**Economic Evaluation of Nurse Staffing and Nurse Substitution in Health Care: a Scoping Review**

**Final draft**

**Abstract**

**Objective**: To undertake a literature review of economic evaluation studies, with the focus on the link between nurse staffing, skill mix between nurses and other medical staff, and patient as well as economic outcomes

**Design**: Scoping literature review

**Data sources**: English-language manuscripts, published between 1989-2009, focussing on the relationship between costs and effects of care and the level of registered nurse staffing or nursing skill mix in the clinical team, using cost-effectiveness, cost-utility, or cost-benefit analysis. Articles selected for the review were identified through Medline, CINAHL, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects and Google Scholar database searches.

**Review methods**: After selecting 17 articles representing 16 unique studies for review, we summarized their main findings, and assessed their methodological quality using criteria derived from recommendations from the guidelines proposed by the Panel on Cost-Effectiveness in Health Care.

**Results** In general, it was found that nurses can provide cost effective care, compared to other health professionals. On the other hand, more intensive nurse staffing was associated with both better outcomes and more expensive care, and therefore cost effectiveness was not easy to assess.

**Conclusions**: Although considerable progress in economic evaluation studies has been reached in recent years, a number of methodological issues remain. In the future, it is hoped that nurse professionals more actively participate in the design and implementation of economic evaluation studies of the services they provide.

***What is already known about the topic?***

* Most existing literature reviews of studies on the nurse provided-care have focussed on the effect of nurses on patient outcomes.
* The general finding has been that greater nurse staffing as well as greater proportion of registered nurses in the health workforce is associated with better patient outcomes.
* However, such studies generally did not consider the effect of nurse staff on both patient outcomes and costs of care, and therefore say little about the cost-effectiveness of nurse-provided care.

***What this paper adds?***

* It gives a thorough review of the recent evidence on the cost-effectiveness of different modes of nurse-provided care.
* In general, nurses can provide cost effective care, compared to other health professionals.
* On the other hand, more intensive nurse staffing was associated with both better outcomes and more expensive care, and therefore cost effectiveness was not easy to assess.

**1. Introduction**

Nurses comprise the largest single group in the health care workforce in many countries, and account for a significant proportion of all health expenditure. In the late 1990s it was estimated that spending on nursing and midwifery staff contributed almost half of all spending on healthcare in the UK (Jenkins-Clarke, 1999, Richardson, 1999). In recent years, there has been an increasing interest in demonstrating the impact of this crucial part of the health care workforce. Studies have examined the impact of variation in the numbers of registered nurses and of the skill mix changes both within the nursing workforce and between doctors and nurses on patient outcomes.

A number of reviews have examined the extensive literature which explores the relationship between nurse staffing levels and patient outcomes (e.g. Kane et al., 2007, Lang et al., 2004, Lankshear et al., 2005). There is an increasing amount of evidence that higher levels of registered nurse staffing and a higher proportion of RNs in the workforce may be associated with reduced mortality and other improvements in patient outcome, although results are not entirely consistent and significant uncertainty remains (Griffiths, 2009). This work has generally been undertaken in acute care settings, although other settings, including nursing homes and primary care have also been studied, with positive associations shown between higher levels of nurse staffing and outcomes, including pressure sore incidence and control of diabetes (e.g.Griffiths et al., 2010, Konetzka et al., 2008).

There is also an increasing number of studies examining changes in the skill mix of the workforce involving nurse for doctor substitution. These studies generally involve nurses managing an aspect of patient care or a group of patients where medicine (qualified doctors) has hitherto been the lead profession. Most of this research involves the use of nurse practitioners in primary care, but studies have also investigated nurse for doctor substitution in other settings including inpatient care. These too have previously been reviewed (Griffiths et al., 2007, Laurant et al., 2004) and, broadly, suggest that appropriately trained nurses can deliver quality and outcomes equivalent to doctors.

The motivation for exploring nurse for doctor substitution has been in large part economic and has been supported by policy in many countries including the UK. Shifting care from doctors to nurses is believed to provide an answer to physician scarcity and to act as a mechanism for cost containment (Laurant et al., 2004). On the other hand, there is also a widely acknowledged global shortage of registered nurses (Buchan and Calman, 2004) and thus the opportunity costs of using nurses to deliver what has previously been medical care might be high.

Despite the economic underpinnings of decision making in this area, there are few economic evaluations, even though without such evidence, it is hard to make an informed choice about allocating money to alternative healthcare programmes (Vincent, 2002). There have been some reviews (e.g.1998, Lämås et al., 2009, Siegel, 1998, Thungjaroenkul et al., 2007), but most are dated or focus on nursing intervention in general (i.e., without considering skill mix or workforce changes), or have little focus on the methodological quality of the economic component of the studies.

