



Review

Hospital to community transitional care by nurse practitioners: A systematic review of cost-effectiveness



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ABSTRACT

Objectives: To determine the cost-effectiveness of nurse practitioners delivering transitional care.

Design: Systematic review of randomised controlled trials.

Data sources: Ten electronic databases, bibliographies, hand-searches, study authors, and websites.

Review methods: We included randomised controlled trials that compared formally trained nurse practitioners to usual care and measured health system outcomes. Two reviewers independently screened articles and assessed study quality using the Cochrane Risk of Bias and the Quality of Health Economic Studies tools. We pooled data for similar outcomes and applied the Grading of Recommendations Assessment, Development and Evaluation tool to rate the quality of evidence for each outcome.

Results: Five trials met the inclusion criteria. One evaluated one alternative provider nurse practitioner (154 patients) and four evaluated six complementary provider nurse practitioners (1017 patients). Two were at low and three at high risk of bias and all had weak economic analyses. The alternative provider nurse practitioner had similar patient outcomes and resource use to the physician (low quality). Complementary provider nurse practitioners scored similarly to the control group in patient outcomes

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except for anxiety in rehabilitation patients (MD: -15.7 , 95%CI: -20.73 to -10.67 , $p < 0.001$) (very low quality) and patient satisfaction after an abdominal hysterectomy (MD: 14 , 95%CI: 3.5 – 24.5 , $p < 0.01$) (low quality), both favouring nurse practitioner care. Meta-analyses of index re-hospitalisation up to 42 days ($n = 766$, pooled relative risk (RR): 0.69 , 95%CI: 0.34 – 1.43 , $I^2 = 0\%$) and any re-hospitalisation up to 180 days ($n = 800$, pooled RR: 0.87 , 95%CI: 0.69 – 1.09 , $I^2 = 32\%$) were inconclusive (low quality). Complementary provider nurse practitioners significantly reduced index re-hospitalisation over 90 days (RR: 0.55 , 95%CI: 0.32 – 0.94 , $p = 0.03$) and 180 days (RR: 0.62 , 95%CI: 0.40 – 0.95 , $p = 0.03$) in complex care patients (both low quality) and they significantly reduced the number and duration of rehabilitation patient-to-staff consultation calls ($p < 0.05$).

Conclusions: Given the low quality evidence, weak economic analyses, small sample sizes, and small number of nurse practitioners evaluated in each study, evidence of the cost-effectiveness of nurse practitioner-transitional care is inconclusive and further research is needed.

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What is already known about the topic?

- Numerous systematic reviews have shown that nurse practitioners are safe and effective healthcare providers.
- With the emphasis on containing healthcare budgets, there is increasing pressure to reduce hospital lengths of stay and re-admissions.
- Transitional care is the delivery of services designed to ensure healthcare continuity, avoid poor patient outcomes, and promote the safe and timely transfer of patients from hospital to community.

What this paper adds

- Five randomised controlled trials of nurse practitioners delivering transitional care that included health system outcomes were identified.
- One trial evaluated the alternative provider nurse practitioner in transitional care and found similar patient outcomes and resource use to the physician (low quality evidence).
- Four trials evaluated the complementary provider nurse practitioner in transitional care and found some evidence of reduced re-hospitalisations (low quality evidence).
- Given the low quality evidence, weak economic analyses, small sample sizes, and small number of nurse practitioners evaluated in each study, evidence of the cost-effectiveness of nurse practitioner-transitional care is inconclusive and further research is needed.

1. Introduction

The transition from hospital to home or other care settings can be a challenging and confusing journey for patients and their families. With ever-shorter hospital stays and growing complexity of post-discharge care, the transition process is increasingly important. Transitional care has been defined as “a broad range of time-limited services designed to ensure healthcare continuity, avoid preventable poor outcomes among at-risk populations, and promote the safe and timely transfer of patients from one level of care to another or from one type of setting to

another” (Naylor et al., 2011, p. 747). Transitional services may include: developing an individualised needs-based comprehensive discharge plan, connecting patients and outpatient providers, providing educational and behavioural interventions, managing symptoms and providing direct patient care, monitoring patients and caregivers regularly through home visits and/or telephone contact, providing counselling and self-care instruction, and reviewing and managing medications (Naylor et al., 2011).

Hospitals are experiencing increasing pressure from payers to reduce the length of stay. Internationally, transitional programmes associated with early discharge from hospital are a common strategy to shorten length of stay, improve the transition to home or other care settings for patients and families, and reduce emergency department visits and 30-day re-admissions following discharge (OECD, 2011).

Two types of advanced practice nurses deliver or manage transitional care: clinical nurse specialists and nurse practitioners. This paper summarises randomised controlled trials (RCTs) that have specifically evaluated nurse practitioners in a transitional care role. Nurse practitioners are registered nurses who possess additional education, usually at the graduate level, to autonomously perform assessments, order diagnostic tests, diagnose, prescribe medications and treatments, and perform procedures, as authorised by legislation and their regulatory scope of practice (International Council of Nurses, 2009). Nurse practitioners work in alternative or complementary roles. In an alternative role, nurse practitioners provide services similar to those for whom they are substituting, often physicians (Laurant et al., 2009). In complementary roles, nurse practitioners provide services that complement or augment existing services. The alternative role is usually designed to lower cost or address labour force shortages while preserving the quality of care; the complementary role is intended to improve the quality of care and/or reduce costs (Laurant et al., 2005).

We conducted a multi-component systematic review of RCTs entitled, *A systematic review of the cost-effectiveness of nurse practitioners and clinical nurse*

specialists: 1980–July 2012. While a single search strategy was used, during analysis we grouped the RCTs according to type of advanced practice nurse (nurse practitioner or clinical nurse specialist), setting (inpatient, outpatient or transition) and role (alternative or complementary). This paper is one in a series of papers reporting findings from this systematic review (Donald et al., *in press*; Kilpatrick et al., 2014; Marshall et al., *submitted for publication*).

2. Objective

We summarise the results of RCTs evaluating the cost-effectiveness of nurse practitioners delivering transitional care in alternative or complementary roles and formulate recommendations based on the evidence.

3. Methods

3.1. Inclusion and exclusion criteria

We included RCTs reported between 1980 and July 2012 that compared nurse practitioner–transitional care with usual care. Participants were patients of any age admitted for any reason to all types, sizes and locations of hospitals. The intervention was transitional care delivered by a nurse practitioner who had completed a formal post-baccalaureate or graduate nurse practitioner education programme or was licensed as a nurse practitioner. We excluded studies if the nurse practitioner contribution could not be isolated from that of other providers or if the control group was exposed to the nurse practitioner over the course of the study.

The primary outcomes of interest were objective measures of health system utilisation. These included length of stay, re-hospitalisation, costs of healthcare (e.g., hospital, professional, family costs) and health resource use (e.g., diagnostic tests, prescriptions). Additional primary outcomes of interest were patient health status (e.g., mortality, morbidity), quality of life and patient satisfaction, as well as provider outcomes including quality of care and job satisfaction. We excluded studies if they did not include a measure of health system utilisation.

3.2. Search strategy

We searched the following electronic databases with no restriction on publication status or language: Allied and Complementary Medicine Database (AMED), CINAHL, Cochrane Database of Systematic Reviews and Central Register of Controlled Trials, Database of Abstracts of Reviews of Effects (DARE), EMBASE, Global Health, HealthStar, Health Economics Evaluation Database (HEED), MEDLINE, and Web of Science. The search was conducted by medical librarians. The detailed search strategy is described elsewhere (Donald et al., *in press*). We reviewed bibliographies of review articles and eligible trials for additional studies. We hand-searched 16 relevant journals, contacted authors and experts in the field, searched personal files, and searched websites of relevant research and professional organisations.

3.3. Study selection

Identified citations were uploaded to a web-based reference management programme (RefWorks) and duplicates were removed. Two-member teams independently screened titles and abstracts for relevance based on inclusion criteria. Those deemed potentially eligible by either reviewer were subject to full-text assessment. Subsequently, two-member teams independently assessed the eligibility of each full-text article. When a study was reported in multiple papers, we reviewed and extracted them as a group. Disagreements were resolved by consensus at any stage of selection, data extraction, and quality assessment.

3.4. Data extraction and quality assessment

One reviewer (KR) extracted data about each study's objective, setting, population, intervention, control, outcomes, and length of follow-up. Team members checked the accuracy of extractions.

Two reviewers (AD and KR) independently assessed study quality using Cochrane risk of bias criteria including sequence generation, allocation concealment, blinding of outcome assessors (or use of measures not likely to be influenced by lack of blinding, e.g., death records, valid self-report measures), completeness of outcome data, selective outcome reporting, and other sources of bias (each rated as high, unclear, or low risk of bias) (Higgins and Green, 2011). We did not assess for lack of blinding of participants and personnel because it is not possible to blind participants to the presence of a nurse practitioner and the nature of the interventions precludes blinding of personnel. We contacted authors if additional information was required. An overall risk of bias was assigned to each study [low (at risk in 0–1 category), moderate (at risk in 2–3 categories), high (at risk in 4–6 categories), and very high (at risk in 7–8 categories)].

Two reviewers independently assessed the quality of the economic analyses in each study using the Quality of Health Economic Studies instrument (Chiou et al., 2003; Ofman et al., 2003; Peterson et al., 2009). The Quality of Health Economic Studies is comprised of 16 questions which assess economic study criteria including objectives, perspective, variable estimates, uncertainty, data abstraction, analytic horizon, cost measurements, economic model, and biases. Scores range from 0 (extremely poor quality) to 100 (high quality) (Marshall et al., *submitted for publication*).

We also rated the overall quality of evidence (confidence in effect estimates) for each outcome by using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system (Guyatt et al., 2011a,b) and GRADEpro software. RCTs begin as high quality evidence but may be rated down by one or more of five categories of limitations: risk of bias, inconsistency, indirectness, imprecision, and publication bias. We downgraded for indirectness if the population, intervention, or outcome was not generalisable to a real-world scenario. A common criticism of nurse practitioner studies is the small number of nurse practitioners evaluated in any one study

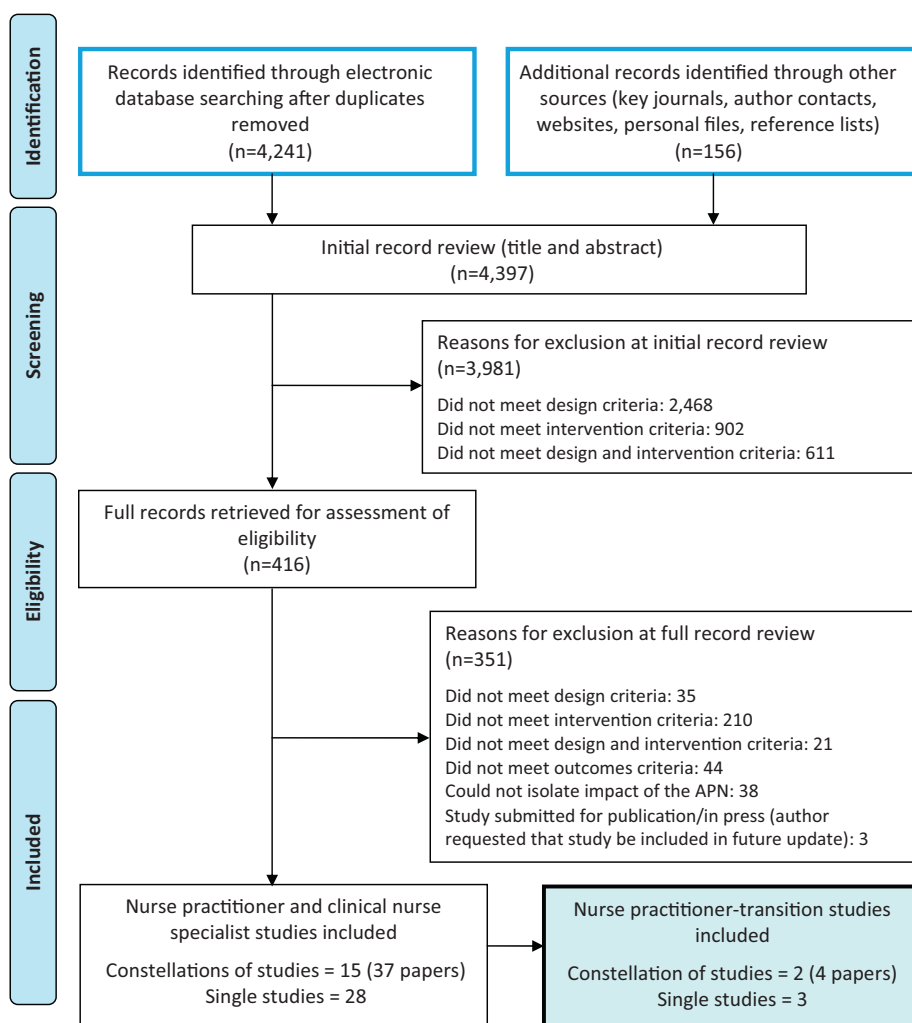


Fig. 1. Identification and screening of relevant studies.

Flow diagram adapted from Moher, D., Liberati, A., Tetzlaff, J., Altman D.G., et al., 2009. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *British Medical Journal* 339, b2535.

raising the concern that results may not be generalisable. In collaboration with our policy advisor, we deemed 10 as the minimum number necessary to generalise results to nurse practitioners in similar roles. Consequently, we downgraded for indirectness when outcomes were based on evaluation of fewer than 10 nurse practitioners. Publication bias was unlikely as well-conducted RCTs with significant results either in favour or against the impact of nurse practitioners are not likely to have difficulty getting published. In the case of non-inferiority studies (i.e., alternative care), studies that have non-significant results are equally important to studies that find significant differences. We thoroughly searched published and grey literature and do not suspect publication bias.

3.5. Analysis and data synthesis

The studies were grouped for analysis based on whether the nurse practitioner was functioning in an

alternative or complementary role. To determine the extent of imprecision of the effect estimate for dichotomous outcomes, we calculated the optimal information size (OIS) using a relative risk difference of 20%, the median control group incidence, $\alpha = 0.05$, and $\beta = 0.2$. For continuous outcomes, we calculated the OIS using the median control group standard deviation, the minimal important difference (MID), $\alpha = 0.05$, and $\beta = 0.2$. We used accepted MID values from the scientific literature and if none were identified, we extrapolated from an established MID of 0.5 points for a 7-point quality of life scale (Jaeschke et al., 1989) for scale-based outcomes and assumed a MID of 20% of the control group mean for other continuous outcomes. For index length of stay, we assumed a MID of 1.0 day. If the outcome sample size or event number was below the OIS threshold, the result was judged to be imprecise. If the OIS criterion was met and the confidence interval overlapped no difference, we judged those that were more than 20% above or below the baseline risk as imprecise for

dichotomous data and those that exceeded the MID as imprecise for continuous outcomes.

When outcomes were sufficiently comparable, we combined data using the RevMan Analyses statistical package in Review Manager, version 5.1 (Cochrane Collaboration, Copenhagen, Denmark). Because of the small number of studies eligible for pooling (≤ 3), we used a fixed-effects model.

We investigated statistical heterogeneity using the Chi² test for homogeneity and the I^2 statistic. Statistical heterogeneity (I^2 statistic) was interpreted as: 0–40%: might not be important; 30–60%: may represent moderate heterogeneity; 50–90%: may represent substantial heterogeneity; 75–100%: considerable heterogeneity (Higgins and Green, 2011). In the event of moderate heterogeneity and if the number of studies in the meta-analysis permitted, we conducted subgroup analyses that were specified a priori in the following order: (1) implementation of nurse practitioner intervention (novice versus expert, working to full-scope of practice); (2) country; (3) year (less and more recent); (4) risk of bias (low, moderate, high, very high); (5) Quality of Health Economic Studies score for health resource outcomes (low, moderate, high); (6) outcome measurement variability (e.g., re-hospitalisation measured over the short-term versus long-term).

Most study results could not be pooled due to different outcome measures across studies. Outcomes were summarised in a tabular form with corresponding effect sizes, 95% confidence intervals and *p*-values.

4. Results

4.1. Search results

The searches yielded 4397 papers after duplicates were removed. A further 3981 papers were excluded during the title and abstract review. Full texts of 416 potentially relevant articles were retrieved of which 351 were excluded (Fig. 1). The list of excluded studies with reasons for exclusion is available from the authors. Of the remaining 65 papers, five studies reported in seven papers evaluated nurse practitioners in a transitional care role.

4.2. Characteristics of included studies (Table 1)

Of the five included studies, one was conducted in the United Kingdom (Nathan et al., 2006), one in Canada (Kotowycz et al., 2010), and three in the United States (Coleman et al., 2006; Hollingsworth and Cohen, 2000; Rawl et al., 1998). All were published in English. All but one (Rawl et al., 1998) was published in the year 2000 or later. One study evaluated the nurse practitioner in the alternative role (Nathan et al., 2006) and four studies evaluated the nurse practitioner in the complementary role.

