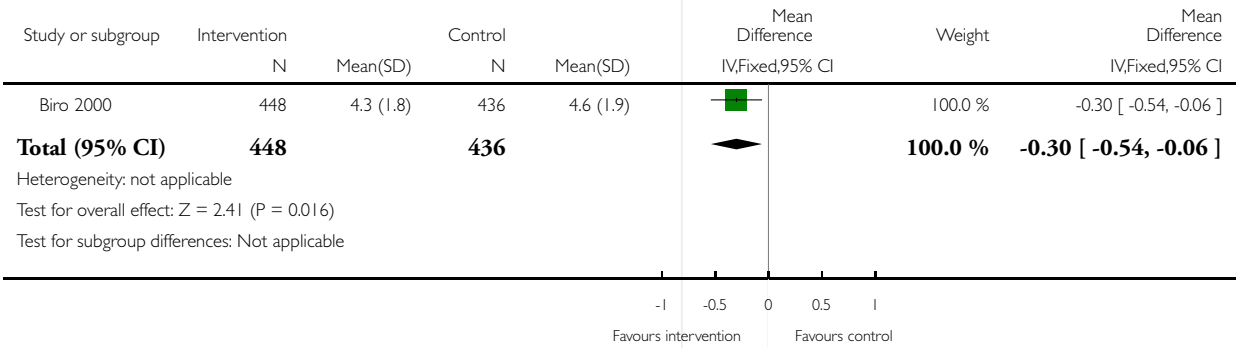


Analysis 3.2. Comparison 3 Team midwifery versus standard care, Outcome 2 Length of stay in hospital (days).

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 3 Team midwifery versus standard care

Outcome: 2 Length of stay in hospital (days)



Analysis 3.3. Comparison 3 Team midwifery versus standard care, Outcome 3 Length of stay in SCN (days).

Review: Hospital nurse staffing models and patient and staff-related outcomes

Comparison: 3 Team midwifery versus standard care

Outcome: 3 Length of stay in SCN (days)

Study or subgroup	Intervention N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Biro 2000	448	6.8 (0.5)	436	8.8 (0.5)		100.0 %	-2.00 [-2.07, -1.93]
Total (95% CI)	**448**		**436**			**100.0 %**	**-2.00 [-2.07, -1.93]**

Heterogeneity: not applicable

Test for overall effect: Z = 59.46 (P < 0.00001)

Test for subgroup differences: Not applicable

ADDITIONAL TABLES

Table 1. Sources of studies

Source		Initial results/ hits	Potentially relevant studies	Studies identified for inclusion	Studies included following further examination
Database search to November 2007 using search strategy	CINAHL	1,525			
	MEDLINE	1,489			
	EMBASE	819			
	CENTRAL	186			
	DARE	34	486	95	
	CAB Health	9			
	Joanna Briggs	0			
	Virginia Henderson	0			
	EPOC register	6			

Table 1. Sources of studies (*Continued*)

Supplementary search of all databases using search strategy (July 2007- April 2009)		1,461	91	7	15
Reference list search		312	193	16	
Grey literature using search engines	OpenSIGLE	48			
	Medscape	116			
	CRD (DARE & NHS EED)	31			
	Biomed Central	43	18	0	
	CRISP	1			
	Google Scholar	122			
TOTAL		**6,202**	**788**	**118**	**15**

Table 2. Outcomes reported across studies

Study	Mortality	Length of stay	Readmission rates	Pressure ulcers	Other clinical	Costs	Staff absence	Staff turnover
Adding a specialist nurse position(s) to staffing								
Forster 2005	x	x			x			
Dawes 2006		x	x					
Davies 2001		x	x					
Forbes 2006			x	x	x			
Einstadter 1996		x	x					
Feddersen 1994		x			x			
Pozen 1977					x			
Ritz 2000						x		
Talley 1990		x						

Table 2. Outcomes reported across studies (*Continued*)

Diluting the skill mix with UAPs or other support staff								
Duncan 2005	x	x						
Neidlinger 1993						x		
Primary nursing versus usual staffing								
Boumans 1999							x	
Melchoir 1996								x
Self-scheduling versus usual scheduling								
O'Connor 1992								x

Notes: This table does not include the outcomes measured in Biro's (2000) study of team midwifery