**2. Economic issues arising**

While lower patient-to-nurse ratios may contribute to better health care and thus lead to better patient outcomes (Aiken, 2008), the costs of this strategy are unclear. The picture is complex. More nurse hours per patient may contribute to higher per patient expenditures, although this may be offset by a reduction in hospital costs through a reduction in the length of stay or adverse outcomes experienced by patients (Dall et al., 2009). As a result, costs per patient may fall or rise, and while the patient outcomes are likely to improve, the cost effectiveness can be unclear. In addition, better nurse staffing may improve nurse retention and thus lead to less nurse stress and better treatment outcomes because of more attention to the patients, fewer medical errors and lower recruitment and training expenditures by hospitals (Aiken, 2008, Greenberg, 2006), implying a lower cost effectiveness ratio.

From a wider, societal perspective, additional benefit from better patient outcomes may be higher productivity from the (former) patients, higher wages, and therefore additional cost offsets. Moreover, better nurse care may lead to lower future medical expenditure per patient (for example, in primary care after discharge), as well as lower indirect costs of care such as the travel costs and lost productivity while attending appointments, or less time spent by family members helping their sick relatives. Such effects, usually long-term, may be unaccounted for in traditional cost-effectiveness analysis.

Some reviews of the link between nurse staffing and patient outcomes have found diminishing marginal returns for greater nurse staffing (Kane et al., 2007, Lang et al., 2004), which suggests the existence of optimal level of nurse staffing, not necessarily the one that leads to the best treatment outcomes (Spetz, 2005). Such levels may depend on various patient, hospital and staff characteristics, and therefore may be context-specific (Curtin, 2003). For example, almost all studies suffer from a failure to consider levels of medical staff as a variable even though these may be highly correlated with levels of nurse staffing (Griffiths, 2009).

Furthermore, some researchers have found that increases in nurse-patient ratios may be linked with little change in patient outcomes, as described in a study exploring the effect of mandated ratios in California (Hall and Buch, 2009). This does not prove that such interventions are not cost effective, since it is possible that the costs per patient for greater nurse staffing could in fact be lower if there were certain economies of scale and scope in service provision. Moreover, the studies where the main focus of interest is patient health outcomes may miss the indirect cost offsets mentioned above. Therefore, information on both costs and effects should be collected in appropriately conducted economic evaluations.

As far as skill mix and nursing staff substitution is concerned, again the link with cost-effectiveness is ambiguous. On the one hand, it is possible that experienced and properly trained nurse practitioners can provide services similar in quality to those provided by physicians, particularly for less complicated medical conditions, while also costing less per unit of time worked, especially taking into account their training costs and lower salary (McGrath, 1990). If this is true, it would be economically rational to delegate a certain proportion of physician-provided services to nurse practitioners. In some countries, for example the United Kingdom, there has been significant support for such changes at a policy level, with enabling measures such as nurse prescribing implemented over recent years (Latter et al., 2007).

However, cost savings depend on the salary differentials between nurses and doctors, and those may be offset by lower productivity of nurses (Laurant et al., 2004). For example, nurses may take longer to treat patients than physicians and use more resources to provide similar quality and quantity of care. Nurse-provided consultations may take longer, nurse practitioners may require additional supervision from doctors (especially in more difficult cases), and they may order more tests and investigations, all of which would increase total costs per patient treated.

While some inferences can be drawn from existing research on the link between nurse staffing models and patient outcomes, direct economic evaluations in which both costs and consequences of alternative workforce models are studied simultaneously are required. This evidence may be of use in understanding which staffing models offer the greatest value for money. Therefore we undertook a scoping review of economic evaluations of nurse staffing, including comparisons between different levels of nurse staffing and the substitution of nurses for other healthcare workers.

**3. Method**

We systematically searched for studies that explored the relationship between costs and effects of care and the level of registered nurse staffing or nursing related skill mix in the clinical team (including nurse for doctor substitution) using cost-effectiveness, cost-utility, or cost-benefit analysis. In those cases where the analytical framework was not explicitly stated, we nevertheless included a study when it simultaneously considered both costs and effects of care as outcome variables

We excluded studies that focused on association between nurse staffing variables and patient outcomes only, without considering costs of care. We also excluded studies that looked at nursing costs only. We did not consider interventions performed by nurses when compared to no intervention or interventions performed by nurses in different settings (e.g. at leg ulcer clinics vs. care at home) because our main interest is in comparing the nurses with other workforce, and not in comparing the effect of specific interventions or settings where nurses work. For that reason we did not include economic evaluations of care provided by nurses and other medical staff using completely different service configurations (e.g., in clinical nurse specialist care vs. inpatient multidisciplinary team care vs. day patient multidisciplinary team; on site vs. off-site care; nursing home vs. hospital care), because in such cases it may be very difficult to tease out the contribution of the health workforce from the effect of different settings and services.

We searched Medline, CINAHL, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects and Google Scholar using combinations of the following freetext and MeSH terms: nursing staff, medical staff; economic evaluation, cost benefit, cost utility, cost effectiveness, staff mix, and skill mix in articles’ titles and abstracts. Where appropriate, we used truncation symbols, e.g. nurs\*, effective\*, staff\*. We limited our search to articles published in English, in 1989-2009.