4.2.1. Study characteristics – alternative provider nurse practitioner-transition role

Nathan et al. (2006) conducted a non-inferiority trial comparing one respiratory specialist nurse practitioner to a respiratory physician delivering the same intervention.

Participants included 154 adults with acute asthma attending a follow-up clinic after discharge from hospital. One nurse practitioner saw patients within two weeks post-discharge followed by appointments as required and a six-month appointment. The nurse practitioner provided comprehensive asthma care. Patient outcomes included exacerbation of asthma, quality of life, and maximal peak flow and health system outcomes included re-hospitalisation and need for emergency treatment and/or additional interventions. Follow-up continued for the six-month duration of the intervention.

4.2.2. Study characteristics – complementary provider nurse practitioner-transition role

Four studies (Coleman et al., 2006; Hollingsworth and Cohen, 2000; Kotowycz et al., 2010; Rawl et al., 1998) were superiority trials comparing nurse practitioner-delivered transitional interventions in combination with usual care to usual care alone. A total of 1017 adult participants were included in the four trials with individual study sample sizes ranging from 54 to 750 participants. Health conditions differed across the four trials. Coleman et al. (2006) studied adults 65 years of age and older with any of 11 chronic illnesses. Hollingsworth and Cohen (2000) studied women having an abdominal hysterectomy. Kotowycz et al. (2010) focused on patients with low-risk ST-segment elevation myocardial infarction treated with percutaneous coronary intervention. Rawl et al. (1998) studied rehabilitation patients who had a primary diagnosis of cerebrovascular accident, orthopaedic diagnoses, or other diagnoses. All studies were conducted in single sites from which patients were discharged.

Two trials evaluated a single nurse practitioner (Kotowycz et al., 2010; Rawl et al., 1998) and two evaluated two nurse practitioners (Coleman et al., 2006; Hollingsworth and Cohen, 2000). In the three trials that described education and experience, the nurse practitioners were experienced, had graduate degrees, and had additional training in the specialty area (e.g., gerontology, rehabilitation) (Coleman et al., 2006; Hollingsworth and Cohen, 2000; Rawl et al., 1998). Only Coleman et al. provided details about development of the intervention (Parry et al., 2003).

In all four studies, the nurse practitioners met with patients pre-discharge followed by regular contact via home visits and/or telephone calls post-discharge during which they provided education regarding the disease process and treatment and ensured timely follow-up with primary or specialty services and referrals to community resources. Post-discharge direct patient care, as needed, was provided by the nurse practitioner in one study (Hollingsworth and Cohen, 2000). Rawl et al. (1998) and Hollingsworth and Cohen (2000) included assessment of the patient for post-discharge complications as an explicit role of the nurse practitioner. Emotional support and counselling were identified as nurse practitioner roles in two studies (Hollingsworth and Cohen, 2000; Rawl et al., 1998). Rawl et al. (1998) included a nurse practitioner intervention specifically addressing patient and family concerns and the nurse practitioners in the Coleman et al. (2006) study facilitated patient and caregiver self-care. The

Table 1
Characteristics of Included Studies (N = 5).

Author, year, country	Study objective	Study setting	Participants	Comparison groups	Intervention	Length of follow-up
Nathan et al. (2006) UK	To compare a respiratory specialist nurse and a respiratory physician in the provision of follow-up care to patients discharged from hospital after admission for acute asthma	A follow-up clinic for patients discharged from West Suffolk Hospital (district general hospital) NHS Trust	154 acute asthma patients (>16 years) discharged from hospital Those with COPD were excluded Median age 35 years; age range 17–91 years; median length of hospital stay was 3 days with a range of 1–14 days	<i>Alternative provider (n = 78):</i> a single nurse practitioner provided follow-up care (qualified nurse practitioner with masters education and specialist training in acute asthma management) <i>Control (n = 76):</i> Respiratory physician provided the same follow-up care as the nurse practitioner (unclear whether this was regarded as standard care)	Nurse practitioner saw outpatients within 2 weeks post-discharge for 30 min, then 15-min follow-up appointments as required, and a 6-month follow-up appointment. Responsibilities included evaluation of events leading to hospitalisation, assessment of patient understanding of asthma and asthma therapy, initiation or reinforcement of asthma education, inhaler technique, self-management plan, and change in asthma medication where appropriate. The nurse practitioner prescribed independently according to a patient group directive.	6 months post-discharge
Coleman et al. (2006) Parry et al. (2003) US	To compare a transition intervention focused on self-care to standard care in older patients with complex care needs	A large integrated, not-for-profit delivery system in Colorado, which cares for >60,000 patients (≥65 years) Comprised of a single hospital, 8 skilled nursing facilities, and a home healthcare agency	750 chronically ill, community-dwelling, local, English speaking adults (≥65 years) admitted to hospital for 1 of 11 non-psychiatric conditions (stroke, congestive heart failure, coronary artery disease, cardiac arrhythmias, chronic obstructive pulmonary disease, diabetes mellitus, spinal stenosis, hip fracture, peripheral vascular disease, deep venous thrombosis, pulmonary embolism) Mean age 76.2 years; 49.7% male; 88.7% white; majority presented with COPD (17.9%), cardiac arrhythmia (16%), and CHF (14.8%), and 77.2% were discharged home	<i>Complementary transitional care (n = 379; 360 analysed):</i> Two nurse practitioners ^a worked as transition coaches to facilitate patient and caregiver roles in self-care (experienced geriatric nurse practitioners skilled in patient education and advocacy) Nurse practitioners worked with 24–28 patients at any given time Each patient also kept a personal health record to facilitate cross-site information transfer <i>Control (n = 371; 352 analysed):</i> Usual care	Nurse practitioner met with patient in-hospital, made a home visit within 72 h of discharge, and telephoned at least 3 times over 28 days post-discharge. Patients transferred to a skilled nursing facility were telephoned or visited at least weekly. Responsibilities included explanation of personal health record, assistance in completing health record, medication review and reconciliation, helping patients communicate their needs, encouraging patient self-reliance, teaching patients to identify and act on 'red flags' indicating a condition was worsening, and ensuring timely follow-up with primary or specialty services.	180 days post-discharge

Table 1 (Continued)

Author, year, country	Study objective	Study setting	Participants	Comparison groups	Intervention	Length of follow-up
Hollingsworth and Cohen (2000) US	To compare early hospital discharge plus transitional home follow-up care to standard care for women who have had an abdominal hysterectomy	University Medical Centre associated with a school of nursing	113 women (≥ 21 years) undergoing abdominal hysterectomy for non-oncologic indications Mean age 47.5 years; 65.6% white; 34.4% African American; 89% had private hospital insurance; 20.4% had annual income \$17000–24,500; 26.6% $>$ \$75,000; and 59.3% had myomas	<i>Complementary post-discharge care (n = 54):</i> Two nurse practitioners (1 full time and 1 part-time; masters prepared) coordinated early discharge and implemented post-discharge care <i>Control (n = 59):</i> Standard post-operative care in the hospital and routine hospital discharge Follow-up services included standard postoperative office visits only	Nurse practitioners had contact with patient in-hospital, encouraged early discharge, and made a minimum of 2 home visits, 1 on the day after discharge and 1 within 1 week of discharge. Nurse practitioners made 10 telephone calls during 8 weeks and were available for patients and families by telephone from 8:00 am to 10:00 pm weekdays and from 8:00 am to 12 noon on weekends. Responsibilities included coordination of discharge planning and patient education, co-ordination of medical follow-up, referrals to community agencies, post-discharge assessment in-home, post-discharge direct care as needed, and counselling and support.	8 weeks post-discharge
Kotowycz et al. (2010) Canada	To compare early hospital discharge (48–72 h) plus nurse practitioner follow-up to standard care for patients with low-risk ST-segment elevation myocardial infarction	Hamilton General Hospital, Hamilton, ON	54 low-risk (Zwolle Primary PCI Index ≤ 3) STEMI patients treated with primary or rescue PCI Mean age 55.3 years; 75.5% male; 59.3% were active smokers; 74% had primary PCI	<i>Complementary post-discharge care (n = 27):</i> A single nurse practitioner implemented post-discharge intervention (training and qualifications were not reported) <i>Control (n = 27):</i> Usual care where discharge planning and follow-up were provided by the treating physician and nursing team with no added nursing intervention	The nurse practitioner saw patients before discharge, within 3 days of discharge, and ≥ 2 times within 30 days of discharge (in person or via telephone). Responsibilities included educating patients about the nature and management of their disease (with a focus on medications), ensuring patients were aware of follow-up appointments and outpatient tests. Permission to prescribe was not reported.	6 weeks post-discharge

Rawl et al.
(1998) Easton
et al. (1995) US

To compare post-discharge follow-up by a nurse practitioner to standard care for rehabilitation patients with long-term disabilities

A single in-patient Rehabilitation Unit at St. Margaret Mercy Healthcare Centers in Hammond, Indiana

100 rehabilitation patients (≥ 18 years), who were not confined to their home, and understood English
Mean age 69.2 years; 70% were ≥ 65 years; 30% male; 79% white; 15% African American; 6% Hispanic/Latin American; primary diagnosis for 46% was CVA and for 33% was orthopaedic issues, primarily hip fractures

Complementary post-discharge care (n = 49): A single nurse practitioner (10 years experience and a certificate in rehabilitation)
Control (n = 51): Usual nursing care that involved discharge planning, a telephone call from a volunteer to administer a satisfaction survey, and patients could telephone the nursing unit with questions
Some control patients received home care services

Nurse practitioner made a total of 4 contacts with patients: in the rehabilitation clinic 1–2 days before discharge, by telephone within 48 h after discharge, and in the rehabilitation clinic or in their home at 30 days and four months after discharge.
Responsibilities were physical examinations, complication assessments, addressing patient and family concerns, provision of emotional support and counselling, provision of community resource information, education on rehabilitation, and consultation as needed.

4 months post-discharge

CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; ON, Ontario; PCI, percutaneous coronary intervention; STEMI–ST, segment elevation myocardial infarction; UK, United Kingdom; US, United States.

^a Data provided by author.

nurse practitioners in the Coleman et al. (2006) and Kotowycz et al. (2010) studies were responsible for medication reviews and reconciliation. The duration of the nurse practitioner intervention ranged from four weeks (Coleman et al., 2006) to four months (Rawl et al., 1998) post-discharge. Patient follow-up usually ceased with the conclusion of the intervention; however, Coleman et al. (2006) followed patients for another 152 days post-intervention.

Only one patient outcome was common to more than one study. Anxiety was measured by Hollingsworth and

Cohen (2000) and Rawl et al. (1998); however, Hollingsworth and Cohen did not report anxiety scores and therefore, we could not pool data. Study-specific patient outcomes are reported in Table 2.

With respect to health system outcomes, all four trials reported re-hospitalisations and we were able to pool some of these data. Coleman et al. (2006) and Hollingsworth and Cohen (2000) measured costs; however, Hollingsworth and Cohen did not report specific cost data and therefore, we could not pool data. The remaining outcomes were study-specific (Table 3).

Table 2
Patient outcomes.

Outcome (outcome measure)	Trial	Population	N	Effect	Intervention effect size (95%CI)	p-Value of effect	GRADE quality ^a
<i>Alternative provider</i>							
Exacerbation of asthma	Nathan et al. (2006)	Asthma	133	RR	0.93 (0.65 to 1.33)	0.67	LOW
Change in maximal peak flow	Nathan et al. (2006)	Asthma	80	MD	-1.39 (-6.63 to 3.85)	0.12	LOW
Change in QoL (AQ-20)	Nathan et al. (2006)	Asthma	101	MD	-0.8 (-2.22 to 0.62)	0.28	LOW
Change in QoL (SGRQ)	Nathan et al. (2006)	Asthma	101	MD	1.08 (-4.93 to 7.09)	0.72	LOW
<i>Complementary provider</i>							
Mortality	Coleman et al. (2006)	Frail elderly	750	RR	1.37 (0.62 to 3.05)	0.44	LOW
Patient satisfaction (LMOPS)	Hollingsworth and Cohen (2000)	Hysterectomy	113	MD	14 (3.5 to 24.5)	<0.01	LOW
Post-operative infections	Hollingsworth and Cohen (2000)	Hysterectomy	113	NR	NR	NS	NA
Personal and social dependency	Hollingsworth and Cohen (2000)	Hysterectomy	113	NR	NR	NS	NA
Anxiety (MAACL_R)	Hollingsworth and Cohen (2000)	Hysterectomy	113	NR	NR	NS	NA
Depression (MAACL_R)	Hollingsworth and Cohen (2000)	Hysterectomy	113	NR	NR	NS	NA
Self-esteem (RSES)	Hollingsworth and Cohen (2000)	Hysterectomy	113	NR	NR	NS	NA
Compliance with aspirin	Kotowycz et al. (2010)	STEMI	54	RR	0.96 (0.87 to 1.07)	0.31	LOW
Compliance with clopidogrel	Kotowycz et al. (2010)	STEMI	54	RR	0.96 (0.84 to 1.09)	0.55	LOW
Compliance with β -blockers	Kotowycz et al. (2010)	STEMI	54	RR	1.08 (0.93 to 1.26)	0.30	LOW
Compliance with statins	Kotowycz et al. (2010)	STEMI	54	RR	1.04 (0.94 to 1.15)	0.31	LOW
Compliance with ACEIs	Kotowycz et al. (2010)	STEMI	54	RR	1.14 (0.90 to 1.46)	0.27	LOW
Attendance at cardiac rehabilitation	Kotowycz et al. (2010)	STEMI	54	RR	1.07 (0.65 to 1.76)	0.78	LOW
Smoking cessation	Kotowycz et al. (2010)	STEMI	32	RR	0.91 (0.39 to 2.10)	0.82	LOW
HRQoL (SF-36) ^b	Kotowycz et al. (2010)	STEMI	NR	NR	NR	NS	NA
Anxiety (STAI)	Rawl et al. (1998)	Rehabilitation	100	MD	-15.7(-20.73 to -10.67)	<0.00001	V. LOW
Functional independence (FIM)	Rawl et al. (1998)	Rehabilitation	100	MD	0.7 (-4.93 to 6.33)	0.81	LOW
Urinary tract infection ≥ 1 fall	Rawl et al. (1998)	Rehabilitation	87	RR	1.37 (0.47 to 3.98)	0.57	LOW
	Rawl et al. (1998)	Rehabilitation	83	RR	0.83 (0.42 to 1.63)	0.58	V. LOW

ACEIs, angiotensin-converting enzyme inhibitors; AQ-20, Asthma Questionnaire 20 (lower score indicates better QoL); CI, confidence interval; FIM, Functional Independence Measure (higher score indicates greater independence); HRQoL, health-related QoL; LMOPS, LaMonica-Oberst Patient Satisfaction Scale (higher score indicates greater satisfaction); MAACL-R, Multiple Affect Adjective Check-list Revised; MD, mean difference; NA, not assessed; NR, not reported; NS, not significant; QoL, quality of life; RR, relative risk; RSES, Rosenberg Self-Esteem Scale; SF-36, Short Form-36; SGRQ, St. George Respiratory Questionnaire (lower percentage indicates better QoL); STAI, State-Trait Anxiety Inventory (lower score indicates lower anxiety); STEMI, ST-elevation myocardial infarction.

^a GRADE Working Group grades of evidence: HIGH quality, further research very unlikely to change confidence in the estimate of the effect; MODERATE quality, further research likely to have an important impact on confidence in the estimate of the effect and may change the estimate; LOW quality, further research is very likely to change confidence in the estimate of the effect and likely to change the estimate; VERY LOW (V. LOW) quality, very uncertain about the estimate of the effect.

^b The majority of the SF-36 HRQoL domains (physical function, role-physical, body pain, general health, vitality, social functioning, and mental health) were higher in the nurse practitioner intervention group. Despite this trend, none of these domains were found to be statistically significant; however, the authors acknowledged that their pilot study was not powered to detect a difference for these outcomes. No appreciable difference was found for the SF-36 Role-emotional domain.

Effect estimate favours intervention: Effect estimate favours usual care:

Table 3
Health system outcomes.