Table 3. Results from Forbes 2006

Forbes 2006	**MS Specialist Nurse**			
Pressure sores (%)	**Post-Time 1**		**Post-Time 2**	
	Study	**Control**	**Study**	**Control**
Pre	23	17	23	17
Post	6	12	6	14
Change	-17	-5	-17	-3
Pretest mean	23 vs 17		23 vs 17	
Posttest mean	6 vs 12		6 vs 14	
Absolute change (post):	-6		-8	
Relative percentage change (post):	-50.00		-57.14	

Table 3. Results from Forbes 2006 (*Continued*)

Absolute change from baseline:	-17 vs -5		-17 vs -3	
Difference in absolute change from base	-12		-14	

Table 4. Outcomes for addition of nursing assistive personnel to usual nurse staffing

Neidlinger 1993	**Addition of nursing assistive personnel**	
Personnel Costs (Mean Dollars PPD)		
	Study	**Control**
Pre	185	205
Post	212	220
Change	27	15
Prettest mean:	185 vs 205	
Posttest mean:	212 vs 220	
Absolute change (post):	-8	
Relative percentage change (post):	-3.64	
Absolute change from baseline:	27 vs 15	
Difference in absolute change from baseline:	12	
Registry (Bank) Costs (Mean Dollars PPD)		
	Study	**Control**
Pre	33.21	24.15
Post	8.83	9.32
Change	-24.38	-14.83
Pretest mean:	33.21 vs 24.15	

Table 4. Outcomes for addition of nursing assistive personnel to usual nurse staffing (*Continued*)

Posttest mean:	8.83 vs 9.32	
Absolute change (post):	-0.49	
Relative percentage change (post):	-5.26	
Absolute change from baseline:	-24.38 vs -14.83	
Difference in absolute change from baseline:	-9.55	

Table 5. Outcomes for self-staffing versus usual staffing models

O'Connor 1992	**Self-staffing**			
	Group A vs Control (D)			
Turnover (%)	**Post 1**		**Post 2**	
	Study	**Control**	**Study**	**Control**
Pre	10	28	10	28
Post	11	7	10	29
Change	1	-21	0	1
Pretest mean:	10 vs 28		10 vs 28	
Posttest mean:	11 vs 7		10 vs 29	
Absolute change (post):	4		-19	
Relative percentage change (post):	57.14		-65.52	
Absolute change from baseline:	1 vs -21		0 vs 1	
Difference in absolute change from baseline:	22		-1	
	Group B vs Control (D)			
Turnover (%)	**Post 1**			

Table 5. Outcomes for self-staffing versus usual staffing models (*Continued*)

	Study	**Control**		
Pre	32	28		
Post	10	7		
Change	-22	-21		
Pretest mean:	32 vs 28			
Posttest mean:	10 vs 7			
Absolute change (post):	3			
Relative percentage change (post):	42.86			
Absolute change from baseline:	-21			
Difference in absolute change from baseline:	-1			
Turnover (%)	**Group A vs Control (C Pre-tests)**			
	Post 1			
	Study	**Control**		
Pre	10	26		
Post	11	24		
Change	1	-2		
Pretest mean:	10 vs 26			
Posttest mean:	11 vs 24			
Absolute change (post):	-13			
Relative percentage change (post):	-54.17			
Absolute change from baseline:	1 vs -2			

Table 5. Outcomes for self-staffing versus usual staffing models (*Continued*)

Difference in absolute change from baseline:	3			
Turnover (%)	**Group B vs Control (c Pre-tests)**			
	Post 1			
	Study	**Control**		
Pre	10	24		
Post	11	24		
Change:	1	0		
Pretest mean:	10 vs 26			
Posttest mean:	11 vs 7			
Absolute change (post):	-13			
Relative percentage change (post):	-54.17			
Absolute change from baseline:	1 vs -21			
Difference in absolute change from baseline:	1			

Table 6. Outcomes for primary nursing versus usual nursing model

Boumans 1999	**Primary Nursing**			
Absence frequency (mean)	**Post - Time 1**		**Post - Time 2**	
	Study	**Control**	**Study**	**Control**
Pre	0.69	0.96	0.69	0.96
Post	0.53	0.91	0.55	0.82
Change	-0.16	-0.05	-0.14	-0.14