As this is a scoping review, we made no a-priori selection for quality. We used established criteria for judging the quality of economic studies derived from recommendations from the guidelines proposed by the Panel on Cost-Effectiveness in Health Care (Drummond et al., 2005). Specifically, the match of the articles against the criteria listed in Table 1 was considered.

**Results**

*Inclusion criteria and study types*

1,050 citations were retrieved from Medline. CINAHL searches returned 189 articles. Similar searches were conducted at Google Scholar[[1]](#footnote-1) and Cochrane Reviews databases, as well as at the Database of Abstracts of Reviews of Effects. Search at the last two databases did not return any additional articles not already found through the first three database searches. Seventeen articles reporting sixteen studies met the criteria for inclusion into our review. Two papers were based on the same underlying study (Cowan et al., 2006, Ettner et al., 2006), although the analysis performed was different. Ten studies were based on studies conducted in USA, four in the UK, one in Canada and one Australia. The majority of studies (11) focused on skill mix variables, while the remaining five considered nurse staffing levels. Most studies (seven) were conducted in acute/critical/intermediate care. They were followed by general hospital care (3); by neonatal/prenatal care (3); primary care (1) and other sectors (A&E departments and anticoagulant care). See tables 2 and three for full summaries.

*Main intervention*

In all skill mix/staff substitution studies, the main approach was to compare the outcomes between treatment and control groups in an experimental/quasi-experimental framework where skill mix of staff varied between groups. Primarily skill mix was considered in terms of formal qualifications or employment grades (e.g. nurse / doctor). In the staffing studies nurse labour inputs were variously measured as RN hours per patient day; median and recommended staffing levels for nurses; proportion and number of nurse hours worked and nurse to patient ratios.

*Cost effectiveness findings*

Although most staff substitution studies reviewed here have found that nurses can provide cost effective care compared to other, more expensive health professionals (Bissinger et al., 1997, Cowan et al., 2006, Ettner et al., 2006, Graveley and Littlefield, 1992, Taylor et al., 1997, Venning et al., 2000), this conclusion was not uniform. Thus some studies have found that nurses were providing more expensive care similar in quality to other health professionals (Griffiths et al., 2001, Richardson et al., 2001), or that the outcomes of care were better for nurse-treated patients, but at higher expense (Sakr et al., 2003). In three articles, the evidence was inconclusive (Mitchell-DiCenso et al., 1996, Pioro et al., 2001, Pratt et al., 1993).

In the nurse staffing studies, it was generally not easy to assess the cost effectiveness of more intensive nursing care, as no strategy was clearly dominant over others. For example, one study found that in the USA, increasing staffing from median to recommended levels was hard to justify on cost effectiveness grounds alone (Ganz et al., 2005). On the other hand, another study (Rothberg et al., 2005) reported that even with the lowest patient to nurse ratio, the incremental cost effectiveness ratio did not exceed USD 136,000 per life saved , a level comparable with many existing interventions.

*Perspective of the economic analysis*

In fifteen articles, the perspective chosen for economic analysis was not reported, so we had to deduce it from the information given. The recurring weakness in most studies was the lack of societal perspective. Only in two cases (Dall et al., 2009, Mitchell-DiCenso et al., 1996) was a societal perspective taken; in others, the perspective was either provider’s, or payer’s. Since various treatment-related costs and benefits may accrue outside of health care system, ignoring them may distort the picture on the overall societal costs from a given healthcare intervention.

*Methodological issues with study designs*

Six of sixteen studies employed randomized control trials (RCTs) as the design of choice (Cowan et al., 2006, Ettner et al., 2006, Griffiths et al., 2001, Mitchell-DiCenso et al., 1996, Pioro et al., 2001, Richardson et al., 2001, Venning et al., 2000), although in two of them (Cowan et al., 2006, Ettner et al., 2006), staff rather than patients were randomized between wards. Although there are inherent strengths in the causal inferences that can be drawn from this research design, it was impossible for RCTs of this type to be blinded, for obvious reasons. Also, even in randomized trials, there may still be remaining factors besides pure differences in staff composition (for example, nurses may still be supervised by GPs or medical director to a certain extent), which might have been the case in all studies reviewed here. It should also be noted that no study on the cost effectiveness of different nurse staffing levels relied on randomized trial data.

The studies with non randomised designs relied mostly on observational, retrospective data, where bias was controlled through the use of regression analysis. However, it is challenging to adjust for a differential patient case mix between sites, let alone for a host of unobservable hospital and other patient-level factors that may confound the observed relationship between the variables of interest. For example, teaching hospitals that use advanced technology may employ more RNs (Curtin, 2003), and a “toxic” work environment may be an underlying issue in hospitals where there are fewer nurses per patient (Curtin, 2003). Geographical settings may also differ considerably.