Outcome (outcome measure)	Trial	Population	N	Effect	Intervention effect size (95%CI)	p-Value of effect	GRADE quality ^a
<i>Alternative provider</i>							
Re-hospitalisation	Nathan et al. (2006)	Asthma	133	RR	0.60 (0.21 to 1.73) ^b	0.34 ^b	LOW
Emergency nebulisation	Nathan et al. (2006)	Asthma	136	RR	1.60 (0.79 to 3.24)	0.19	LOW
Additional intervention	Nathan et al. (2006)	Asthma	136	RR	1.02 (0.66 to 1.56)	0.93	LOW
<i>Complementary provider</i>							
Index re-hospitalisation (short-term ^c)	Coleman et al. (2006) and Kotowycz et al. (2010) ^d	Frail elderly; STEMI	766	RR	0.69 (0.34 to 1.43)	0.32	LOW
Index re-hospitalisation (90 days)	Coleman et al. (2006)	Frail elderly	712	RR	0.55 (0.32 to 0.94)	0.03	LOW
Index re-hospitalisation (180 days)	Coleman et al. (2006)	Frail elderly	712	RR	0.62 (0.40 to 0.95)	0.03	LOW
Any re-hospitalisation (30 days)	Coleman et al. (2006)	Frail elderly	712	RR	0.70 (0.45 to 1.09)	0.11	LOW
Any re-hospitalisation (90 days)	Coleman et al. (2006)	Frail elderly	712	RR	0.74 (0.55 to 1.00)	0.05	LOW
Any re-hospitalisation (long term ^e)	Coleman et al. (2006) and Rawl et al. (1998) ^f	Frail elderly; Rehabilitation	800	RR	0.87 (0.69 to 1.09)	0.23	LOW
Hospital costs (30 days)	Coleman et al. (2006)	Frail elderly	712	MD	−\$134 (−\$644 to \$376)	0.61	LOW
Hospital costs (90 days)	Coleman et al. (2006)	Frail elderly	712	MD	−\$497 (−\$1216 to \$222)	0.18	LOW
Hospital costs (180 days)	Coleman et al. (2006)	Frail elderly	712	MD	−\$488 (−\$1290 to \$314)	0.23	LOW
Index length of stay	Hollingsworth and Cohen (2000)	Hysterectomy	113	MD	−0.5 day	NR	NA
Re-hospitalisations	Hollingsworth and Cohen (2000)	Hysterectomy	113	NR	NR	NS	NA
Acute care visits ^g	Hollingsworth and Cohen (2000)	Hysterectomy	113	RR	0.33 (0.10 to 1.13)	0.08	LOW
Total costs	Hollingsworth and Cohen (2000)	Hysterectomy	113	NR	6% savings	NR	NA
Cardiac ER visits	Kotowycz et al. (2010)	STEMI	54	RR	0.75 (0.19 to 3.04)	0.69	LOW
Total number of consultation calls	Rawl et al. (1998)	Rehabilitation	100	NR	1 versus 7 call	<0.05	NA
Total duration of consultation calls	Rawl et al. (1998)	Rehabilitation	100	NR	5 versus 48.5 min	<0.05	NA

CI, confidence interval; ER, emergency room; MD, mean difference; NA, not assessed; NR, not reported; NS, not significant; RR, relative risk; STEMI, ST-elevation myocardial infarction.

^a GRADE Working Group grades of evidence: HIGH quality, further research very unlikely to change confidence in the estimate of the effect; MODERATE quality, further research likely to have an important impact on confidence in the estimate of the effect and may change the estimate; LOW quality, further research is very likely to change confidence in the estimate of the effect and likely to change the estimate; VERY LOW (V. LOW) quality, very uncertain about the estimate of the effect.

^b The RR reported here was based on the raw data. Using Poisson regression and controlling for exacerbation rate in each group, Nathan et al. (2006) calculated the adjusted RR for re-hospitalisation as 0.40 (95%CI 0.14–1.12; $p = 0.09$).

^c Index re-hospitalisations within 30 days (Coleman et al., 2006) and 42 days (Kotowycz et al., 2010).

^d Analysis of statistical heterogeneity: $X^2 = 0.89$; degree of freedom = 1; X^2 p -value = 0.35; $I^2 = 0\%$.

^e Any re-hospitalisations within 120 days (Rawl et al., 1998) and 180 days (Coleman et al., 2006).

^f Analysis of statistical heterogeneity: $X^2 = 1.46$; degree of freedom = 1; X^2 p -value = 0.23; $I^2 = 32\%$.

^g Unscheduled acute care visits to the surgeon, the clinic, or the ER.

Effect estimate favours intervention:  Effect estimate favours usual care: 

4.3. Quality assessment

We attempted to contact authors to seek more information related to risk of bias and two provided additional information (Coleman et al., 2006; Nathan et al., 2006).

4.3.1. Quality assessment – alternative provider nurse practitioner-transition role

Overall, the risk of bias in the study by Nathan et al. (2006) was low (Table 4) (Donald et al., in press). The Quality of Health Economic Studies score was 33 points out of a possible 100 with outcome comparisons limited to

health resource use (e.g., re-hospitalisation, clinic attendance) (Marshall et al., submitted for publication).

4.3.2. Quality assessment – complementary provider nurse practitioner-transition role

One study (Coleman et al., 2006) was at low risk of bias and three studies (Hollingsworth and Cohen, 2000; Kotowycz et al., 2010; Rawl et al., 1998) were judged at high risk of bias (Table 4) (Donald et al., in press). Quality of Health Economic Studies scores was low ranging from 19 (Kotowycz et al., 2010) to 27 (Coleman et al., 2006) out of a possible 100 (Marshall et al., submitted for publication). All four studies compared health resource use and Coleman

Table 4

Bottom line, overall risk of bias, and quality of health economic analysis.

Author, year, country	Provider role	Bottom line	Overall risk of bias ^a	QHEs score ^b
Nathan et al. (2006) UK	Alternative	Equal effectiveness Equal resource use	Low risk	33
Coleman et al. (2006) Parry et al. (2003) US	Complementary	Equal effectiveness Equal-to-less resource use Equal cost	Low risk	27
Hollingsworth and Cohen (2000) US	Complementary	Equal-to-more effectiveness Equal resource use	High risk	26
Kotowycz et al. (2010) Canada	Complementary	Equal effectiveness Equal resource use	High risk	19
Rawl et al. (1998) Easton et al. (1995) US	Complementary	Equal-to-more effectiveness Less resource use	High risk	26

QHEs, Quality of Health Economic Studies instrument; UK, United Kingdom; US, United States.

^a Overall risk of bias was based on a modified version of the Cochrane Risk of Bias tool (Higgins and Green, 2011) where studies at risk in ≤ 1 category were judged to be at Low risk of bias; 2–3 categories at Moderate risk; 4–6 at High risk; and 7–8 categories at Very High risk of bias.

^b The QHEs measured the quality of studies with respect to their health economic analysis. The score ranged from 0 to 100 where studies scoring from 0 to 24 points were judged to be extremely poor quality, 25–49 were poor, 50–74 were fair, and 75–100 were high quality.

et al. (2006) compared costs but did not link costs with outcomes.

4.4. Key findings – alternative provider nurse practitioner-transition role (Tables 2 and 3)

4.4.1. Patients with asthma

The OIS for each of the seven outcomes reported below was greater than the study population (for continuous outcomes) or event number (for dichotomous outcomes); therefore, we rated the quality of evidence down for imprecision. One nurse practitioner was evaluated; thus the quality of evidence was rated down for indirectness. Consequently, the quality of evidence for each outcome was rated as low meaning that 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.

With respect to patient outcomes, no significant differences were found between nurse practitioner and physician care in number of patients experiencing exacerbations (relative risk (RR): 0.93, 95%CI: 0.65–1.33, $p=0.67$), change in maximal peak flow (mean difference (MD): -1.39 , 95%CI: -6.63 to 3.85 , $p=0.12$), and change in asthma-related (Asthma Questionnaire-20; MD: -0.8 , 95%CI: -2.22 to 0.62 , $p=0.28$) and respiratory-related quality of life (St. George Respiratory Questionnaire; MD: 1.08 , 95%CI: -4.93 to 7.09 , $p=0.72$).

With respect to health system outcomes, no significant differences were found between nurse practitioner and physician care in the number of patients who experienced re-hospitalisations (RR: 0.60, 95%CI: 0.21–1.73, $p=0.34$), emergency nebulisations (RR: 1.60, 95%CI: 0.79–3.24, $p=0.19$), and the need for additional interventions (RR: 1.02, 95%CI: 0.66–1.56, $p=0.93$).

When evaluating nurse practitioners in alternative roles, trials typically aim to assess whether nurse practitioners can perform at least at the level of the comparator, usually physicians, with equal or less costs. Based on low quality evidence, there were no significant differences between nurse practitioner and respiratory physician care for all seven outcomes. Of note, point

estimates for three outcomes (exacerbations, asthma-related quality of life, re-hospitalisations) favoured nurse practitioner care and point estimates for four outcomes (maximal peak flow, respiratory-related quality of life, emergency nebulisations, need for additional interventions) favoured respiratory physician care.

Regarding cost-effectiveness, Nathan et al. (2006) measured resource use and patient outcomes but did not link them. In order to make an assessment, we created a 'bottom line' that integrates patient outcome comparisons (effectiveness) with health system outcome comparisons (resource use) based on whether results were statistically significant (Tables 2 and 3). Given that Nathan et al. (2006) found no significant differences between groups for any patient outcomes or any health system outcomes, the bottom line for this study is *equal effectiveness and equal resource use* (Table 4).

4.5. Key findings – complementary provider nurse practitioner-transition role (Tables 2 and 3)

The OIS for each outcome in the four studies reported below was greater than the study population (for continuous outcomes) or event number (for dichotomous outcomes) in all instances except one, mean functional independence score in the study by Rawl et al. (1998). We rated the quality of evidence for all but this one outcome down for imprecision. Two of the trials evaluated one nurse practitioner and two evaluated two nurse practitioners and therefore we graded the quality of evidence down for indirectness. We were able to pool data for two analyses, each with two studies: index re-hospitalisation up to 42 days (Coleman et al., 2006; Kotowycz et al., 2010) and any re-hospitalisation up to 180 days (Coleman et al., 2006; Rawl et al., 1998). Even with the pooled data, the OIS was still greater than the event rates in both meta-analyses and therefore, we downgraded for imprecision. In combination, these outcomes were based on evaluation of only three nurse practitioners and consequently, we also downgraded for indirectness. As a result, we rated the quality of evidence for all but two outcomes as low. All but

one outcome in the study by [Rawl et al. \(1998\)](#) were downgraded for risk of detection and attrition bias because the data were collected for both groups by the nurse practitioner who delivered the intervention and a large number of patients refused to participate in the four-month follow-up. The quality of evidence for two of these outcomes was rated as very low, meaning we are very uncertain about these estimates. Because the patient populations varied, each study will be summarised individually below followed by the results of the meta-analyses of re-hospitalisation data.

4.5.1. Older patients with complex care needs

While study results indicated no significant differences between the two groups in mortality, the results are inconclusive given the wide confidence interval (RR: 1.37; 95%CI: 0.62–3.05). This was the only patient outcome measured by [Coleman et al. \(2006\)](#). With respect to health system outcomes, complementary provider nurse practitioners significantly reduced re-hospitalisation for the index reason over 90 days (RR: 0.55, 95%CI: 0.32–0.94, $p = 0.03$) and over 180 days (RR: 0.62, 95%CI: 0.40–0.95, $p = 0.03$). The nurse practitioner impact on reducing re-hospitalisations for any reason over 90 days bordered on significance (RR: 0.74; 95%CI: 0.55–1.00, $p = 0.05$) and over 30 days (RR: 0.70; 95%CI: 0.45–1.09, $p = 0.11$) was inconclusive. As well, nurse practitioner impact on reducing costs at 30 days (US\$134 lower in the nurse practitioner + usual care group; 95%CI: \$644 lower to \$376 higher), 90 days (US\$497 lower in the nurse practitioner + usual care group; 95%CI: \$1216 lower to \$222 higher) and 180 days post-discharge (US\$488 lower in the nurse practitioner + usual care group; 95%CI: \$1290 lower to \$314 higher) was inconclusive.

4.5.2. Abdominal hysterectomy

Complementary nurse practitioner care was associated with significantly higher patient satisfaction with nursing care than usual care alone at eight weeks post-discharge as measured by the LaMonica–Oberst Patient Satisfaction Scale (MD: 14, 95%CI: 3.5–24.5, $p < 0.01$). [Hollingsworth and Cohen \(2000\)](#) report that there were no statistically significant differences between groups in postoperative infections, personal and social dependency, anxiety, depression, and self-esteem; however, we could not apply GRADE to these outcomes as specific data were not provided. With respect to health system outcomes, the authors report that the nurse practitioner group was associated with a shorter length of hospital stay by 0.5 days and 6% savings in total costs (statistical significance not reported for either) and that there were no significant differences in re-hospitalisation between groups; we could not apply GRADE to these outcomes as specific data were not provided. There were no significant differences in postoperative acute care visits to the physician's office, clinic, or emergency room beyond routine postoperative care (RR: 0.33; 95%CI: 0.1–1.13, $p = 0.08$).

4.5.3. Low-risk ST-segment elevation myocardial infarction

[Kotowycz et al. \(2010\)](#) measured patient compliance with a number of cardiac drugs at six weeks post-discharge

and found no significant difference between groups in compliance with aspirin (RR: 0.96; 95%CI: 0.87–1.07, $p = 0.31$), clopidogrel (RR: 0.96; 95%CI: 0.84–1.09, $p = 0.55$), beta-blockers (RR: 1.08 95%CI: 0.93–1.26, $p = 0.30$), statins (RR: 1.04; 95%CI: 0.94–1.15, $p = 0.31$), and angiotensin-converting enzyme inhibitors (RR: 1.14; 95%CI: 0.90–1.46, $p = 0.27$). Attendance at cardiac rehabilitation at least once over six weeks post-discharge did not differ significantly between groups (RR: 1.07 95%CI: 0.65–1.76, $p = 0.78$) nor did smoking cessation during the same time period (RR: 0.91; 95%CI: 0.39–2.10, $p = 0.82$). [Kotowycz et al. \(2010\)](#) measured quality of life using the SF-36 and reported the findings according to eight subscales without reporting an overall score. They found no significant differences between groups on any of the subscales. We did not apply GRADE to this outcome as there was no overall score and our methods specified that we would not apply GRADE to subscales. With respect to the health system outcome, emergency department visits for cardiac reasons during the six weeks post-discharge did not differ significantly between groups (RR: 0.75; 95%CI: 0.19–3.04, $p = 0.69$). All of these results are inconclusive as they are imprecise. This trial had a small sample size ($n = 54$) as it was a single centre pilot study to determine the feasibility of conducting a larger multi-centre trial.

4.5.4. Rehabilitation

[Rawl et al. \(1998\)](#) compared scores on the State-Trait Anxiety Inventory at four months post-discharge and found significantly lower anxiety in the nurse practitioner group (MD: –15.7, 95%CI: –20.73 to –10.67, $p < 0.001$). There were no significant differences between groups in functional independence (MD: 0.7, 95%CI: –4.93 to 6.33, $p = 0.81$), urinary tract infections (RR: 1.37; 95%CI: 0.47–3.98), and patients experiencing one or more falls (RR: 0.83; 95%CI: 0.42–1.63). With respect to health system outcomes, [Rawl et al.](#) reported significant reductions in the number of consultation calls from patients to unit staff (1 in nurse practitioner group and 7 in the control group, $p < 0.05$) and the duration of consultation calls to unit staff (5 min for nurse practitioner group and 48.5 min for the control group, $p < 0.05$) (it is unclear whether these findings were over the entire four-month follow-up period); however, the data were not reported in sufficient detail to apply GRADE.

4.5.5. Re-hospitalisations

Results of two meta-analyses, one of re-hospitalisations over the short term (30 and 42 days) with 766 patients (pooled RR: 0.69, 95%CI: 0.34–1.43, $I^2 = 0\%$, heterogeneity $p = 0.35$) ([Coleman et al., 2006](#); [Kotowycz et al., 2010](#)) and one of re-hospitalisations over the long term (120 and 180 days) with 800 patients (pooled RR: 0.87, 95%CI: 0.69–1.09, $I^2 = 32\%$, heterogeneity $p = 0.23$) ([Coleman et al., 2006](#); [Rawl et al., 1998](#)) were inconclusive.

4.5.6. Summary of findings – complementary provider nurse practitioner-transition role

In summary, across 13 patient outcomes to which GRADE was applied, quality of evidence was very low for two outcomes and low for 11 outcomes ([Table 2](#)). Complementary nurse practitioner care was equivalent

to usual care for 11 of 13 patient outcomes; point estimates for six favoured nurse practitioner care (compliance with beta-blockers, statins, and angiotensin-converting enzyme inhibitors; attendance at cardiac rehabilitation; functional independence; falls) and five favoured usual care (mortality, compliance with aspirin and clopidogrel, smoking cessation, urinary tract infections). Of 13 patient outcomes, nurse practitioner care was superior to usual care in reducing anxiety and increasing patient satisfaction.