Table 6. Outcomes for primary nursing versus usual nursing model (*Continued*)

Pretest mean:	0.69 vs 0.96		0.69 vs 0.96	
Posttest mean:	0.53 vs 0.91		0.55 vs 0.82	
Absolute change (post):	-0.38		-0.27	
Relative percentage change (post):	-41.76		-32.93	
Absolute change from baseline:	-0.16 vs -0.05		-0.14 vs -0.14	
Difference in absolute change from baseline:	-0.11		0	
Absence duration (mean days)	**Post - Time 1**		**Post - Time 2**	
	Study	**Control**	**Study**	**Control**
Pre	2.33	10.39	2.33	10.39
Post	1.68	8.81	2.51	4.8
Change	-0.65	-1.58	0.18	-5.59
Pretest mean:	2.33 vs 10.39		2.33 vs 10.39	
Posttest mean:	1.68 vs 8.81		2.51 vs 4.8	
Absolute change (post):	-7.13		-2.29	
Relative percentage change (post):	-80.93		-47.71	
Absolute change from baseline:	-0.65 vs -1.58		0.18 vs -5.59	
Difference in absolute change from baseline:	0.93		5.77	
Mechoir 1996	**Primary Nursing**			
Job Turnover (%)	**Study**	**Control**		
Pre*	-	-		

Table 6. Outcomes for primary nursing versus usual nursing model (*Continued*)

Post	17.1	26.7		
Change	-	-		
Pretest mean:	-			
Posttest mean:	-			
Absolute change (post):	17.1 vs 26.7			
Relative percentage change (post):	-35.96			
Absolute change from baseline:	-			
Difference in absolute change from baseline:	-			

*Turnover values before intervention (pretest) not reported

APPENDICES

Appendix 1. Search strategies

Appendix One: Search strategies used for MEDLINE, CINAHL, EMBASE and CAB Health

Search Strategy: Ovid MEDLINE(R)

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1 Nursing Staff, Hospital/ [ML] (15987)
2 nursing staff/ [ML] (10241)
3 exp Nurses/ [ML] (29769)
4 RN.ti,ab. (2528)
5 (nurse or nurses or nursing).ti,ab,hw. (209751)
6 exp nursing/ or exp specialties, nursing/ (88489)
7 or/1-6 (213142)
8 exp hospital units/ or exp hospitals/ [ML] (101503)
9 (hospital? or ICU or "intensive care" or ward?).ti,ab,hw. (445712)
10 ("delivery room?" or "burn unit?" or "recovery room?" or "operating room?" or "operating theat$").ti,ab,hw. (15846)
11 (care adj (unit? or department?)).ti,ab,hw. (52638)
12 (inpatient? or hospitali$).ti,ab,hw. (114794)
13 or/8-12 (516555)
14 "Personnel Staffing and Scheduling"/ [ML] (8065)
15 (scheduling or roster$).ti,ab,hw. (10938)