In three studies (Dall et al., 2009, Rothberg et al., 2005, Rothschild et al., 2009), the link between nurse staffing levels and patient outcomes/total costs was measured indirectly, by estimating the probability of adverse events/ length of stay (LOS) based on patient to nurse ratios, and then linking this with cost savings from avoided adverse events/shorter LOS. In the future, to avoid making unnecessary assumptions, it may be better to model the relationship between staff variables and patient outcomes and costs directly.

One of the quality criteria chosen for this review (see Table 1) is that effectiveness estimates should incorporate both benefits and harms to health arising from a given intervention. None of the studies reviewed here explicitly did that. Moreover, of all studies reviewed, only one (Ganz et al., 2005) followed the recommendation that changes to mortality and morbidity should be measured by the changes in quality adjusted life years (QALYs), and three (Bissinger et al., 1997, Mitchell-DiCenso et al., 1996, Pioro et al., 2001) considered both morbidity and mortality without combining them into a single indicator.

It should be noted, however, that QALYs may not always be correlated with nurse-sensitive indicators such as patient satisfaction with care, especially in supportive and palliative care (Douglas and Normand, 2005), therefore using other measures is probably justified. For example, several studies paid attention to quality of care indicators (including patient satisfaction with care) as an outcome variable (Mitchell-DiCenso et al., 1996, Pioro et al., 2001, Pratt et al., 1993, Taylor et al., 1997, Venning et al., 2000). Some other authors (Pratt et al., 1993, Sakr et al., 2003, Taylor et al., 1997) used intermediate, or process-related measures of care (e.g., process errors for minor injury units; proportion of time patients spent in therapeutic range), because significantly adverse events may be rare, or true state of health may be hard to measure. In addition, treatment by nurses may involve symptom-free progression of disease (especially in an on-demand model of follow-up care), which may be very difficult to measure with any indicator (Helgesen et al., 2000).

*Selection bias*

In some studies (Bissinger et al., 1997, Richardson et al., 2001), there were substantial differences in mortality between comparison groups, and as a result, differentials in the rate of missing outcome data. Even though the authors argued these differences were not statistically significant, this may have been due to small sample sizes, rather than true lack of statistically significant differences in mortality. Certainly the randomized controlled trials were not powered to detect differences in this significant outcome. There was another possibility for selection bias in some studies, for example when a considerable number of patients (around 47 per cent) initially randomized to receive care from nurses, eventually received “usual care”, because of nurse practitioner or medical staff request (Pioro et al., 2001). The authors did not find significant baseline differences between this group and those who stayed in the nurse-treated group, but even in this case, some unobservable confounding factors may have been unaccounted for.

*Costing methodology*

As far as costs are concerned, in studies like this they may be hard to estimate, especially when resources are not traded for money (Douglas and Normand, 2005). Having said that, six authors employed a bottom-up/micro costing approach (i.e., the approach where resource use and prices are collected for separate items consumed) (Bissinger et al., 1997, Graveley and Littlefield, 1992, Mitchell-DiCenso et al., 1996, Pioro et al., 2001, Taylor et al., 1997, Venning et al., 2000), while the rest used a less detailed top-down, case-mix or disease-specific per diem design. When some resources were shared, it was not usually explained by the authors what the basis for allocating costs was. In three studies (Bissinger et al., 1997, Dall et al., 2009, Pioro et al., 2001), charges rather than payments were used for estimation. Cost of pharmaceuticals was not always included (the exceptions were (Bissinger et al., 1997, Mitchell-DiCenso et al., 1996, Pioro et al., 2001, Richardson et al., 2001, Sakr et al., 2003, Venning et al., 2000), although their consumption may in part depend on whether care is managed by nurses or other medical staff. In all studies, there was also a lack of information on possible co-payments and fees that patients may have paid under different arrangements.

No authors adequately accounted for costs accruing outside of the healthcare system, for example for the travel and time costs for patients and their families, or for productivity losses or gains from specific interventions, although some authors explicitly considered post-discharge costs and outcomes (Cowan et al., 2006, Ettner et al., 2006, Mitchell-DiCenso et al., 1996, Pioro et al., 2001, Richardson et al., 2001). One of them (Richardson et al., 2001) found that the initially higher costs of nurse-based treatment in the hospital setting may be partly offset with less expensive community care, and therefore post-discharge costs should be considered if cost substitution between settings is suspected.

Almost all studies took a relatively short-term perspective on estimating costs and outcomes (although a few considered longer term outcomes, but not costs (Ganz et al., 2005, Mitchell-DiCenso et al., 1996)) . While an obvious explanation for this is that it may be hard to justify expenses on a long-term trial, some studies (e.g. Richardson et al., 2001) showed that the conclusions may be affected by the length of follow-up. As mentioned above, this may be especially true if cost-shifting between hospital and primary care in the community is potentially sizeable. Another possibility is that in the longer run, training and supervision costs may decrease for nurses, thus improving their cost-effectiveness relative to other, more skilled and expensive staff (Pratt et al., 1993).