Across 11 health system outcomes to which GRADE was applied, quality of evidence was low for all 11 (Table 3). Complementary nurse practitioner care was equivalent to usual care for nine of 11 health system outcomes (point estimates all favoured nurse practitioner care). Nurse practitioner care was superior to usual care in two of 11 health system outcomes: reducing re-hospitalisation for index reason at 90 days and 180 days post-discharge.

With respect to cost-effectiveness, all four of these studies scored very low on the Quality of Health Economic Studies and none linked costs to outcomes. For the complementary nurse practitioner role, integration of patient outcome comparisons (*effectiveness*) with health system outcome comparisons (*resource use/costs*) based on statistical significance (Tables 2 and 3) revealed a bottom line for the study by Coleman et al. (2006) of equal effectiveness, equal-to-less resource use, and equal costs; for the study by Hollingsworth and Cohen (2000), equal-to-more effectiveness and equal resource use; for the study by Kotowycz et al. (2010), equal effectiveness and equal resource use; and for the study by Rawl et al. (1998), equal-to-more effectiveness and less resource use (Table 4).

5. Discussion

The emphasis on reducing length of hospital stays means that patients are often discharged “quicker and sicker” and in need of transitional care. Discharge planning and post-discharge care have become important for bridging the gap between acute inpatient services and community services. We conducted a systematic review of RCTs reported between 1980 and July 2012 on the cost-effectiveness of nurse practitioners delivering transitional care. We identified five trials, one of nurse practitioner alternative provider and four of nurse practitioner complementary provider roles.

Studies evaluating the effectiveness of nurse practitioners have been previously summarised in systematic reviews (Horrocks et al., 2002; Newhouse et al., 2011). Our review differs in that it: (1) explores the cost-effectiveness of nurse practitioners; (2) focuses specifically on the transition role of nurse practitioners; (3) separates out alternative and complementary provider roles; (4) limits study design to RCTs with no language, publication, or geographical restrictions; and (5) includes only studies that evaluated nurse practitioners who had completed a formal post-baccalaureate or graduate nurse practitioner education programme or were licensed as a nurse practitioner. Naylor et al. (2011) completed a systematic review of studies evaluating transitional care in which nurses delivered some interventions. They found the interventions that showed reduced re-admissions relied

on nurses as clinical managers or leaders of care and in-person home visits. Naylor et al. concluded that advanced practice nurses will assume expanded roles in the delivery of transitional care in the future. While our review was related and included some common studies, it was narrower, focusing only on nurse practitioners.

In the one study designed as a non-inferiority trial, care provided by the nurse practitioner in the alternative provider role for patients with acute asthma was associated with similar patient outcomes and resource use as care delivered by the physician (Nathan et al., 2006). However, all outcomes in the study were low quality evidence due to imprecision (failure to meet the OIS) and indirectness (evaluated only one nurse practitioner).

When comparing nurse practitioners in complementary roles to usual care, the trials are designed as superiority trials to determine if the addition of a nurse practitioner to usual care results in improved patient outcomes and/or reduced costs. Nurse practitioners in the complementary provider role were evaluated in transitional care of older patients with complex needs (Coleman et al., 2006), rehabilitation patients (Rawl et al., 1998), patients with low-risk ST-segment elevation myocardial infarction (Kotowycz et al., 2010) and patients who had had an abdominal hysterectomy (Hollingsworth and Cohen, 2000). Care delivered by the nurse practitioner in a complementary provider role was associated with no statistically significant differences in most patient outcomes and some evidence of reduced re-hospitalisations (very low to low quality evidence due to imprecision and indirectness).

A central feature of the complementary provider nurse practitioner interventions was the continuity of care from the hospital to the home setting. An important element of discharge planning is the quality of communications between hospital, patient and family, and follow-up care providers to ensure seamless follow-through (Lambrinou et al., 2011) and avoid duplication of services (Enguidanos et al., 2012). By having nurse practitioners both initiate the transition process in hospital and implement it upon the patient's discharge, communication breakdown is avoided and continuity is more likely. The follow-through in the community also facilitates timely interventions to meet patient needs that may not be evident while in the hospital (Fabbre et al., 2011).

Study details were sometimes lacking. Three studies of complementary provider nurse practitioners were judged to be at high risk of bias and in some cases this was likely due to incomplete reporting and unsuccessful attempts to contact the authors. In addition, details were sometimes lacking about nurse practitioner and usual care provider education and experience. Only one study provided details about how the intervention was developed (Coleman et al., 2006). One trial was published as a book chapter (Hollingsworth and Cohen, 2000) and did not include the level of detail that is typically reported in a journal article.

Generalisability of study findings may be limited as each study was conducted in a single site and the intervention was delivered by a small number of nurse practitioners who may not be representative of their colleagues. As a result, every outcome evaluated through GRADE was downgraded due to indirectness because no single or meta-analysed

outcome met our threshold for 10 or more nurse practitioners. Some may argue that our criterion of 10 or more nurse practitioners for individual outcomes was too strict or too lenient; if so, readers can set their own threshold and alter the assessment of indirectness and overall quality of evidence for each outcome accordingly.

All but one outcome failed to meet the OIS resulting in downgrading due to imprecision. Wide confidence intervals around the effect estimates are consistent with the failure to meet the OIS. The OIS represents the sample size that would be required for a single optimally powered study using a modest estimate of treatment effect. When interpreting statistically significant findings, it is important to consider the clinical significance of the point estimates as well (i.e., does the confidence interval cross the MID or the relative risk difference threshold?).

It is not possible with this set of studies to determine whether nurse practitioners in transition roles are cost-effective. All five studies scored low on the Quality of Health Economic Studies with analyses limited to resource use and cost comparisons and none linking costs to outcomes. Patient, family and societal costs were not considered. The cost to family members would be particularly important to measure for patients being discharged early from hospital as this may increase family member expenses, for example, if they needed to take time off work to care for a family member. Given that the main objective of early discharge is to reduce healthcare costs, consideration needs to be given to the cost of the nurse practitioner in transitional care. Who pays the nurse practitioner, what the role entails (e.g., discharge planning, in-person home visits), whether the transition role is integrated into an existing inpatient or primary care provider nurse practitioner role, and whether the cost of the role can be shared among local hospitals or with community agencies are examples of decisions that would impact costs.

5.1. Strengths and limitations

The strengths of this review are inclusion of only RCTs, a comprehensive search strategy with no language or publication restrictions, strict criteria to ensure that studies evaluated formally trained nurse practitioners, use of two independent reviewers at each stage of the review process, use of established tools to evaluate risk of bias and quality of economic analyses, and use of GRADE to evaluate and interpret individual outcomes. Limitations of our review included the small number of trials that met our inclusion criteria, the small number of outcomes that were evaluated in more than one study reducing the opportunity to pool study findings and increase precision, the absence of detail in some studies that made it difficult to assess for risk of bias and the lack of specific data for some outcomes, and the inability to test for publication bias because we did not have the recommended minimum number of 10 trials (Sutton et al., 2000).

The recent development of GRADE, which permits assessment of individual outcomes brings into question the usefulness of the Cochrane risk of bias tool that assesses the overall bias in a study. For instance, although the overall risk of bias for some studies was low, when it came to

grading each outcome, they were consistently rated down for indirectness because the study evaluated a small number of nurse practitioners and for imprecision because they failed to meet the OIS, neither of which are considered in the risk of bias assessment. This creates a somewhat contradictory situation in which a study with an overall low risk of bias yields low quality evidence. On a finer point, the overall risk of bias may reveal detection bias for one or more outcomes in a study and be rated as high for risk of bias but when GRADE is applied to one of these outcomes, detection bias may not be an issue (e.g., lack of blinding of outcome assessor poses a more serious risk for measuring patient satisfaction than it does for mortality).

5.2. Recommendations

Based on results of this review, the nurse practitioner-transition role is a promising intervention that warrants further testing. The first step may be to bring together an expert panel to consider the goals of transitional care and to identify the best match between health provider knowledge and skills and the requirements of transitional care (and this may differ by patient groups) (Bryant-Lukosius and DiCenso, 2004). Nurse practitioners or other types of nurses (e.g., clinical nurse specialists, public health nurses, nurse case managers) could implement the role. Different from other nurse roles, nurse practitioners are able to make medical diagnoses, order and interpret diagnostic tests, prescribe pharmaceuticals, and perform specific procedures within their legislated scope of practice.

Given that most trials to date have been conducted with a small number of nurse practitioners, relatively small sample sizes, and inadequate health economic analyses, consideration needs to be given to the role of trials in future evaluations. One possibility is that RCTs be used only when policy makers are contemplating a system-wide transition innovation (e.g., province or state-wide) that would justify the large amount of funding necessary for a multi-setting trial with adequate numbers of nurse practitioners and study participants.

When being considered on a small scale (e.g., one hospital), the design of the transition intervention should be based on close examination of the health needs, risk factors, and outcomes of population subgroups who may benefit the most from transitional care (Bryant-Lukosius and DiCenso, 2004). At a minimum, interventions should include comprehensive discharge planning and post-discharge follow-up. Formative evaluation should be consistent with the goals of the intervention and should focus on structure, process, and outcome measures to inform required modifications. Studies to establish the intervention dose or intensity for different at-risk populations would also facilitate administrative and clinical decision-making about how to best target and tailor nurse practitioner-transitional care. Objective performance measures that address care coordination including transitional care should be developed (e.g., identification of administrative and clinical data that should be routinely collected and analysed) for ongoing systematic monitoring of quality and outcomes of care (including costs) for nurse practitioner-transition roles.

Few studies evaluated the impact of nurse practitioner-transitional care on quality of care and patient safety and thus the potential for cost avoidance or savings through the reduction of adverse events and/or complications. Future studies should evaluate the potential long-term consequences of health-promoting and self-care management interventions for patients and caregivers. Because of the critical role of family members in the delivery of transitional care and the unique challenges faced in assuming this role, interventions should include features that prepare and support informal caregivers and these interventions should be evaluated.

When the nurse practitioner is employed by the hospital to provide transitional care, the nurse practitioner should be involved in the pre-discharge assessment and discharge planning (Naylor et al., 2011), as well as follow-through to the community to promote continuity of care. Another model of transitional care may be nurse practitioners in primary care practices. Transitional care could be incorporated into the role of nurse practitioners and/or family practice nurses in primary care for patients in the practice. This would require close communication between the acute and primary care settings to know when patients are being discharged. If the patient's primary practice is geographically near the hospital, the nurse practitioner could visit pre-discharge to begin the transition process into the community ensuring continuity of care. If the patient's primary practice is geographically distant from the hospital, the nurse practitioner in the primary care setting could collaborate with inpatient staff to co-implement transitional care.

All healthcare professionals need the knowledge and skills to deliver effective transitional care. Educational programmes should incorporate a conceptual and practical foundation in the provision of transitional care. Healthcare licensure, certification, and accreditation requirements should reflect these emerging roles and the associated responsibilities and accountabilities (Naylor et al., 2011).

The nurse practitioner-transition role warrants further testing based on the following findings: among patients with complex care needs, the complementary provider nurse practitioner significantly reduced index re-hospitalisation 90 days and 180 days post-discharge (with a bordering-on-significance reduction in any re-hospitalisation 90 days post-discharge); and all non-statistically significant point estimates for health system outcomes across studies favoured nurse practitioner care (index re-hospitalisations up to 42 days post-discharge; any re-hospitalisations over 30 and 180 days post-discharge; hospital costs at 30, 90 and 180 days; emergency department visits; and acute care visits). This would require identification of populations at high risk of re-hospitalisation, careful design and evaluation of tailored interventions, and exploration of the most efficient use of a nurse practitioner (e.g., incorporation into an existing inpatient nurse practitioner role, sharing of a nurse practitioner across neighbouring hospitals, or between hospitals and communities). Studies designed to test the cost-effectiveness of these roles should be designed in conjunction with a health economist and should include all related hospital, community, patient and family costs, and should link costs to

outcomes. It is also important to establish which outcomes are critical to measure (for a given role and population) and to establish the clinically and economically important thresholds (MIDs and RR differences) that would inform practice and policy decisions.

6. Conclusion

The objective of this systematic review was to determine the cost-effectiveness of nurse practitioners in alternative and complementary roles delivering transitional care from hospital to community. Most effect estimates showed no significant differences between nurse practitioner-provided and usual care. There is some low quality evidence that nurse practitioners may reduce re-hospitalisations. Given the low quality evidence, weak economic analyses, small sample sizes, and small number of nurse practitioners evaluated in each study, results about the cost-effectiveness of nurse practitioner-transitional care are inconclusive and further research is needed.

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The Impact of Nonphysician Clinicians

Do They Improve the Quality and Cost-Effectiveness of Health Care Services?

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Health care is changing rapidly. Unacceptable variations in service access and quality of health care and pressures to contain costs have led to the redefinition of professional roles. The roles of nonphysician clinicians (nurses, physician assistants, and pharmacists) have been extended to the medical domain. It is expected that such revision of roles will improve health care effectiveness and efficiency. The evidence suggests that nonphysician clinicians working as substitutes or supplements for physicians in defined areas of care can maintain and often improve the quality of care and outcomes for patients. The effect on health care costs is mixed, with savings dependent on the context of care and specific nature of role revision. The evidence base underpinning these conclusions is strongest for nurses with a marked paucity of research into pharmacists and physician assistants. More robust evaluative studies into role revision are needed, particularly with regard to economic impacts, before definitive conclusions can be drawn.

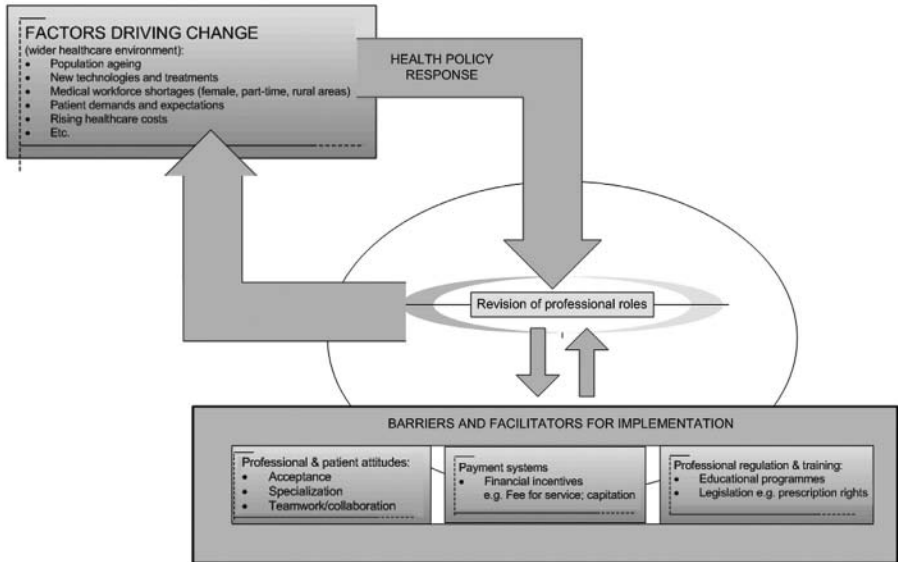
Keywords: *systematic review; evaluation; advanced nursing; physician assistants; pharmacists; revision of professional roles*

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Figure 1
Schematic Overview of Factors Governing Revision of Professional Roles



Introduction

The factors shaping health care professional roles are many and complex (Sibbald, Laurant, & Scott, 2006). These factors may be grouped into three broad areas—namely, the factors driving change, health policy response to those drivers, and the factors influencing policy implementation (see Figure 1).

The factors driving change in the wider health care environment include rising demand for health care, unacceptable variations in service access and quality, pressure to contain costs, and medical workforce shortages (Buchan, Ball, & O'May, 2000; Sergison, Sibbald, & Rose, 1997; Sibbald, Laurant, & Scott, 2006; Taylor & Leese, 1998). Policy makers can respond to these challenges in a variety of ways, but one widespread strategy has been to extend the role of nonphysician clinicians into areas that were previously the domain of physicians alone. The expectation is that nonphysician clinicians can (Jenkins-Clarke, Carr-Hill, & Dixon, 1998; Sibbald, Laurant, & Scott, 2006; Whitecross, 1999)

- enhance the quality of physician care;
- substitute for physicians, so reducing demand for physicians and relieving physician shortages; and
- reduce service costs because nonphysician clinicians are cheaper to hire than physicians.