16 staffing.ti,ab. (4638)
17 manpower.fs,ti,hw. (23136)
18 ((day$ or night$ or work$ or job? or rotat$ or team$ or interval? or "long-hour?" or alternat$ or enhanc$ or shared or group? or overtime) adj shift?).ti,ab. (1700)
19 (skill? adj2 mix$).ti,ab. (369)
20 or/14-19 (35979)
21 7 and 13 and 20 (5238)
22 randomized controlled trial/ or controlled clinical trial/ [ML EM] (108984)
23 clinical trial/ [ML] (165107)
24 (randomized controlled trial or controlled clinical trial or clinical trial).pt. [ML] (342395)
25 evaluation studies/ or multicenter study/ [ML] (142175)
26 (evaluation studies or multicenter study).pt. [ML] (258552)
27 intervention studies/ [ML] (3387)
28 (guideline or practice guideline).pt. [ML] (16008)
29 validation studies/ or validation studies.pt. [ML] (49352)
30 cross-over studies/ [ML] (23142)
31 pilot projects/ [ML] (44832)
32 comparative study.pt. [ML] (576629)
33 evidence-based practice/ or exp evidence-based medicine/ [ML] (46258)
34 or/22-33 (1108458)
35 random$.ti,ab,hw. (445428)
36 (controlled or (control$ adj2 (group? or study or studies or trial?))).ti,ab. (362466)
37 (evaluat$ adj (study or studies)).ti,ab. (2577)
38 intervention?.ti,ab. (278181)
39 guideline?.ti,ab. (106626)
40 (protocol? adj2 (practice? or adherence or adhere?)).ti,ab. (599)
41 (piloting or (pilot adj (study or project? or studies or program?))).ti,ab. (31949)
42 evidence-base?.ti,ab. (42790)
43 or/35-42 (992728)
44 randomized controlled trials as topic/ or controlled clinical trials as topic/ or clinical trials as topic/ [ML] (57864)
45 evaluation studies as topic/ or multicenter studies as topic/ [ML] (7303)
46 guidelines as topic/ [ML] (8009)
47 validation studies as topic/ [ML] (338)
48 or/44-47 (70530)
49 control groups/ or double-blind method/ or patient selection/ or random allocation/ [ML] (111420)
50 chi-square distribution/ or monte carlo method/ [ML] (41740)
51 or/49-50 (151928)
52 ("pre test$" or pretest$ or posttest$ or "post test$").ti,ab. (10577)
53 ((single$ or double$ or triple$ or treble$) adj (blind$ or mask$)).ti,ab. (61578)
54 ("chi square$" or "monte carlo$" or "latin square").ti,ab. (35566)
55 ((control$ adj2 (before or after or group$ or trial$ or study or studies or design$ or method$ or clinical)) or controlled).ti,ab. (394129)
56 ("quasi-experiment$" or quasiexperiment$ or "quasi random$" or quasirandom$ or "quasi control$" or quasicontrol$ or (quasi$ adj3 (method$ or study or studies or trial or design$))).ti,ab. (5950)
57 ("time series" adj2 interrupt$).ti,ab,hw. (573)
58 or/52-57 (459720)
59 (outcome$ or policy or policies or quality).ti,ab,hw. (1173913)
60 cost$.ti,ab,hw. or economics.fs. (294449)
61 "organization & administration".fs. [ML] (214924)
62 implement$.ti,ab,hw. (133294)
63 or/59-62 (1562076)
64 21 and 63 (3980)
65 limit 64 to ed="20070701 - 20090430" (1039)

66 limit 65 to humans (992)
67 18 or 15 or 14 (12361)
68 (Staff$ adj2 (model? or plan$ or structure? or improv$)).ti,ab. (1433)
69 67 or 68 (13597)
70 6 or 4 or 1 or 3 or 2 (122608)
71 (nursing adj2 (care or staff? or employee? or aide? or registered or practical or clinical)).ti,ab. (15818)
72 70 or 71 (130406)
73 69 and 72 (4846)
74 limit 73 to ed="20070701 - 20090430" (1151)
75 limit 74 to humans (1113)
76 69 and 13 (5904)
77 limit 76 to humans (5199)
78 limit 77 to ed="20070701 - 20090430" (1433)
79 or/66,75,78 (2227)
80 from 79 keep 1-2227 (2227)

Database: CINAHL - Cumulative Index to Nursing & Allied Health Literature
Search Strategy:

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1 Nursing Outcomes/ (1641)
2 exp "Outcomes (Health Care)"/ (57535)
3 Sentinel Event/ (241)
4 ((sentinel or adverse) adj event?).tw. (4008)
5 ((patient or healthcare or nurs$) adj outcome?).tw. (4001)
6 or/1-5 (63091)
7 Sick leave/ (852)
8 ((sick or medical or illness or stress) adj (leave? or day?)).tw. (713)
9 exp Job satisfaction/ (12451)
10 ((employment or work$ or job or professional?) adj (satisfaction or stress$ or burnout or turnover?)).tw. (3156)
11 Personnel turnover/ (1184)
12 ((employee? or staff or personnel) adj turnover?).tw. (232)
13 or/7-12 (15098)
14 6 and 13 (495)
15 Nurse-Patient Ratio/ (904)
16 Nursing Staff, Hospital/ (7286)
17 exp Nurses by Educational Level/ (739)
18 exp Skill Mix/ (1154)
19 ((skill? or grade or qualification?) adj mix).tw. (437)
20 or/15-19 (9948)
21 6 and 20 (555)
22 13 and 20 (1271)
23 Shiftwork/ (589)
24 Shift Workers/ (705)
25 (shift? adj (evening? or night? or split or work$)).tw. (307)
26 exp "Personnel Staffing and Scheduling"/ (11168)
27 exp Nursing Manpower/ (95672)
28 registries, personnel/ (637)
29 ((personnel or nurs$ or staff$ or employment) adj (register? or registries)).tw. (47)
30 or/23-29 (102645)
31 6 and 30 (2294)
32 13 and 30 (5548)
33 clinical trials/ (34016)
34 (controlled adj (study or trial)).tw. (8598)