In no cases were the opportunity costs explicitly included. Considering such costs may be important when it is suspected that some services may be replaced as a result of an intervention. For example, it may be important to know how the doctors use their freed up time as a result of the transfer of some of the services from them to nurses (Richardson, 1999). Also, one study (Pratt et al., 1993) reported significant stress arising from the obligation of registered nurses to supervise enrolled nurses, which may be the case in other set-ups (e.g., physicians supervising nurses), and therefore including the cost of stress in the analysis may be important. Finally, in no study were the training costs of nurses and other medical personnel considered.

*Issues with choice of alternatives*

In almost all staff mix studies, a comparison of the proposed intervention with an existing and/or viable low-cost alternative was made. In a few staff substitution studies, however, although an alternative was specified, it was not clear if the list was exhaustive (e.g., see Bissinger et al., 1997, Cowan et al., 2006, Ettner et al., 2006, Pratt et al., 1993)). In addition, some authors (e.g., Ganz et al., 2005, Needleman et al., 2006) did not consider a range of possible staffing levels, but rather examined how a change from a status quo to a new level (such as recommended nursing levels) may affect costs and outcomes of care. Such a perspective may be limiting, since there can be other, more cost effective staffing levels.

*Discounting*

Another quality criterion from Table 1 is that the discounting for both costs and effects should be undertaken at appropriate rates (usually assumed to be 3-5 per cent a year). However, in most cases the outcomes were measured over a relatively short period of time, so this recommendation may be of little relevance here. However, on two occasions discounting was attempted (Dall et al., 2009, Ganz et al., 2005).

*Sensitivity analysis and extrapolation of findings in the future*

In less than half of all articles was a sensitivity analysis to test the robustness of findings to different assumptions performed (Ettner et al., 2006, Ganz et al., 2005, Griffiths et al., 2001, Needleman et al., 2006, Richardson et al., 2001, Rothberg et al., 2005, Rothschild et al., 2009, Taylor et al., 1997). In almost all cases, only a one-way sensitivity analysis was undertaken. Only two studies reported incremental cost effectiveness ratios (ICER) (Ganz et al., 2005, Rothberg et al., 2005). One explanation for this is that in many cases (especially in skill mix studies), one strategy clearly dominated another, so ICER was not necessary for demonstrating cost-effectiveness results. Also, where it was presented, there was little, if any, discussion of acceptable threshold levels.

Although randomized control trials have very important advantages compared to alternative methods, there are also important drawbacks to their use in economic evaluation. For example, most RCT studies reviewed here had a rather limited time horizon, and not taking future into account can give a distorted picture on the longer-term flow of costs and benefits associated with a particular intervention (Drummond et al., 2005). For such purposes, special decision modelling approaches (e.g., Markov modelling), where both costs and effects of an intervention are projected in to the future, based on assumptions about transition probabilities between various health states, costs, benefits, as well as future discount rates, have been developed (Drummond et al., 2005). Similarly, short-term observational studies could also benefit from extrapolation techniques, when they are correctly implemented. Among the articles we reviewed, only one (Ganz et al., 2005) utilized Markov cohort simulation approach.

*Generalizability issues*

Another weakness of the staff mix articles was that most of them (eight) were based on studies conducted on a single site, which may make it hard to generalize their findings to other settings. On the other hand, although all nurse staffing studies were based on data collected across multiple sites, the data was observational, rather than experimental. A related problem is a predominance of studies with small sample sizes in the staff mix group, and possible lack of power to detect statistically significant relationships for rare outcomes. Finally, most studies (twelve) were conducted in specialized care setting (e.g., in neonatal, anticoagulation or critical care), with fewer in general care settings.

Cost-effectiveness analysis is but one approach to economic evaluation in healthcare. A major limitation of this method is its inability to confirm whether a given intervention is worth undertaking on its own merit. For example, one can be interested to know whether overall monetary benefits from a given intervention are larger than the overall costs. While this goal may be very difficult to achieve, given the challenge of estimating health and some other benefits in monetary terms, one can be interested in a less ambitious, but still useful goal of finding out whether cost savings and/or revenue gains from improving quality may offset the costs of interventions. Three reviewed studies employed an approach similar to the cost-benefit analysis, although it was somewhat restricted, in that outcomes measured only parts of the monetary gains from nurse staff interventions, such as costs savings from reduced length of stay and from avoiding adverse events (Dall et al., 2009, Needleman et al., 2006, Rothschild et al., 2009)[[2]](#footnote-2). The general finding was that the monetary benefit from increasing nursing staff levels was greater than the corresponding costs.

5. Discussion

Previous reviews of studies on nursing and patient outcomes highlighted a number of methodological problems: small sample sizes, studies conducted on single sites, lack of randomization and resulting potential patient, staff and hospital-level confounding, and variations in cost measurements across sites. Indirect costs were rarely considered, and there was also usually lack of information on post-discharge outcomes of care (Griffiths et al., 2007, Kane et al., 2007, Lang et al., 2004). Our review has highlighted similar methodological issues and has further outlined specific methodological weaknesses related to cost-effectiveness analysis.