Medical workforce shortages in specific clinical areas and/or geographic populations (e.g., rural and remote) were key factors driving the introduction of advanced practice nurses (such as nurse practitioners, clinical nurse specialists, specialist practitioner, nurse therapist, nurse consultant, etc.) in the United States in the 1960s, the United Kingdom in the 1980s, Canada in the 1970s, and Australia in the 1990s (American College of Nurse Practitioners [ACNP], 2006; Ball, 2006; Carnwell & Daly, 2003; Carryer, Gardner, Dunn, & Gardner, 2007; Daly & Carnwell, 2003; Laurant, 2007; Spitzer & Kergin, 1975). Advanced practice nurses are registered nurses who followed advanced education (mostly at master's level) and clinical training, allowing them to provide a wide range of preventive and acute health care services to groups and individuals of all ages. In the United States, they were first introduced in pediatrics, but now they practice in many other specialty areas (ACNP, 2006; Ball, 2006; Carnwell & Daly, 2003; Daly & Carnwell, 2003). Physician assistants were first introduced in the United States in the 1960s to improve patient access to care in medically underserved populations (American Academy of Physician Assistants [AAPA], 2008) and have subsequently been deployed in the United Kingdom, the Netherlands, Canada, Australia, and Taiwan for the same purpose (Hooker, Hogan, & Leeker, 2007). In the United States, physician assistants work across a wide range of health care settings (e.g., hospital, satellite clinics, community practices, and government agencies) and in a wide variety of clinical areas, including family medicine, cardiothoracic surgery and cardiology, respiratory medicine, gastroenterology, obstetric and gynecology, emergency medicine, pediatrics, geriatrics, and so on (AAPA, 2004, 2005). Physician assistants are only licensed to practice medicine with physician supervision (Hooker & Cawley, 1997).

A second important driver has been the desire to improve the quality of care without increasing the demand on physicians. This was the principal reason behind the growth in nurse practitioner roles in primary care in the United Kingdom and the Netherlands from the 1990s (Ball, 2006; Carnwell & Daly, 2003; Daly & Carnwell, 2003; Laurant, 2007). Similarly, extended roles for pharmacists were introduced in the United States, the United Kingdom, and Canada primarily to improve the quality of patient care (American College of Clinical Pharmacy [ACCP], 2000; Keeley, 2002).

The pace and extent of role revision is modified by factors such as professional and patient attitudes, payment systems, and professional regulation and training. Health care professionals' willingness to renegotiate the boundaries between themselves and other disciplines is one important factor moderating the pace of change (Atkin & Lunt, 1996; Wilson, Pearson, & Hassey, 2002; Zwart & Filippo, 2006) as is patients' acceptance of those role changes (Laurant et al., 2008; McKenna, 1995). Nurses, physician assistants, and pharmacists generally have been willing to extend their roles while physicians often have opposed this trespass on their role. Patients' views of nonphysicians working in extended roles are shaped by many factors but physician attitudes again play a vital role. Physicians need to foster patient

acceptance of nonphysician clinicians working in new roles if role revision is to succeed (Branson, Badger, & Dobbs, 2003; Laurant et al., 2008).

The successful implementation of role revision additionally requires payment systems that reward, or at least do not penalize, the health care professionals and employers who adopt new ways of working. Where health insurance systems prohibit charging for the services provided by nonphysician clinicians, role revision is constrained (Hansen-Turton et al., 2006; Hansen-Turton, Ritter, & Torgan, 2008; McGregor, Jabareen, O'Donnell, Mercer, & Watt, 2008; Maisey et al., 2008; S. Phillips, 2007). Conversely, role revision may spread rapidly where health care organizations are able to realize financial gains. This was the situation in U.K. general practice in the 1990s when a new payment system enabled practices to employ nurses, rather than doctors, to deliver a range of services that attracted new payments (Baker & Klein, 1991; Glennerster, Matsaganis, Owens, & Hancock, 1994; Newton, Fraser, Robinson, & Wainwright, 1993). Finally, professional education and regulatory systems have to be adapted to support and facilitate role revision (Sibbald, Laurant, & Scott, 2006). Nonphysician clinicians working in new roles need to be trained and accredited for this work, and it takes time and effort to agree on and implement new standards. Regulations governing health professions' scope of practice also may need to be revised to realize the full benefits of role revision. For example, nonphysician clinicians without prescribing rights must have their prescriptions signed by a physician—a practice that interrupts service delivery, irritates both patients and physicians, and reduces health care efficiency (Broers, Van Haelst, Umans, & Voorberg, 2007; Kaplan & Brown, 2004; Redsell, Stokes, Jackson, Hastings, & Baker, 2006; Wilson et al., 2002). For this reason, many countries have extended prescribing privileges to suitably qualified nonphysician clinicians (e.g., Avery & Pringle, 2005; Department of Health, 2002; Ministerie van Volksgezondheid, Welzijn en Sport, 2007; Morgenstern & Brown, 1996).

While the revision of roles between physicians and nonphysician clinicians is widespread and growing, the evidence base to support such changes is both difficult to access and meager in relation to the scale and scope of workforce reforms. It therefore remains unclear whether professional role revision delivers the expected gains for patients, professionals, and health care systems. Our aim was to synthesize the available evidence in order to inform future workforce reforms. The focus is on those types of nonphysician clinicians who figure most prominently in role revisions of this kind, notably

- Nurses, including advanced practice nurses, nurse practitioners, specialist nurses, clinical nurse specialists, and practice nurses
- Physician assistants
- Pharmacists

New Contribution

Past reviews relating to revision of professional roles have focused on only one type of role revision (e.g., substitution but not supplementation), one type of nonphysician clinician (e.g., nurse but not pharmacist), one specific health care setting (e.g., general practice but not hospital), or one specific clinical area (e.g., chronic disease management but not acute care). This review makes a new contribution to the literature by synthesizing the evidence on role revision between physicians and nonphysician clinicians across both types of revision, all principal types of nonphysician clinicians, all health care settings, and all clinical areas. In doing so, the review enables us to identify the key impacts of role revision on patient care and outcomes that cannot easily be distilled in the fragmented evidence base underpinning previous reviews. The findings should help inform the decisions of policy makers, health care planners, and health care professionals who may be contemplating role revision as a means to improve health care quality, outcomes, and/or efficiency.

Conceptual Framework

Health care professional roles undergo continuous revision in response to technological, economic, and social pressures. Here, we are concerned with that subset of revisions in which nonphysician clinicians take on defined tasks that were previously the domain of physicians alone. There are two conceptually different approaches to role revision in this context (Sibbald, Laurant, & Scott, 2006). The first is to deploy nonphysician clinicians as *supplements* for physicians. Nonphysician clinicians working in this way provide additional services that are intended to complement or extend those provided by physicians. The aim is generally to improve the quality of care and extend the range of services available to patients. The second approach is to deploy nonphysician clinicians as *substitutes* for physicians. Nonphysician clinicians working in this way provide the same services as physicians to reduce physician workload, increase service capacity, and/or reduce costs. Gains in service efficiency may be achieved if physicians give up providing the services that are transferred to nonphysicians and instead invest their time in activities that only physicians can perform.

A single role revision may combine elements of both supplementation and substitution. For example, a nurse practitioner may be deployed to undertake the routine follow-up of patients with asthma. If follow-ups were previously conducted by physicians, the nurse is acting as a physician substitute. However, the follow-up service provided by the nurse may contain additional elements (e.g., patient education and support for lifestyle change) that were not previously provided by physicians. In this situation, the nurse is acting as a physician supplement as well as a substitute.

In reviewing the evidence on role revision, it is generally unclear whether nonphysician clinicians are working as supplements, substitutes, or both, based on the description of their roles. It is however possible to separate the effects of supplementation and substitution based on the study design. Studies that compare nonphysician clinicians to physicians performing the same task provide evidence on the effects of substitution. They address the question of whether one type of professional performs as well as another when asked to undertake the same work. Studies that compare a nonphysician clinician and physician working in partnership to a physician working alone provide evidence on the effects of supplementation. They address the question of how multiprofessional service provision compares with uniprofessional service provision. The role undertaken by the nonphysician clinician may be similar in both types of studies but the implications for health service provision are distinct.

Revision of roles may take place in different types of settings, including primary care, ambulatory or outpatient care, community care, hospital care, inpatient care, accident and emergency departments, or at the interface care between primary and secondary care. Role revision may be targeted to a wide range of clinical areas, including the prevention of diseases, chronic disease management, and the treatment of minor illnesses, acute illnesses, or minor injuries.

Literature Search Method

Electronic searches were performed by the research team to identify articles for this review. The databases searched included Medline, Cumulative Index to Nursing & Allied Health Literature (CINAHL), Embase, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects (DARE), Joanna Briggs Institute Systematic Review Database, Agency for Healthcare Research and Quality Electronic Catalogue (AHRQ), British Library Integrated Catalogue, Organization for Economic Cooperation and Development (OECD), Grey Literature in the Netherlands (GLIN), ProQuest Dissertations and Theses—A&I (PQDT), Sociological Abstracts, World Health Organization (WHO), and Web of Science. As electronic searches did not find any literature reviews or controlled studies in the area of physician assistants, an expert from the United States (who is very familiar with the literature on physician assistants) was contacted to identify articles in this area. Electronic searches covered all publications to February 2008; expert contact covered publications from 1961 to July 2008. Both English and Dutch articles were included. For complete listing of keywords used in the electronic searches, see Laurant et al. (2009).

We adopted a stepped approach to data collection, based on “best evidence” concepts. We first searched for systematic reviews or meta-analyses. If evidence from systematic reviews and meta-analysis was sparse (less than four systematic reviews or meta-analyses) or out of date (published before 2005), we added articles reporting the findings of original studies that employed a control condition (e.g., experimental

studies, quasi-experimental studies, controlled observational studies; Khan, ter Riet, Popay, Nixon, & Kleijnen, 2001). Original studies were included only if they had not already been included in a systematic review or meta-analysis. Each article identified through our search process was independently reviewed for relevance by at least two reviewers. Articles were included if they compared nonphysician clinicians (working alone or in partnership with a physician) to usual care provided by physicians and reported outcomes of interest (clinical, patient, process of care, resource utilization, and costs/cost-effectiveness). Data were extracted using a standardized form by one reviewer (ML, MH, or MF). The methodological quality of studies was assessed using a set of six self-developed criteria related to reproducibility and validity of the method used in the (systematic) literature reviews or controlled studies and the strength of evidence presented in the articles. The following criteria were used: (a) Was the search period specified? (b) Were the search terms given? (c) Was there a list of the databases that were searched? (d) Was study selection and data extraction carried out independently by at least two reviewers? (e) Were the criteria used to assess the methodological quality of included studies clearly stated (self-developed or frequently used by others)? (f) Was each original study awarded an overall score reflecting methodological quality? One point was awarded for each criterion that was met, yielding an overall score ranging from 0 to 6 points for each review. Methodological quality was rated *poor* when the overall score was 0 to 2 points, *moderate* 3 or 4 points, and *good* 5 or 6 points.

No formal statistical analyses were performed to assess the impact of role revision. We focused on describing the strength of the evidence in terms of effect sizes (e.g., effect sizes, odds ratios, relative risk, standardized or weighted mean difference), 95% confidence intervals, level of statistical significance, and number of studies included in the statistical analysis. Where these data were not reported, we included qualitative reports of the findings.

For a complete overview of the data extraction, validity assessment, and data synthesis, see Laurant et al. (2009). Overall, the evidence review was based on findings from 24 systematic reviews (a total of 28 articles) and three original, controlled observational studies (all related to physician assistant role revision).

Organization of Evidence

For the purpose of this study, three reviewers (ML, MH, and MF) independently divided the articles on the basis of the description of the “intervention” and study design into one of the following categories of role revision: substitution, supplementation, or a mixture of both. Disagreements between the reviewers were resolved by discussion.

Although the objectives of substitution and supplementation are different (see section “Conceptual Framework”), the outcomes reported in the research were not necessarily linked to the objective(s) and different types of role revision often included in the same types of outcomes.

Frequently studied outcomes were quality of life, reduction of symptoms or amelioration of pathological conditions, patient satisfaction, and frequency of tests and investigations. Outcomes were grouped differently by different authors, and some measures may appear in more than one category. For example, the number of prescriptions may be seen as a resource utilization outcome, whereas the appropriateness of a prescription may be seen as a process of care outcome. The first is relevant to the assessment of costs and cost-effectiveness, while the latter is relevant to the assessment of quality of health care. For the purpose of comparison, the outcomes reported in the articles included were assigned to one of five categories (although the authors of these reviews and original studies did not necessarily use the same taxonomy): (a) clinical outcomes (e.g., metabolic parameters, health status), (b) patient outcomes (e.g., patient satisfaction), (c) process of care (e.g., quality/appropriateness of care), (d) resource utilization (e.g., number of visits, prescriptions), and (e) costs/cost-effectiveness.

First, we present the findings on the effectiveness of role revision grouped by type of nonphysician clinician (nurses, physician assistants, and pharmacists). Next, we present the findings grouped by type of role revision (substitution, supplementation, or mixture of both).

Key Findings

Nurse–Physician Role Revision

Our literature search identified 18 systematic reviews of role revision between physicians and advanced practice nurses (including nurse practitioners, nurse specialists) in which at least one of our outcomes of interest (see previous paragraph) was reported. See Table 1 for a description of the reviews and key findings.

Context. Nurses worked as physician substitutes and/or supplements in a range of care settings. Six reviews studied the impact of role revision in primary health care settings such as general practice/family medicine, ambulatory or outpatient care, and community care (Brown & Grimes, 1995; Chapman, Zechel, Carter, & Abbott, 2004; Du Moulin, Hamers, Paulus, Berendsen, & Halfens, 2005; Horrocks, Anderson, & Salisbury, 2002; Laurant et al., 2004; Oakeshott, Kerry, Austin, & Cappuccio, 2003). Five reviews focused on secondary health care settings such as hospitals and accident and emergency departments (Dealey, 2001; French, Bilton, & Campbell, 2003; Griffiths, Edwards, Forbes, Harris, & Ritchie, 2007; C. O. Phillips, Singa, Rubin, & Jaarsma, 2005; Smallwood, 2004). The remaining reviews included research in either primary and secondary health care settings (Bradley & Lindsay, 2001; Hearnshaw et al., 2006; Loveman, Royle, & Waugh, 2003; Thomas et al., 1999;

Vrijhoef, Diederiks, & Spreeuwenberg, 2000) or a home care setting (Frich, 2003; Smith, Appleton, Adams, Southcott, & Ruffin, 2001).

The clinical domain in which the nurses worked varied from generalist care, undifferentiated care, or care for multiple diseases (Brown & Grimes, 1995; Chapman et al., 2004; Horrocks et al., 2002; Laurant et al., 2004) to care for a specific patient group, such as patients with diabetes (Hearnshaw et al., 2006; Loveman et al., 2003), chronic obstructive pulmonary disease (COPD; Smith et al., 2001), hypertension or other cardiovascular diseases (Oakeshott et al., 2003; C. O. Phillips et al., 2005; Smallwood, 2004), and minor injuries (Dealey, 2001). The clinical domain was not specified in two reviews (Griffiths et al., 2007; Thomas et al., 1999). An exact description of nurses' roles was lacking in the majority of reviews. The control condition was often not clearly described but was assumed to represent usual care by physicians.

Eight reviews studied the effects of substitution (Chapman et al., 2004; Dealey, 2001; French et al., 2003; Horrocks et al., 2002; Laurant et al., 2004; Oakeshott et al., 2003; Smallwood, 2004; Thomas et al., 1999). Both primary and secondary health care settings were represented, and the clinical domains encompassed both patients with single conditions and those with multiple diagnoses. Eight reviews evaluated the effects of nurses working in extended roles as physician supplements (Bradley & Lindsay, 2001; Du Moulin et al., 2005; Griffiths et al., 2007; Hearnshaw et al., 2006; Loveman et al., 2003; C. O. Phillips et al., 2005; Smith et al., 2001; Vrijhoef et al., 2000). Both primary and secondary care settings were represented. Nurses' clinical domain often was focused on patients with a specific condition (e.g., diabetes, COPD, cardiovascular diseases, incontinence, or epilepsy). Two reviews were identified as a mixture of substitution and supplementation (Brown & Grimes, 1995; Frich, 2003).

With the exception of one review (Brown & Grimes, 1995), all were published in the 2000s, with four published in 2005 or later (Du Moulin et al., 2005; Griffiths et al., 2007; Hearnshaw et al., 2006; C. O. Phillips et al., 2005). The original studies included in those reviews covered all previously published relevant research, extending back to the 1960s. The majority of original studies were carried out in the United States and the United Kingdom. Exact figures for each country are difficult to give as five authors failed to report this information (Brown & Grimes, 1995; Dealey, 2001; French et al., 2003; Frich, 2003; Horrocks et al., 2002).

Bradley and Lindsay (2001), Du Moulin et al. (2005), French et al. (2003), Griffiths et al. (2007), C. O. Phillips et al. (2005), and Smallwood (2004) all included original studies that were not included in one of the other reviews. All other reviews included at least one original study that also was included in 1 or 2 other reviews. In total, 199 unique original studies were included of which 27 studies were included in 2 reviews and 5 studies were included in 3 reviews.