35 (randomised or randomized).tw. (26549)
36 (random$ adj1 (allocat$ or assign$)).tw. (6691)
37 exp pretest-posttest design/ (10261)
38 exp quasi-experimental studies/ (3727)
39 comparative studies/ (40478)
40 time series/ (671)
41 (time adj series).tw. (559)
42 experiment$.tw. (14619)
43 intervention?.tw. (60951)
44 or/33-43 (148816)
45 (21 or 22 or 31 or 32) and 44 (923)
46 nursing home?.tw. (7592)
47 45 not 46 (881)

Search Strategy: EMBASE

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1 nursing staff/ [EM] (3021)
2 exp Nurse/ [EM] (18236)
3 exp nursing/ [EM] (15646)
4 RN.ti,ab. (1791)
5 (nurse or nurses or nursing).ti,ab,hw. (74788)
6 or/1-5 (76475)
7 hospital/ or community hospital/ or general hospital/ or geriatric hospital/ or non profit hospital/ or pediatric hospital/ or private hospital/ or public hospital/ or "hospital subdivisions and components"/ or delivery room/ or hospital department/ or operating room/ or recovery room/ or exp ward/ or exp mental hospital/ or exp teaching hospital/ [EM] (132314)
8 (hospital? or ICU or intensive care).ti,ab,hw. (518246)
9 ((care adj (unit? or department?)) or ward?).ti,ab,hw. (99201)
10 (inpatient? or hospitali$).ti,ab,hw. (149253)
11 or/7-10 (615734)
12 (scheduling or roster$).ti,ab,hw. (3618)
13 work schedule/ [EM] (2528)
14 staffing.ti,ab. (3259)
15 night work/ or working time/ [EM] (3382)
16 ((day$ or night$ or work$ or job? or rotat$ or team$ or interval? or "long-hour?" or alternat$ or enhanc$ or shared or group? or overtime) adj shift?).ti,ab. (1864)
17 (skill? adj2 mix$).ti,ab. (164)
18 or/12-17 (13443)
19 randomized controlled trial/ or controlled clinical trial/ [EM] (179176)
20 controlled study/ [EM] (2877472)
21 evaluation/ or evaluation research/ or outcome assessment/ [EM] (114426)
22 clinical study/ or major clinical study/ [EM] (1298376)
23 intervention study/ [EM] (4834)
24 practice guideline/ [EM] (104043)
25 validation study/ [EM] (6624)
26 pilot study/ [EM] (14168)
27 comparative study/ [EM] (117375)
28 or/19-27 (3803218)
29 random$.ti,ab,hw. (436937)
30 (controlled or (control$ adj2 (group? or study or studies or trial?))).ti,ab. (478382)
31 (evaluat$ adj (study or studies)).ti,ab. (2403)
32 intervention?.ti,ab. (261197)
33 guideline?.ti,ab. (95716)