Specifically, we have found that although most studies on economic evaluation of skill mix employed a randomized control design, this was not the case when the main variable of interest was nurse staffing levels. For stronger causal inference and confidence that effects seen are not confounded, ideally more of these studies should rely on random assignment of patients or units (e.g. wards), although this may be technically challenging and expensive. On the other hand, most skill mix studies, where random assignment was employed more frequently, had small sample sizes, and they were usually conducted on a single site, in a small geographic area, and/or specific healthcare sector.

All studies included in the review were conducted in high-income, English-speaking countries, which may have altogether different healthcare systems, demographic trends and income levels from the rest of the world. Thus, even with the most rigorous design, external validity of findings may be questionable. The solution for this appears to be conducting considerably more multi-site studies that go beyond examining single diseases areas. In addition, more use of decision modelling may help the available evidence from other settings be adapted to local conditions (Drummond et al., 2005). Likewise, a preferred solution is always to conduct properly designed longer term studies. However, when this is not feasible, Markov modelling techniques may be a step in the right direction.

One of the major ‘Panel on Cost Effectiveness’ recommendations, not followed in most studies reviewed here, is the use of societal perspective. Given the huge social investment in nursing this seems an appropriate perspective. Having said that, some researchers have argued that provider perspective may be more appropriate when hospitals themselves pay for interventions. In addition, in some countries (e.g., the US) healthcare costs are mainly funded through private channels, in which case the application of societal perspective may not be accepted by the main institutional participants. However, this qualification is of less relevance in a state-funded system similar to the one in the United Kingdom.

On a related note, with rare exceptions, post-discharge costs were not included in the studies reviewed. One common explanation for this is that cost consideration is limited by the perspective chosen. However, as mentioned above, wherever possible, the societal perspective should be adopted. When properly conducted, it will give the most complete picture on the costs and benefits to society from a given intervention. Even without the wider societal perspective, hospital stays make up increasingly small components of the episode of care even for simple elective surgical procedures, and so costs of care occurring elsewhere in the system need to be considered.

Only one study employed QALYs as the outcome variable designed to measure effectiveness of interventions. Although it is possible that nurse-provided care may not always lead to a significant change in QALYs, the question of finding outcomes that can be used commonly across studies remains. Without them, making comparisons and pooling results between studies may be very difficult. The same logic applies when one advocates a more common system for measuring costs across studies.

This review has two potentially significant limitations. Because of the time and resource constraints, we did not consider the grey literature of unpublished manuscripts, dissertations and articles. In addition, all our articles were written in English, which implies that we may have missed knowledge from non-English speaking countries. However the predominance of English language scientific publication means that it is unlikely that there is a significant volume of literature in proportion to that considered here.

While there are limitations in this literature, there are encouraging signs. First, the very fact of an increasing number of economic evaluation studies of nurse staffing and skill mixes in recent years is a promising development in itself. Moreover, as a greater number of authors have started to employ robust designs, more methodologically sound conclusions are made. The researchers were also utilizing a range of health outcome variables, which may help understand cost effectiveness of interventions in various dimensions. In the future, it is hoped that these trends will be supported with more research funding going into methodologically strong studies.

What are the policy implications of the main findings in the literature? Importantly, if policymakers were to follow the main message of some articles that greater nurse staffing, or that nurse/other staff substitution may be cost effective, one should carefully consider any general equilibrium implications of such a policy move. For example, mandating lower patient to nurse ratios may lead to a greater demand for nurses and therefore higher nurse wages in new equilibrium. This may require new assumptions on the wage level for nurses, and thus lead to revised cost-effectiveness estimations. In addition, decision making may be constrained by legislative restrictions on nursing practices in some countries (including their prescription authority), as well as by general nurse shortages. In the US in particular, a significant nurse shortage constraint does appear to exist (Greenberg, 2006).

On the provider side, hospitals may have little incentive to provide high quality nursing care, since they do not generally get compensated for it (Aiken, 2008). Therefore, they may provide less than optimal amount of nursing care, unless they are mandated to do it. This is because the cost savings from the reduction of costly adverse events from higher quality care may accrue differently to hospitals vs. payers depending on the payment arrangement (Rothschild et al., 2009). Mandated staffing ratios may incentivise employing less qualified and lower grade registered nursing staff in order to meet minimum numbers which again may change the underlying economic and clinical basis of the policy.

In conclusion, nurses have, in general, to date treated economic evaluation of their services with considerable suspicion (Jenkins-Clarke, 1999), although this may have started to change recently. One explanation for this may be that many believe the holistic process of nursing to be no less important than the treatment outcomes, and they feel that the this is often ignored in such evaluations (Jenkins-Clarke, 1999). This is unfortunate, since answering the significant economic questions that arise from nursing work requires the perspective of those who best understand nursing work. An important goal of further research would be bringing more nurses to participate in economic evaluation of their services, together with greater attention to patient experience of nursing services, and the value placed on this by patients and by society.

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**References**

Aiken, L.H., 2008. Economics of Nursing. Policy, Politics, & Nursing Practice 9 (2), 73.