The methodological quality of the reviews was generally rated as "good." Four reviews were rated as having "moderate" overall methodological quality (Brown & Grimes, 1995; Chapman et al., 2004; Smallwood, 2004; Vrijhoef et al., 2000) and one

review was rated “poor” (Dealey, 2001). The methodological quality of the original studies included in the reviews, as rated by the review authors, varied from adequate or good (Bradley & Lindsay, 2001; French et al., 2003; Frich, 2003; Oakeshott et al., 2003) to insufficient or weak (Brown & Grimes, 1995; Chapman et al., 2004; Dealey, 2001; Horrocks et al., 2002; Smallwood, 2004; Thomas et al., 1999).

Effects on clinical outcomes. Sixteen of 18 reviews measured clinical outcomes, such as mortality, reduction of symptoms, metabolic/pathological parameters (e.g., HbA1c, blood pressure, cholesterol), and quality of life. Mortality was assessed in 7 reviews (Chapman et al., 2004; Frich, 2003; Griffiths et al., 2007; Laurant et al., 2004; C. O. Phillips et al., 2005; Smith et al., 2001; Vrijhoef et al., 2000). Three reviews conducted a meta-analysis (covering 18 original studies) wherein all studies showed no difference in the number of deaths between nurse-led care and physician-led care (Griffiths et al., 2007; C. O. Phillips et al., 2005; Smith et al., 2001). Two original studies in Vrijhoef et al. (2000) (both including a respiratory nurse specialist) and one study in Frich (2003) found significantly better survival rates in the nurse-led care group. All other reviews supported the results of the meta-analysis.

Reduction of symptoms or improvement in pathological condition (metabolic parameters such as HbA1c, lung function) was measured in 8 systematic reviews (Bradley & Lindsay, 2001; Brown & Grimes, 1995; Du Moulin et al., 2005; French et al., 2003; Hearnshaw et al., 2006; Loveman et al., 2003; Oakeshott et al., 2003; Thomas et al., 1999). Only Brown and Grimes (1995) conducted a meta-analysis, which showed a significant improvement in pathological condition (effect size [ES] = 0.28, 95% confidence interval [CI] = 0.04-0.51, $p = .01$, $n = 6$). Du Moulin et al. (2005) showed a significant reduction in number of incontinence episodes in 8 out of 11 original studies. All other reviews, each including 1 to 8 original studies, found no differences between groups.

Quality of life, health status, or functional status was measured in 11 systematic reviews (Bradley & Lindsay, 2001; Brown & Grimes, 1995; Du Moulin et al., 2005; French et al., 2003; Griffiths et al., 2007; Hearnshaw et al., 2006; Horrocks et al., 2002; Laurant et al., 2004; C. O. Phillips et al., 2005; Smith et al., 2001; Vrijhoef et al., 2000). Brown and Grimes (1995), Griffiths et al. (2007), and C. O. Phillips et al. (2005) conducted meta-analyses. Griffiths et al. (2007) showed significant improvements in quality of life or health status in favor of the nurse-led care group (standardized mean difference = 0.35, 95% CI = 0.16-0.53, $p < .0005$, $n = 6$), while the other 2 reviews found no difference between nurse-led care and physician-led care (respectively, ES = 0.03, 95% CI = -0.09 to 0.15, $p = .60$, $n = 3$; % improvement 30.6% [standardized difference (SD), 20.7% vs. 19.3, SD 12.6%], $p = .13$, $n = 3$). The majority of the other reviews also found no differences between groups. Two reviews showed inconclusive findings (Smith et al., 2001; Vrijhoef et al., 2000). Half of the studies included in these reviews showed significant improvements in quality of life

in the nurse-led care group, whereas the other half found no differences. There was an overlap in studies (results of 2 trials included in both reviews).

For all other clinical outcomes no differences were found between nurses and physicians. The findings were quite similar across different health care settings (see Table 1).

Effects on patient outcomes. Patient outcomes, such as patient satisfaction, compliance, and knowledge, were included in 12 out of 18 reviews (Bradley & Lindsay, 2001; Brown & Grimes, 1995; Chapman et al., 2004; Dealey, 2001; Du Moulin et al., 2005; Frich, 2003; Griffiths et al., 2007; Hearnshaw et al., 2006; Horrocks et al., 2002; Laurant et al., 2004; Thomas et al., 1999; Vrijhoef et al., 2000). Evidence is strongest for patient satisfaction, which was measured in 10 reviews. In primary health care settings, all reviews showed significantly higher levels of patient satisfaction in the nurse-led care group. Two reviews in hospital settings showed no differences between nurses and physicians with regard to patient satisfaction (Dealey, 2001; Griffiths et al., 2007). Findings in the remaining 3 reviews were mixed. Thomas et al. (1999) showed that patients were significantly more satisfied with nurses in 2 out of 3 trials. The findings of Vrijhoef et al. (2000) were inconclusive (2 trials with significantly higher levels of patient satisfaction in the nurse-led care group and 2 trials with no differences). Frich (2003) found no difference in patient satisfaction in 6 trials.

The effect on patient compliance is inconclusive. Meta-analysis in one review showed that compliance significantly improved in the nurse-led care group ($ES = 0.36$, $95\% CI = 0.08-0.64$, $p < .01$, $n = 3$; Brown & Grimes, 1995), but semiquantitative analysis of three studies in a second review (Laurant et al., 2004) found no differences (one trial was also included in the review by Brown & Grimes, 1995). Improvement in patient knowledge was measured in five reviews (Bradley & Lindsay, 2001; Brown & Grimes, 1995; Laurant et al., 2004; Thomas et al., 1999; Vrijhoef et al., 2000). With the exception of Vrijhoef et al. (2000), none of the reviews found significantly improved knowledge.

For all other patient outcomes no appreciable differences were found between nurses and physicians (see Table 1).

Effects on process of care outcomes. Process of care outcomes, such as appropriate management, appropriate diagnosis/screening, appropriate testing and investigation, and appropriate record keeping, was measured in eight reviews (Bradley & Lindsay, 2001; Brown & Grimes, 1995; Chapman et al., 2004; Dealey, 2001; Horrocks et al., 2002; Laurant et al., 2004; Smallwood, 2004; Thomas et al., 1999). The majority of these outcomes were measured in only a few original studies. Evidence is strongest for appropriate advice giving; patients are significantly better informed by nurses when compared with physicians ($ES = 0.56$, $95\% CI = 0.26-0.85$, $p < .001$, $n = 3$; Brown & Grimes, 1995). Horrocks et al. (2002) and Laurant et al.

(2004) also found that nurses were significantly more likely to offer patients advice and were better communicators than physicians.

Although measured in a small number of original studies, access to health care services also seemed better with nurse-led care (Chapman et al., 2004; Dealey, 2001; Smallwood, 2004; Thomas et al., 1999). Three reviews that studied the impact on access in the hospital emergency setting showed significantly shorter waiting times (Dealey, 2001; Thomas et al., 1999) and faster administration of appropriate life-saving medication with nurse-led care (Smallwood, 2004). Chapman et al. (2004) found that walk-in centers located in primary health care settings enhanced access to health care, but only for a minority of the population. Contrary to expectations, walk-in centers did not reduce inequalities in access to health care services (based on four studies).

The evidence regarding other processes of care outcomes is meager as each was investigated in fewer than three studies, but findings suggest that nurse-led care is at least as good as physician-led care (see Table 1).

Effects on resource utilization. Resource utilization was measured in 16 of 18 reviews, though the majority of these outcomes were measured in only a few original studies (Bradley & Lindsay, 2001; Brown & Grimes, 1995; Chapman et al., 2004; Dealey, 2001; Du Moulin et al., 2005; French et al., 2003; Frich, 2003; Griffiths et al., 2007; Hearnshaw et al., 2006; Horrocks et al., 2002; Laurant et al., 2004; Loveman et al., 2003; C. O. Phillips et al., 2005; Smith et al., 2001; Thomas et al., 1999; Vrijhoef et al., 2000). The number of tests and investigations ordered was the most frequent outcome studied (Bradley & Lindsay, 2001; Brown & Grimes, 1995; Chapman et al., 2004; Dealey, 2001; Hearnshaw et al., 2006; Horrocks et al., 2002; Laurant et al., 2004; Thomas et al., 1999). Meta-analysis (Brown & Grimes, 1995; Horrocks et al., 2002) showed that nurses ordered significantly more tests and investigations than physicians (respectively, $ES = 0.20$, 95% $CI = 0.10-0.29$, $p < .001$, $n = 4$; odds ratio [OR] = 1.22, 95% $CI = 1.02-1.46$, $p < .05$, $n = 5$). This was confirmed by semiquantitative and qualitative analyses by Bradley and Lindsay (2001), Chapman et al. (2004), Hearnshaw et al. (2006), and Thomas et al. (1999), who each reviewed 3 or fewer original studies. Other reviews found, however, no difference between nurses and physicians (Laurant et al., 2004) or inconclusive results (Dealey, 2001).

Hospitalization was measured in seven reviews (Bradley & Lindsay, 2001; Brown & Grimes, 1995; French et al., 2003; Laurant et al., 2004; Loveman et al., 2003; Smith et al., 2001; Thomas et al., 1999), and length of hospital stay was measured in four reviews (Frich, 2003; C. O. Phillips et al., 2005; Smith et al., 2001). Meta-analysis of three original studies showed a significant decrease in patients' admissions to the hospital in the nurse-led group ($ES = -0.17$, 95% $CI = -0.22$ to -0.12 , $p < .0001$, $n = 3$; Brown & Grimes, 1995). This was confirmed by one study included in Bradley and Lindsay (2001). Other reviews found no difference in hospitalization, with

the exception of Smith et al. (2001), who found a significant increase in hospital admissions. Two reviews found significantly shorter lengths of stay in hospital in the nurse-led care group (Frich, 2003; C. O. Phillips et al., 2005), whereas two others found increased lengths of stay (Griffiths et al., 2007; Smith et al., 2001).

A key finding in primary health care settings was that the length of consultations was significantly longer for nurses than physicians (Brown & Grimes, 1995; Chapman et al., 2004; Dealey, 2001; Du Moulin et al., 2005; Horrocks et al., 2002; Laurant et al., 2004).

Other resource utilization outcomes were seldom measured and these generally showed no appreciable differences between nurse-led care and physician-led care (see Table 1).

Effects on costs and cost-effectiveness. Eleven reviews included economic outcomes, but none included a formal cost-effectiveness analysis. The findings are inconclusive. Three reviews showed cost savings (Du Moulin et al., 2005; Griffiths et al., 2007; Vrijhoef et al., 2000) whereas two reviews showed increased costs (French et al., 2003; Smith et al., 2001). All other reviews found no difference in cost of health care (Bradley & Lindsay, 2001; Dealey, 2001; Frich, 2003; Hollinghurst, Horrocks, Anderson, & Salisbury, 2006; Laurant et al., 2004; C. O. Phillips et al., 2005).

Physician Assistant–Physician Role Revision

Our literature search and expert contact identified two systematic reviews (one unpublished) and three original studies (not included in the systematic reviews) in which the effectiveness and efficiency of revision of roles between physicians and physician assistants was assessed on at least one of our outcomes of interest. See Tables 2 and 3 for a description of the key findings.

Context. The majority of the studies were conducted in the United States. Frossard, Hooker, O'Connor, Brooks, and Robinson (2007) were not clear about the countries in which the included studies were performed although the majority was conducted in the United States, with a small number in Europe and Africa.

Ohman-Strickland et al. (2008) evaluated the impact of physician assistant care in family practice settings. The physician assistants in the studies by Freedman, Jillson, Coffin, and Novick (1986) and Goldman, Occhiuto, Peterson, Zapka, and Palmer (2004) were deployed at an outpatient women's health center. In all three articles the tasks of the physician assistants were limited to one specific clinical domain—diabetes in the first article and surgical abortion in the latter two articles. The role of the physician assistants studied by Ohman-Strickland et al. (2008) was classified as supplementation. The other two articles studied the effects of substitution. The two review articles (Buchan, O'May, & Ball, 2007; Frossard et al., 2007) were not

Table 1
Systematic Reviews ($n = 18$) on Nurse-Physician Role Revision

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Brown and Grimes (1995)	38 articles (12 RCTs); Q4	To May 1992; D2	United States, Canada	Primary health care; To determine the impact that nurses in primary care roles have on health outcomes and the health care system; mixture	Results of meta-analysis (expressed ES, 95% CI)	<p><i>Clinical outcomes:</i> Both resolution of (pathological) conditions (e.g., HbA1C, blood pressure, symptom relief) significantly improved with nurse-led care (ES = 0.28, 95% CI = 0.04-0.51, $n = 6$). No difference in functional status ($n = 3$).</p> <p><i>Patient outcomes:</i> Nurse-led care had significantly higher levels of patient satisfaction and improved compliance with treatment regimes (respectively, ES = 0.30, 95% CI = 0.20-0.40, $n = 5$; ES = 0.36, 95% CI = 0.08-0.64, $n = 3$). No difference in patient knowledge ($n = 3$).</p> <p><i>Process of care:</i> No difference in quality of care ($n = 5$). Nurse significantly more likely to give advice to patient (ES = 0.56, 95% CI = 0.26-0.85, $n = 3$).</p> <p><i>Resource utilization:</i> Nurses had significantly longer consultations (ES = 1.02, 95% CI = 0.68-1.36, $n = 3$), nurses ordered significantly more tests and investigations and were more likely to refer patients or make use of consultants (respectively, ES = 0.20; 95% CI = 0.10-0.29, $n = 4$; ES = 0.06, 95% CI = 0.01-0.11, $n = 3$). Patients were significantly less often hospitalized with nurse-led care (ES = -0.17, 95% CI = -0.22 to -0.12, $n = 3$). No difference in consultation rate ($n = 4$), number of prescriptions ($n = 3$), use of emergency services ($n = 3$).</p>

(continued)

Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Chapman et al. (2004)	14 articles (5 RCTs); Q3	From 1980 to 2003; D4	United Kingdom (n = 14)	Primary health care; To review the evidence of seven recent innovations in service provision (4 related to role revision) to improve access or equity in access to primary care; substitution	Qualitative description of results (statistics not reported)	<i>Clinical outcomes:</i> No difference in mortality rate (n = 1) or other (not specified) clinical outcomes (n = 4). <i>Patient outcomes:</i> Patients more satisfied with nurse-led care services (n = 7). <i>Process of care:</i> Improved access in nurse-led care services (n = 1). <i>Resource utilization:</i> Nurse had longer consultations (n = 2) and carried out more tests and investigations (n = 2). The number of home visits by a general practitioner was decreased in nurse-led service group (n = 2). No difference in number of referrals to secondary care services (n = 4), number of return visits (n = 4), use of emergency services (n = 4), and use of neighboring services (n = 4). <i>Clinical outcomes:</i> A significant reduction in incontinence episodes was found in 8 of 11 trials in the nurse-led care group (p < .05, n = 2, p < .001, n = 6). No difference in quality of life in 3 of 5 trials, but 2 showed a significant improvement with nurse-led care. <i>Patient outcomes:</i> Patients were significantly more satisfied with nurse-led care in 3 of 4 trials (p < .001). <i>Resource utilization:</i> Two of 3 trials found a reduction in use of pads (p < .05). Evidence is inconclusive regarding length of consultation; in 1 trial, nurses had significantly longer consultations, whereas in another trial no difference was found.
Du Moulin et al. (2005)	11 articles (11 RCTs); Q5	To April 2004; D3	United States (n = 7), Canada (n = 1), Norway (n = 1), Australia (n = 1), mix of countries (n = 1)	Primary health care; To determine what the effect is of nurses treating patients with urinary incontinence when compared with usual care; supplementation	Semi-quantitative report of results (including p values)	

(continued)

Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Horrocks et al. (2002) and Hollinghurst et al. (2006)	34 articles (11 RCTs); Q6	To 2001; D8	Developed countries such as Europe, North America, Australia, Israel, South Africa, and Japan	Primary health care; To determine whether nurse practitioners (NP) can provide care at first point of contact equivalent to general practitioners (GP) and to compare the costs of NP with salaried GP; substitution	Results of meta-analysis (expressed SMD, WMD, OR, 95% CI), semiquantitative analysis (significance of outcomes reported)	<p><i>Costs:</i> One of 2 trials found a significant reduction in costs as a result of treatment by nurses (no formal cost–utility analysis). <i>Clinical outcomes:</i> No difference in health status or quality of life ($n = 7$). <i>Patient outcomes:</i> Patients were significantly more satisfied with nurses compared to physicians using one approach to measurement (SMD = 0.27, 95% CI = 0.07–0.47, $p < .0001$, $n = 5$; continuous data), whereas no difference in satisfaction was found using a second approach to measurement ($n = 3$); dichotomous data.</p> <p><i>Process of care:</i> Nurse practitioners seemed to offer better care (more often identified physical abnormalities ($n = 1$), but no difference in interpretation of X-rays ($n = 2$), gave more information ($n = 2$), more complete records ($n = 2$), and better communication ($n = 2$)).</p> <p><i>Resource utilization:</i> Nurses had significantly longer consultations and ordered more tests and investigations (respectively, WMD = 3.67, 95% CI 2.05–5.29, $p < .0001$, $n = 5$; OR 1.22, 95% CI = 1.02–1.46, $p < .05$, $n = 5$). No difference in number of prescriptions ($n = 4$), return consultations ($n = 6$), or referrals ($n = 2$). <i>Costs:</i> No difference in costs between nurse practitioner and salaried general practitioner from general practice perspective or NHS perspective ($n = 2$).</p>