34 (protocol? adj2 (practice? or adherence or adhere?)).ti,ab. (444)
35 (piloting or (pilot adj (study or project? or studies or program?))).ti,ab. (32596)
36 evidence-base?.ti,ab. (25124)
37 or/29-36 (1096535)
38 chi square test/ or monte carlo method/ or latin square design/ [EM] (13358)
39 control group/ or crossover procedure/ or experimental design/ or pretest posttest control group design/ or pretest posttest design/ or single blind procedure/ or double blind procedure/ or triple blind procedure/ [EM] (97897)
40 or/38-39 (110998)
41 ("pre test$" or pretest$ or posttest$ or "post test$").ti,ab. (9297)
42 ((single$ or double$ or triple$ or treble$) adj (blind$ or mask$)).ti,ab. (93701)
43 ("chi square$" or "monte carlo$" or "latin square").ti,ab. (26549)
44 ((control$ adj2 (before or after or group$ or trial$ or study or studies or design$ or method$ or clinical)) or controlled).ti,ab. (517612)
45 ("quasi-experiment$" or quasiexperiment$ or "quasi random$" or quasirandom$ or "quasi control$" or quasicontrol$ or (quasi$ adj3 (method$ or study or studies or trial or design$))).ti,ab. (3107)
46 ("time series" adj2 interrupt$).ti,ab,hw. (299)
47 intervention$.ti,ab,hw. (288389)
48 or/41-47 (835632)
49 (outcome$ or policy or policies or quality).ti,ab,hw. (1137375)
50 cost$.ti,ab,hw. or economics.fs. (280283)
51 implement$.ti,ab,hw. (97463)
52 or/49-51 (1379850)
53 or/28,37,40,48,52 (4924618)
54 6 and 11 and 18 and 53 (913)
55 limit 54 to em="200726 - 200917" (79)
56 limit 55 to human (63)
57 or/12-13,15-17 (10415)
58 (Staff$ adj2 (model? or plan$ or structure? or improv$)).ti,ab. (1150)
59 or/57-58 (11521)
60 or/1-4 (35785)
61 (nursing adj2 (care or staff? or employee? or aide? or registered or practical or clinical)).ti,ab. (7936)
62 or/60-61 (39606)
63 59 and 11 (2931)
64 limit 63 to em="200726 - 200917" (309)
65 limit 64 to human (230)
66 59 and 62 (958)
67 limit 66 to em="200726 - 200917" (75)
68 limit 67 to human (59)
69 (nurs$ adj2 (competence or education$)).ti,ab. and 18 (33)
70 limit 69 to human (19)
71 (nurs$ adj2 (competence or education$ or degree? or bachelor? or master? or registered)).ti,ab. (2476)
72 71 and 18 (208)
73 limit 72 to human (136)
74 limit 73 to em="200726 - 200917" (10)
75 56 or 68 or 65 (281)
76 from 75 keep 1-281 (281)

Search strategy: CAB Global Health Search Strategy

"nursing outcome?" OR "health outcome?" or "patient outcome?" OR "nursing outcome?" OR "care outcome?" OR "sentinel event? " OR "adverse event?" OR "sentinel surveillance" OR "sick leave" OR "sick day?" OR "medical leave" OR "illness leave" OR "stress leave" OR "job satisfaction" OR "job burnout" OR "job stress" OR "job turnover" OR "professional satisfaction" OR "professional burnout" OR "professional stress" OR "personnel turnover" OR "employee turnover" OR "staff turnover"

AND
shift? OR shift work* OR schedule* OR scheduling OR manpower OR staffing OR "personnel management" OR "skill mix" OR "clinical competence" or "clinical competencies" OR qualification*
AND
nurs*
AND
random* OR control* OR intervention? OR "time series" OR experiment* OR evaluat*

HISTORY

Protocol first published: Issue 1, 2008

Review first published: Issue 7, 2011

CONTRIBUTIONS OF AUTHORS

All authors have contributed to this systematic review. MB led the writing of the protocol, all other authors provided comment and feedback. For the full review: MB and EPOC librarians /UCD librarians developed the search strategy and ran the search. MB, RC, PH, AS, TS and EV screened records for eligibility. DO'M acted as local supervisor and provided valuable support and advice to the team. MB, RC, PH, AS, JD, TS and EV extracted data. MB, RC, PH, AS and JD contributed to the analysis and the interpretation of results. MB wrote up the review with feedback from all authors.

DECLARATIONS OF INTEREST

None

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External sources

- Health Research Board, Ireland.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

None with the exception of analysis limitations.

INDEX TERMS

Medical Subject Headings (MeSH)

*Models, Nursing; Clinical Trials as Topic; Midwifery [organization & administration]; Nursing Staff, Hospital [*organization & administration]; Outcome Assessment (Health Care); Personnel Staffing and Scheduling [*organization & administration]; Specialties, Nursing [organization & administration]

MeSH check words

Humans