Allred, C.A., Arford, P.H., Mauldin, P.D., Goodwin, L.K., 1998. Cost-effectiveness analysis in the nursing literature, 1992-1996. Journal of Nursing Scholarship 30 (3), 235-242.

Bissinger, R.L., Allred, C.A., Arford, P.H., Bellig, L.L., 1997. A cost-effectiveness analysis of neonatal nurse practitioners. Nursing economic$ 15 (2), 92.

Buchan, J., Calman, L., 2004. The Global Shortage of Registered Nurses:An Overview of Issues and Actions. International Council of Nurses, Geneva.

Cowan, M.J., Shapiro, M., Hays, R.D., Afifi, A., Vazirani, S., Ward, C.R., Ettner, S.L., 2006. The effect of a multidisciplinary hospitalist/physician and advanced practice nurse collaboration on hospital costs. Journal of Nursing Administration 36 (2), 79.

Curtin, L.L., 2003. An integrated analysis of nurse staffing and related variables: Effects on patient outcomes. Online Journal of Issues in Nursing 8 (3), 118.

Dall, T.M., Chen, Y.J., Seifert, R.F., Maddox, P.J., Hogan, P.F., 2009. The economic value of professional nursing. Medical care 47 (1), 97.

Douglas, H.R., Normand, C., 2005. Economic evaluation: what does a nurse manager need to know? Journal of Nursing Management 13 (5), 419-427.

Drummond, M.F., Sculpher, M.J., Torrance, G.W., O'Brien, B.J., Stoddart, G.L., 2005. Methods for the economic evaluation of health care programmes. Oxford University Press, USA.

Ettner, S.L., Kotlerman, J., Afifi, A., Vazirani, S., Hays, R.D., Shapiro, M., Cowan, M., 2006. An alternative approach to reducing the costs of patient care? A controlled trial of the Multi-Disciplinary Doctor-Nurse Practitioner (MDNP) model. Medical Decision Making 26 (1), 9.

Ganz, D.A., Simmons, S.F., Schnelle, J.F., 2005. Cost-effectiveness of recommended nurse staffing levels for short-stay skilled nursing facility patients. BMC Health Services Research 5 (1), 35.

Graveley, E.A., Littlefield, J.H., 1992. A cost-effectiveness analysis of three staffing models for the delivery of low-risk prenatal care. American Journal of Public Health 82 (2), 180.

Greenberg, P.B., 2006. Nurse-to-Patient Ratios: What Do We Know? POLICY POLITICS AND NURSING PRACTICE 7 (1), 14.

Griffiths, P., 2009. RN+RN=better care? What do we know about the association between the number of nurses and patient outcomes? International Journal of Nursing Studies 46 (10), 1289-1290.

Griffiths, P., Edwards, M., Forbes, A., Harris, R., Ritchie, G., 2007. Effectiveness of intermediate care in nursing-led in-patient units. Cochrane Database of Systematic Reviews (2), CD002214.

Griffiths, P., Harris, R., Richardson, G., Hallett, N., Heard, S., Wilson-Barnett, J., 2001. Substitution of a nursing-led inpatient unit for acute services: randomised controlled trial of outcomes and cost of nursing-led intermediate care. Age and Ageing 2001 (30), 483-488.

Griffiths, P., Murrells, T., Maben, J., Jones, S., Ashworth, M., 2010. Nurse staffing and quality of care in UK general practice: cross-sectional study using routinely collected data. British Journal of General Practice 60 (1), e36-e48.

Griffiths, P.D., Edwards, M.E., Forbes, A., Harris, R.L., Ritchie, G., 2007. Effectiveness of intermediate care in nursing-led in-patient units. Cochrane Database of Systematic Reviews (2), CD002214.

Hall, L.M.G., Buch, E., 2009. Skill Mix Decision-Making for Nursing. International Centre for Human Resources in Nursing.

Helgesen, F., Andersson, S.O., Gustafsson, O., Varenhorst, E., Gobén, B., Carnock, S., Sehlstedt, L., Carlsson, P., Holmberg, L., Johansson, J.E., 2000. Follow-up of prostate cancer patients by on-demand contacts with a specialist nurse: a randomized study. Scandinavian journal of urology and nephrology 34 (1), 55-61.

Jenkins-Clarke, S., 1999. Does nursing needthe dismal science'? The case for economic evaluations in nursing. Journal of Research in Nursing 4 (6), 448.

Kane, R.L., Shamliyan, T.A., Mueller, C., Duval, S., Wilt, T.J., 2007. The association of registered nurse staffing levels and patient outcomes: Systematic review and meta-analysis. Medical care 45 (12), 1195.

Konetzka, R.T., Stearns, S.C., Park, J., 2008. The Staffing: Outcomes Relationship in Nursing Homes. Health Services Research 43 (3), 1025-1042.

Lämås, K., Willman, A., Lindholm, L., Jacobsson, C., 2009. Economic evaluation of nursing practices: a review of literature. International Nursing Review 56 (1), 13-20.