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Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Laurant et al. (2004)	16 articles (13 RCTs); Q6	To December 2002; D8	United Kingdom ($n = 6$), United States ($n = 6$), Canada ($n = 4$)	Primary health care; To investigate the impact of nurses working as doctors' substitutes; substitution	Results of meta-analysis (expressed SMD, RR, 95% CI) Semi-quantitative analysis (significance of outcomes reported)	<p><i>Clinical outcomes:</i> Meta-analysis found no difference in physical function ($n = 3$). No difference in health status or quality of life ($n = 1$) and mortality rate ($n = 3$).</p> <p><i>Patient outcomes:</i> Patients were significantly more satisfied with nurse-led care (SMD = 0.28, 95% CI = 0.21-0.34, $p < .00001$, $n = 3$).</p> <p>Semi-quantitative analysis of remaining studies ($n = 4$) showed no difference in level of satisfaction. No difference in patient compliance ($n = 3$) or knowledge ($n = 2$) was found.</p> <p><i>Process of care:</i> Nurses were significantly more likely than physicians to provide lifestyle advice (2 of 3 trials). No difference regarding appropriate assessments and examinations ($n = 3$), management of episodes ($n = 1$), lapses in care ($n = 1$), or adequate drug prescriptions ($n = 2$).</p> <p><i>Resource utilization:</i> Meta-analysis showed no differences in number of return consultations ($n = 3$), number of prescriptions ($n = 3$), hospital referrals ($n = 3$) or admissions ($n = 3$), and use of emergency services ($n = 3$). Semi-quantitative analysis of remaining outcomes found that nurses had significantly longer consultations ($n = 3$). Other outcomes did not differ (test and investigations [3 of 4 trials], use of other services [2 of 3 trials], or consultation rate [3 of 3 trials]).</p>

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Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Oakeshott et al. (2003)	10 articles (10 RCTs); Q5	From 1990 to December 2001; D4	United Kingdom (n = 10)	Primary health care; To determine the effectiveness of nurse-led management of patients with high blood pressure; substitution	Semi-quantitative analyses (difference in change and significance of outcomes reported)	<p><i>Costs:</i> No difference in costs, with the exception of 1 trial that found a net reduction in direct health care costs (n = 5).</p> <p><i>Clinical outcomes:</i> No difference in blood pressure without a change in prescribing (7 of 8 trials).</p>
Dealey (2001)	9 articles (? RCTs); Q2	To 2000; D8	Not reported	Secondary health care; To determine the effectiveness of the emergency nurse practitioner in treating minor injuries in comparison with junior physicians; substitution	Semi-quantitative analyses (p value reported)	<p><i>Patient outcomes:</i> No difference in patient satisfaction in 3 of 4 trials.</p> <p><i>Process of care:</i> Nurses were significantly better at recording an adequate medical history (p < .001, n = 1). Nurses significantly reduced waiting times (n = 3) and transit time between different services (n = 1). No difference regarding appropriateness of treatment (n = 1), and interpretation of radiographs (n = 5).</p> <p><i>Resource utilization:</i> Nurses had significantly longer consultations (n = 1). Significantly fewer patients had an unplanned return visit with nurse-led care (p < .05, n = 1). No difference in planned</p>

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Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
French et al. (2003)	1 article (1 RCT); Q6	To July 2006; DI	Not reported	Secondary health care; To determine the effectiveness of nurse-led care in the management of bronchiectasis; substitution	Quantitative analysis (expressed WMD, 95% CI)	<p>follow-up visits ($n = 1$). Findings are inconclusive regarding number of tests and investigations ordered ($n = 2$).</p> <p><i>Costs</i>: No difference in cost of investigations or treatments ($n = 10$).</p> <p><i>Clinical outcomes</i>: No differences in lung function, exercise capacity, infective flare ups, and quality of life.</p> <p><i>Resource utilization</i>: No difference in hospital admissions after correction for bronchiectasis, without correction patients in nurse-led care group were significantly more likely to be admitted to hospital. No difference in prescriptions.</p> <p><i>Costs</i>: Increased costs with nurse-led care due to hospital admissions and use of intravenous antibiotics.</p>
Griffiths et al. (2007) and Edwards, Forbes, and Harris (2005)	11 articles (10 RCTs); Q6	To December 2006; D7	United Kingdom ($n = 8$), United States ($n = 3$)	Secondary health care; To determine whether nurse-led inpatient units are effective in preparing patients for discharge from hospital; supplementation	Results of meta-analyses (expressed SMD, WMD, OR, 95% CI) description of costs	<p><i>Clinical outcomes</i>: Functional status and quality of life or health status improved significantly in nurse-led group (respectively, SMD = 0.35, 95% CI = 0.16-0.53, $p < .0005$, $n = 6$; SMD = 0.28, 95% CI = 0.09-0.48, $p < .005$, $n = 5$). No difference in mortality ($n = 8$) or psychological well-being ($n = 3$).</p> <p><i>Patient outcomes</i>: No difference in patient satisfaction ($n = 4$).</p> <p><i>Resource utilization</i>: Patients in nursing group had significantly more hospital days (WMD = 7.37</p>

(continued)

Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Phillips et al. (2005)	6 articles (6 RCTs); Q5	To November 2004; D4	United States ($n = 1$), Sweden ($n = 3$), Ireland ($n = 1$), New Zealand ($n = 1$)	Secondary health care; To determine the effectiveness of a diversity of published protocols of heart failure disease	Results of meta-analysis (expressed RR, differences in scores, 95% CI)	<p>days, 95% CI 2.86-11.88, $p < .001$, $n = 9$). The odds of readmission were reduced for patients in the nurse-led care unit (OR = 0.52, 95% CI = 0.34-0.80, $p < .005$, $n = 5$). Discharge to institutional care was significantly reduced in the nurse-led care unit (OR = 0.44; 95% CI = 0.22-0.89, $p < .05$, $n = 7$). Intensive care units ($n = 1$): no differences were found regarding discharge to institutional care or length of hospital stay, but patients from intensive nurse-led care units were significantly less likely to be readmitted to hospital ($p < .05$, $n = 1$). Qualitative analysis of other resource use showed that nurse-led care units used fewer resources ($n = 4$) with the exception of physiotherapy ($n = 3$).</p> <p><i>Costs:</i> Six of 7 studies showed lower costs of care nurse-led units. Costs after discharge showed no substantial differences at 6 months ($n = 3$).</p> <p><i>Clinical outcomes:</i> No difference in mortality rate ($n = 6$) or quality of life ($n = 3$).</p> <p><i>Resource utilization:</i> Patients were less likely to be readmitted in the nurse-led group compared with usual care, although the difference was not significant (RR = 0.91, 95% CI = 0.72-1.16, $n = 6$). Heart failure readmission was, however, significantly reduced by 70% ($p < .01$, $n = 2$) when discharge planning was included in the</p>

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Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Smallwood (2004)	5 articles (0 RCTs); Q4	From 1994 to May 2003; D4	United Kingdom ($n = 5$)	management incorporating specialist nurse-led heart failure clinics; supplementation	Data Synthesis/ Report of Findings	nurses' disease management protocol and by 35% ($p < .05$, $n = 4$) when discharge planning was not included in disease management protocol. The number of hospital days was significantly reduced when the disease management protocol included discharge planning (RR = -0.26, 95% CI = -0.49 to -0.02, $n = 2$). <i>Costs:</i> No differences between groups ($n = 3$). <i>Process of care:</i> Door-to-needle time was reduced in nurse-led care group (from median 15 to 18 minutes in nurse group vs. median 20 to 68 minutes in physician group [$n = 5$]).
Bradley & Lindsay (2001) and Meads, Bradley, and Burls (2001)	4 articles (4 RCTs); Q6	To October 2004; D6	United Kingdom ($n = 4$)	Mixture of primary and secondary health care; To determine the effectiveness of specialist epilepsy nurses compared to routine care; supplementation	Semi-quantitative analysis (p value reported)	<i>Clinical outcomes:</i> No differences in seizure frequency ($n = 1$), psychosocial functioning (2 of 3 trials), social functioning ($n = 1$), or quality of life ($n = 1$). <i>Patient outcomes:</i> No overall difference in knowledge (2 of 3 trials) but the subgroup of patients with little knowledge at the start of the study showed significant improvement ($p < .01$, $n = 1$). Second study showed knowledge significantly improved ($p < .05$, $n = 1$). No differences in sick leave ($n = 1$).

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Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Hearnshaw et al. (2006) and Vermeire et al. (2005)	4 articles (4 RCTs); Q6	To end 2005; D9	United States (n = 4)	Mixture of primary and secondary health care; To evaluate the impact of the role of nurses in delivering a range of diabetes care interventions; supplementation	Semi-quantitative analysis (significance of outcomes or p values reported)	<p><i>Process of care:</i> Specialist nurses were significantly more likely to record in medical notes that they had given advice to patients ($p < .001$, $n = 1$).</p> <p><i>Resource utilization:</i> There was a significant increase in serum concentration measurement in the nursing group ($p < .01$, $n = 1$) and significant decrease in outpatient hospital attendance with doctors in the nursing group ($p < .01$, $n = 1$). No difference in general practice consultations ($n = 1$).</p> <p><i>Costs:</i> Specialist nurse care was cheaper compared to usual care, although differences in costs were not significant ($n = 1$).</p> <p><i>Clinical outcomes:</i> No difference in HbA1c ($n = 2$), although 1 trial showed a significant reduction in HbA1c in patients with an initial level of ≥ 8 ($p < .05$, $n = 1$). One trial found a significant reduction in serum glucose in nurse-led care group, whereas the reduction in the usual care group was not significant; but the difference between groups was not reported ($n = 1$). One trial found diabetes-related symptoms decreased in the nurse-led care group (-10%) but increased in the control group ($+10\%$), but the significance of the difference between groups was not reported. No difference in metabolic outcome measures (e.g., blood pressure, lipid profile, renal functions, weight) ($n = 1$) or quality of life ($n = 1$).</p>

(continued)

Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Loveman et al. (2003)	6 articles (6 RCTs); Q6	To 2002; D11	United States ($n = 4$), Canada ($n = 1$), Australia ($n = 1$)	Mixture of primary and secondary health care; To assess the effects of diabetes specialist nurse/ nurse case manager in diabetes; supplementation	Semiquantitative analysis (significance of outcomes reported)	<p><i>Patient outcomes:</i> No differences in compliance with medication and/or tests ($n = 1$).</p> <p><i>Resource utilization:</i> One trial found increased number of tests and investigations with nurse-led care (e.g., HbA1c, low-density lipoproteins, microalbuminuria, diabetic retinopathy), but the significance of the difference was not reported. No difference in use of preventive health services ($n = 1$).</p> <p><i>Clinical outcomes:</i> No difference in HbA1c in 5 of 6 studies while the remaining study found a significant decrease in HbA1c ($p < .01$) with nurse-led care. In the subgroup of patients with initial levels of HbA1c ≥ 8 HbA1c nurses significantly decreased HbA1c ($p < .05$). Inconclusive findings regarding number of hypoglycemic episodes and hyperglycemic episodes (complications). One trial showed significantly fewer episodes ($p < .001$) with nurse-led care, whereas another trial found no difference in episodes. No difference in quality of life ($n = 1$).</p> <p><i>Resource utilization:</i> No difference in hospitalizations ($n = 2$) or emergency admissions ($n = 2$).</p>

(continued)

Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Thomas et al. (1999)	6 articles (6 RCTs); Q6	From 1975 to January 1996; D9	United States ($n = 3$), United Kingdom ($n = 1$), Australia ($n = 1$), Canada ($n = 1$)	Mixture of primary and secondary health care; To evaluate the ability of guidelines to facilitate nurse physician role substitution;	Semiquantitative analysis (p values reported)	<p><i>Clinical outcomes</i>: No difference in reduction of symptoms ($n = 3$), metabolic measures (e.g., blood pressure, sterile urine samples) ($n = 2$), complications or adverse effects ($n = 3$), or (postoperative) blood loss ($n = 1$).</p> <p><i>Patient outcomes</i>: Patients significantly more satisfied with nurse-led care compared to physician-led care (2 of 3 trials). No difference in knowledge ($n = 1$).</p> <p><i>Process of care</i>: Nurse produced a significant reduction in (waiting) time, both time to activated partial thromboplasin ($p = .01, n = 1$), and time in emergency department ($p < .001, n = 1$), but no difference in time to perform a coagulation test ($n = 1$). Nurse produced a significant improvement in record keeping in 3 areas of activity (e.g., urine tests, pulse at each visit and weight, $p < .01$) but two other smoking habits and blood pressure were not significantly improved ($n = 1$). Findings are inconclusive regarding diagnosis: one trial showed no difference, and a second trial showed significantly high rates of muscle headache diagnosis with nurse-led care ($p < .001, n = 1$). No difference in patient management (e.g., medical history, results of physical examination, therapy and referral, and laboratory analysis) ($n = 1$).</p>

(continued)

Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Vrijhoef et al. (2000)	10 articles (10 RCTs); Q3	To January 1999; D1	United States ($n = 5$), United Kingdom ($n = 3$), Canada ($n = 1$), Ireland ($n = 1$)	Mixture of primary and secondary health care; To determine the effects on quality of care for patients with diabetes or COPD when the specialized nurse has a central role in care; supplementation	Semiquantitative analysis (significance of outcomes reported)	<p><i>Resource utilization:</i> Nurses ordered significantly more tests and investigations ($p < .05$, $n = 2$ of 3 trials, for X-rays, but no significant difference for coagulation tests). Significantly more patients in nurse-led care group had an unplanned return visit ($p < .05$, $n = 1$). Patients in nursing group were significantly more likely to receive packed cells infusion and blood (products) transfusions ($p < .05$, $n = 1$). No difference in prescriptions with the exception of minor tranquilizers which were less frequently prescribed by nurses ($p < .05$, $n = 1$). No difference in hospitalization ($n = 1$).</p> <p><i>Clinical outcomes:</i> Significant improvement in survival in favor of specialist nurses ($n = 2$, both COPD). Quality of life was significantly improved in favor of the specialist nurses in 3 trials, whereas 3 trials found no differences. No difference in clinical parameters in 4 of 6 trials; the other 2 trials (both COPD) found significant improvements in favor of nurses.</p> <p><i>Patient outcomes:</i> Self-care and knowledge improved significantly in specialist nursing group in 4 of 5 trials. Findings regarding patient satisfaction were inconclusive; 2 trials found significantly higher patient satisfaction in the nursing group, whereas 2 trials found no differences.</p>

(continued)

Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Frich (2003)	15 articles (15 RCTs); Q5	From 1993 to 2003; D5	Not reported	Home care; To describe nursing interventions during home visits and their effects on people suffering from a range of chronic conditions; mixture	Semiquantitative analysis (significance of outcomes reported)	<p><i>Resource utilization:</i> Effects on medical consumption were inconclusive; 4 of 8 trials showed significantly higher medical consumption in the nurse group, whereas 2 of 4 trials found significantly lower medical consumption in nurse group. One of these trials found that patients consumed less of some services and more of others.</p> <p><i>Costs:</i> A significant decrease in costs was found with nurse-led care ($n = 1$).</p> <p><i>Clinical outcomes:</i> No difference for the majority of clinical outcomes ($n = 13$), such as metabolic measures, quality of life, well-being, functional status, and so on. The exception was mortality where findings were inconclusive: one trial found significantly lower mortality with nurse-led care, while another trial found no difference.</p> <p><i>Patient outcomes:</i> Although there was a tendency toward higher patient satisfaction with nurse-led care this was not significant ($n = 6$). No difference in other patient outcomes ($n = 8$), such as knowledge, confidence, self-efficacy, and activity level.</p> <p><i>Resource utilization:</i> No difference in resource use ($n = 2$) and hospitalization ($n = 2$). One trial showed significantly shorter hospital stays with nurse-led care.</p> <p><i>Costs:</i> No differences in costs ($n = 8$).</p>

(continued)

Table 1 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Smith et al. (2001)	4 articles (4 RCTs); Q6	To October 2002; D2	United States ($n = 1$); United Kingdom ($n = 2$); Australia ($n = 1$)	Home care; To evaluate the effectiveness of outreach respiratory health care worker programs for patients with COPD; supplementation	Results of meta-analysis (expressed WMD, Peto OR, 95% CI) and qualitative report of resource use and costs	<i>Clinical outcomes:</i> No differences in mortality ($n = 4$), pulmonary function ($n = 1$), exercise tolerance/walking distance ($n = 1$). Findings inconclusive regarding quality of life; one trial using a disease specific instrument found significantly improved quality of life with nurse-led care ($p < .05$), whereas 2 trials using a generic instrument found no differences, except for the physical dimension, which was better in the nursing group ($p < .01$). <i>Resource utilization:</i> Increased admission rates and longer duration of stay in nurse-led care group (statistics not reported, $n = 1$). <i>Costs:</i> Higher overall medical costs in nurse-led care group (statistics not reported, $n = 1$).