Lang, T.A., Hodge, M., Olson, V., Romano, P.S., Kravitz, R.L., 2004. Nurse-patient ratios: a systematic review on the effects of nurse staffing on patient, nurse employee, and hospital outcomes. Journal of Nursing Administration 34 (7-8), 326.

Lankshear, A.J., Sheldon, T.A., Maynard, A., 2005. Nurse staffing and healthcare outcomes: a systematic review of the international research evidence. Advances in Nursing Science 28 (2), 163.

Latter, S., Maben, J., Myall, M., Young, A., 2007. Evaluating the clinical appropriateness of nurses’ prescribing practice: method development and findings from an expert panel analysis. Quality and Safety in Health Care 16 (6), 415-421.

Laurant, M., Reeves, D., Hermens, R., Braspenning, J., Grol, R., Sibbald, B., 2004. Substitution of doctors by nurses in primary care. Cochrane Database of Systematic Reviews (4), DOI: 10.1002/14651858.CD14001271.pub14651852.

McGrath, S., 1990. The cost-effectiveness of nurse practitioners. The Nurse Practitioner 15 (7), 40.

Mitchell-DiCenso, A., Guyatt, G., Marrin, M., Goeree, R., Willan, A., Southwell, D., Hewson, S., Paes, B., Rosenbaum, P., Hunsberger, M., 1996. A controlled trial of nurse practitioners in neonatal intensive care. Pediatrics 98 (6 Pt 1), 1143.

Needleman, J., Buerhaus, P.I., Stewart, M., Zelevinsky, K., Mattke, S., 2006. Nurse staffing in hospitals: Is there a business case for quality? Health Affairs 25 (1), 204.

Pioro, M.H., Landefeld, C.S., Brennan, P.F., Daly, B., Fortinsky, R.H., Kim, U., Rosenthal, G.E., 2001. Outcomes-based trial of an inpatient nurse practitioner service for general medical patients. Journal of Evaluation in Clinical Practice 7 (1), 21-33.

Pratt, R., Burr, G., Leelarthaepin, B., Blizard, P., Walsh, S., 1993. The effects of All-RN and RN-EN staffing on the quality and cost of patient care. The Australian journal of advanced nursing: a quarterly publication of the Royal Australian Nursing Federation 10 (3), 27.

Richardson, G., 1999. Identifying, evaluating and implementing cost-effective skill mix. Journal of Nursing Management 7 (5), 265-270.

Richardson, G., Griffiths, P., Spilsbury, P., Wilson-Barnett, J., Batehup, L., 2001. Economic evaluation of a nursing-led intermediate care unit. International Journal of Technology Assessment in Health Care 17 (3), 442-450.

Rothberg, M.B., Abraham, I., Lindenauer, P.K., Rose, D.N., 2005. Improving nurse-to-patient staffing ratios as a cost-effective safety intervention. Medical care 43 (8), 785.

Rothschild, J.M., Bates, D.W., Franz, C., Soukup, J.R., Kaushal, R., 2009. The costs and savings associated with prevention of adverse events by critical care nurses. Journal of Critical Care 24 (3), 471-477.

Rothschild, J.M., Bates, D.W., Franz, C., Soukup, J.R., Kaushal, R., 2009. The costs and savings associated with prevention of adverse events by critical care nurses. Journal of Critical Care 24 (3), 471e471.

Sakr, M., Kendall, R., Angus, J., Saunders, A., Nicholl, J., Wardrope, J., 2003. Emergency nurse practitioners: a three part study in clinical and cost effectiveness. British Medical Journal 20 (2), 158.

Siegel, J.E., 1998. Cost-effectiveness analysis and nursing research -- is there a fit? Image: Journal of Nursing Scholarship 30 (3), 221-222.

Spetz, J., 2005. The cost and cost-effectiveness of nursing services in health care. Nursing outlook 53 (6), 305-309.

Taylor, F.C., Gray, A., Cohen, H., Gaminara, L., Ramsay, M., Miller, D., 1997. Costs and effectiveness of a nurse specialist anticoagulant service. British Medical Journal 50 (10), 823.

Thungjaroenkul, P., Cummings, G.G., Embleton, A., 2007. The impact of nurse staffing on hospital costs and patient length of stay: a systematic review. Nursing Economics 25 (5), 255.

Venning, P., Durie, A., Roland, M., Roberts, C., Leese, B., 2000. Randomised controlled trial comparing cost effectiveness of general practitioners and nurse practitioners in primary care. British Medical Journal 320 (7241), 1048.

Vincent, D., 2002. Using cost-analysis techniques to measure the value of nurse practitioner care. International Nursing Review 49 (4), 243-249.

1. Since Google Scholar returned a vast number of search results, only the first 100 links for any specific search term were checked. [↑](#footnote-ref-1)
2. Needleman et al also more explicitly employed cost-effectiveness approach, since they also considered avoided death as another outcome variable. [↑](#footnote-ref-2)