Note: RCT = randomized controlled trial; COPD = chronic obstructive pulmonary disease; SMD = standardized mean difference; WMD = weighted mean difference; OR = odds ratio; RR = relative risk; 95% CI = 95% confidence interval; ns = not significant; n = number of studies included in analysis; ES = Effect Size; ? indicates that the information is unknown.

a. Type of role revision determined by authors.

Table 2
Systematic Reviews ($n = 2$) on Physician Assistant (PA)–Physician Role Revision

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Buehan et al. (2007)	15 articles included in “evaluation of impact” (? RCTs); Q3	From 1990 to 2005; D5	United States ($n = 15$)	Setting not reported; To assess the role of PA including costs, benefits, and impact; mixture	Qualitative report of findings (no statistics reported)	<i>Patient outcomes:</i> High level of satisfaction with PA ($n = 4$) <i>Process of care:</i> Decreased transfer time in PA group ($n = 1$) <i>Resource utilization:</i> PA contributed to increased productivity ($n = 2$). Decreased length of stay in hospital in PA group ($n = 1$). <i>Costs:</i> Cost savings in PA group ($n = 7$)
Frossard et al. (2007)	38 articles (of which 17 research articles) (? RCTs); Q1	Not reported; D?	United States ($n = 38$)	Mixture of primary, secondary, or tertiary care; To assess the impact of PA on patient satisfaction, clinical outcomes, cost-effectiveness, productivity, acceptance of physician assistants, and level of liability; mixture	Qualitative report of findings (for majority of findings no statistics reported)	<i>Clinical outcomes:</i> No differences in (not specified) clinical outcomes ($n = 10$). <i>Patient outcomes:</i> High level of satisfaction with PA ($n = 5$). <i>Resource utilization:</i> PA contributed to increased productivity ($n = 1$). <i>Costs:</i> Cost savings in PA group ($n = 1$)

Note: PA = physician assistant; RCT = randomized controlled trial; n = number of studies included in analysis. ? indicates that the information is unknown.
a. Type of role revision determined by authors.

Table 3
Original Studies (n = 3) on Physician Assistant (PA)–Physician Role Revision

Reference	Study Design	Study Period; Number of Participants: PA, MD, Clinics, Patients, and/or Episodes	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Type of Data Analyzed	Key Findings
Freedman et al. (1986)	Prospective cohort study	January 1981 to January 1983; Unknown number of PAs and physicians, 1 clinic, 2454 women, 2458 procedures (PA 1285 vs. MD 1173)	United States	Hospital; To evaluate safety of care (surgical abortion) provided by PA compared with physicians; substitution	Abstract form by provider on day of procedure; delayed complications added by trained abstractor	<i>Clinical outcomes:</i> No differences between procedures performed by PA and physician with respect to overall, immediate, or delayed complication rates.
Goldman et al. (2004)	Prospective cohort study	July 1996 to October 1997; 3 PAs, 3 physicians, 2 clinics, 1363 women, 1363 procedures (PAs 546 vs. physicians 817)	United States	Hospital; To evaluate safety of care (surgical abortion) provided by PA compared with physicians; substitution	Extraction from clinic medical record by trained researchers	<i>Clinical outcomes:</i> No differences between procedures performed by PA and physician with respect to overall, immediate, or delayed complication rates.
Ohman- Strickland et al. (2008)	Cross-sectional study	17 PAs in 9 practices; number of physicians unclear in 28	United States	Hospital; To assess whether the quality of diabetes care differs among practices	Audit of patients' charts	<i>Clinical outcomes:</i> PAs were 32% less likely than physicians to have patients attain targeted low-density lipoprotein

(continued)

Table 3 (continued)

Reference	Study Design;	Study Period; Number of Participants: PA, MD, Clinics, Patients, and/or Episodes	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Type of Data Analyzed	Key Findings
		practices; 846 patients (approximately 20 patients per practice)		employing nurse practitioners (not included in this article), PA or neither (only physician); supplementation		cholesterol ($p < .001$). No significant difference regarding targeted HbA1c or microalbumin levels. <i>Process of care:</i> PAs were significantly (67%) less likely to assess microalbumin levels compared with physicians ($p < .05$). No significant differences in assessment of HbA1c, blood pressure, and lipids, although PAs tended to have lower assessment rates.

Note: PA = physician assistant; MD = medical doctor/physician.
a. Type of role revision determined by authors.

restricted to one type of health care setting or one type of clinical area. The roles of physician assistants were not clearly described but were judged by us to include a mixture of both substitution and supplementation articles.

Seven original studies were included in both reviews. We judged the methodological quality of reviews to be “poor” (Frossard et al., 2007) or “moderate” (Buchan et al., 2007). The authors of both reviews failed to report the methodological quality of the original studies they included.

Effects on clinical outcomes. Frossard et al. (2007) reported that there was no difference in clinical outcomes between patients cared for by physician assistants or physicians ($n = 10$). Two out of the three original studies also found no differences between physician assistants and physicians with regard to overall complication rate and the rates of immediate or delayed complications following surgical abortion (Freedman et al., 1986; Goldman et al., 2004). Ohman-Strickland et al. (2008), however, found that physician assistants were 32% less likely than physicians to have patients attain targeted low-density lipoprotein cholesterol ($p < .001$). No significant differences were found with respect to targeted HbA1c or microalbumin levels.

Effects on patient outcomes. Both systematic reviews reported that patients were very satisfied with physician assistants. Findings were chiefly drawn from the same original studies (Buchan et al., 2007; Frossard et al., 2007). None of the three original studies included other patient outcome measures.

Effects on process of care outcomes. One study (Miller, Riehl, Napier, Barber, & Dabideen, 1998), included in Buchan et al. (2007), showed that access to health care services improved. Transfer time to operating room decreased by 43% and to intensive care unit by 51%, with physician assistant care resulting in 4 to 5 hours saved each day. Ohman-Strickland et al. (2008) found that, despite guideline recommendations for diabetic care, physician assistants were 67% less likely to assess microalbumin levels when compared with physicians ($p < .05$). There were no significant differences in the assessment of HbA1c, blood pressure, and lipids, although physician assistants tended to have lower assessment rates.

Effects on resource utilization. Both reviews reported that physician assistants contributed to increased productivity (Buchan et al., 2007; Frossard et al., 2007). In addition, Miller et al. (1998) showed a decreased length of hospital stay in the physician assistant group (Buchan et al., 2007). None of the original studies included resource utilization outcome measures.

Effects on costs and cost-effectiveness. Both reviews reported that care provided by physician assistants was cheaper than care provided by physicians. There was a slight overlap in original studies ($n = 4$) on which this conclusion was based (Buchan et al., 2007; Frossard et al., 2007).

Pharmacist–Physician Role Revision

Searches identified four reviews that reported the effectiveness of pharmacist interventions to improve health care delivery, in particular the impact on drug prescriptions and medication use. See Table 4 for a description of the reviews and key findings.

Context. Two reviews (Finley, Crismom, & Rush, 2003; Lindenmeyer et al., 2006) included studies conducted in different types of health care settings (such as primary health care, hospitals, outpatient clinics, and nursing homes), whereas Cotter, McKee, and Barber (1995) included only studies conducted in hospitals. Garcia (2006) included one original trial being conducted in a Veteran's Administration Medical Clinic. While the reviews included studies comparing pharmacist-led care with physician-led care, their broader aim was to assess the impact of pharmacist interventions on prescribing and medication use. Pharmacist interventions included educating physicians and other staff members, medication monitoring, and direct service provision to patients involving patient counseling, information giving, or support for patient self-management. Here, we include those interventions in which pharmacists had an indirect (e.g., prescribing advice to physicians) or direct (e.g., teaching self-management skills to patients) impact on patient care. In this context, the pharmacist's role is best described as supplementation.

With the exception of Cotter et al. (1995), pharmacists' work was targeted to a specific patient group, specifically mental health (Finley et al., 2003), the elderly (Garcia, 2006), or diabetes (Lindenmeyer et al., 2006). The majority of original studies were located in the United Kingdom (Cotter et al., 1995), with the remainder in the United States (Garcia, 2006; Lindenmeyer et al., 2006). Finley et al. (2003) failed to report the countries in which the studies were executed.

The methodological quality of the reviews was, with the exception of Lindenmeyer et al. (2006), rated "moderate." The original studies had several methodological flaws and were said to be poor to moderate in quality by the authors of the reviews (Cotter et al., 1995; Finley et al., 2003; Lindenmeyer et al., 2006). Only Lindenmeyer et al. (2006) included a semiquantitative analysis reporting the statistical effects. The other three reviews were mainly limited to a narrative description of outcomes (Cotter et al., 1995; Finley et al., 2003; Garcia, 2006).

Effects on clinical outcomes. Lindenmeyer et al. (2006) showed a significant decrease in HbA1c levels as a result of pharmacist intervention, but the impact on other clinical outcomes (such as quality of life and other metabolic outcome measures such as blood pressure and weight) remained unclear. Garcia (2006) also found no difference in quality of life but did report fewer serious adverse drug reactions in the pharmacist intervention group although the difference was not statistically significant. Lindenmeyer et al. (2006) found the opposite; the number of hypoglycemic episodes was higher in the pharmacist-led group (significance not reported).

Table 4
Systematic Reviews ($n = 4$) on Pharmacist-Physician Role Revision

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/Report of Findings	Key Findings
Cotter et al. (1995)	169 articles (?); Q3	To June 1994	United Kingdom ($n = 169$)	Hospital; To evaluate the evidence of clinical pharmacy service provision (5 services related to role revision); supplementation	Qualitative description of results (statistics not reported)	<i>Patient outcomes:</i> Several studies were shown to improve patient compliance and knowledge (patient-directed interventions and provision of clinical service to primary care recipients), and this may improve (unspecified) patient outcomes. <i>Process of care outcomes:</i> Medication monitoring seemed to improve quality of care, but improvements were rarely significant. The provision of advice to health care providers and integration into health care teams seemed also to improve quality of care. <i>Costs:</i> Medication monitoring, provision of advice to health care providers, integration into health care teams, and provision of clinical pharmacy services to primary care recipients all showed potential cost savings as it promoted the economic use of medicines and reduced drug expenditure.
Finley et al. (2003)	16 articles ($n = 3$ RCTs); Q3	January 1972 to March 2003; D1	Not reported	Mixture of settings (inpatient clinics, outpatient clinics, primary care clinics, and nursing homes); To summarize outcomes of	Qualitative description of results (statistics not reported)	<i>Clinical outcomes:</i> No difference in 2 of 3 trials, but one trial showed significant improvements in clinical outcomes. <i>Patient outcomes:</i> Adherence to drug regimens significantly improved in patients treated by pharmacists ($n = 3$). Patients were also significantly more satisfied with

(continued)

Table 4 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score (range 0 to 6)	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
Garcia (2006)	1 article (1 RCT); Q3	January 1990 to January 2006; D2	United States (n = 1)	pharmacist-provided clinical services for patients with mental illnesses; supplementation	Qualitative description of results (statistics not reported)	pharmacists' services compared with usual care (n = 3). <i>Process of care:</i> Prescribing improved in the pharmacist care group through reduction in the dosage and absolute number of psychotropic drugs (significance not reported) (n = 16). <i>Costs:</i> Pharmacists' services reduced the health care costs as drug acquisition costs decreased, as did the number of hospitalizations and number of consultations (significance not reported) (n = 8). <i>Clinical outcomes:</i> No difference in quality of life (n = 1). Fewer patients in the pharmacist group experienced adverse drug events, although the difference was not significant (n = 1). <i>Process of care:</i> Inappropriate prescribing and the number of drugs prescribed reduced by 24% in pharmacist-led group versus 6% in usual care group (n = 1).
Lindemeyer et al. (2006) and Vermeire et al. (2005)	5 articles (5 RCTs); Q6	To end 2005; D9	United States (n = 5)	Mixture of settings (primary health care, outpatient, community and hospital setting); To evaluate the impact	Semiquantitative analysis (significance of outcomes or p values reported)	<i>Clinical outcomes:</i> HbA1c significantly decreased in pharmacist-led group (n = 3). More patients in the pharmacist group experienced serious adverse events (hypoglycemic episodes): 17 versus 2 (significance not reported) (n = 1). No

(continued)

Table 4 (continued)

Reference	Number of Studies (Number of RCTs); Methodological Quality Score	Study Period; Number of Electronic Databases Searched	Geographic Scope	Study Setting; Study Purpose; Type of Revision (Substitution, Supplementation, or Mixture) ^a	Data Synthesis/ Report of Findings	Key Findings
				of pharmacists' role in delivering a range of diabetes care interventions; supplementation		<p>difference in quality of life ($n = 2$) or other pathologic/metabolic outcome measures (e.g., blood pressure, weight) ($n = 2$).</p> <p><i>Patient outcomes:</i> Results were inconclusive regarding patient drug compliance: 1 trial showed no difference, whereas 1 trial showed a significant increase in medication possession rate in the pharmacist-led group.</p> <p><i>Process of care:</i> Pharmacists' recommendations were significantly more often related to patient education (47% vs. 12%) ($n = 1$).</p> <p><i>Resource utilization:</i> A significant decrease in use of other services was found in the pharmacist-led group ($n = 1$).</p> <p><i>Costs:</i> Costs reduced by \$US68 per capita (significance not reported) ($n = 1$).</p>

Note: RCT = randomized controlled trial; n = number of studies included in analysis; ES = Effect Size; SMD = standardized mean difference; WMD = weighted mean difference; OR = odds ratio; RR = relative risk; 95% CI = 95% confidence interval; ns = not significant. ? indicates that the information is unknown.

a. Type of role revision determined by authors.

Effects on patient outcomes. It was unclear whether pharmacists-led care increased drug compliance by patients. One trial included by Lindenmeyer et al. (2006) showed a significant improvement in patient compliance in the pharmacist group, but another showed no difference. Cotter et al. (1995) found that patient compliance and knowledge improved when pharmacists provided services directly to patients.

Only Finley et al. (2003) included patient satisfaction as an outcome measure. Three studies showed that depressed patients were significantly more satisfied with pharmacist services.

Process of care outcomes. Garcia (2006) showed that inappropriate prescribing was reduced by 24% in the pharmacist-led group when compared with 6% in the usual care group. Finley et al. (2003) reported that pharmacist interventions improved prescribing, most commonly by reducing the dosage and number of psychotropic drugs ($n = 16$ retrospective studies). Lindenmeyer et al. (2006) reported that 42% of the recommendations regarding diabetes therapy made by pharmacists were related to patient education compared with 12% in the usual care group.

Resource utilization outcomes. Only one trial, included in Lindenmeyer et al. (2006), examined resource use. This showed a significant decrease in use of other services in the pharmacist-led group (Skaer, Sclar, Markowski, & Won, 1993).

Costs and cost-effectiveness. Three reviews reported that pharmacists working in extended roles produced cost savings, largely by reducing unnecessary drug prescriptions and use of health care services (Cotter et al., 1995; Finley et al., 2003; Lindenmeyer et al., 2006).

Overall Synthesis

Nonphysician Clinicians—Physician Role Revision

Table 5 summarizes the findings (i.e., setting, clinical area, and outcome measures) by type of role revision and type of nonphysician clinician. Here, we synthesize the findings by type of role revision, discussing the differences and similarities in outcomes by type of nonphysician clinician.

Substitution. Ten articles (eight systematic reviews and two original studies) evaluated the impact of nonphysician clinicians working as physician substitutes. Eight focused on nurse substitutes (Chapman et al., 2004; Dealey, 2001; French et al., 2003; Horrocks et al., 2002; Laurant et al., 2004; Oakeshott et al., 2003; Smallwood, 2004; Thomas et al., 1999), while two focused on physician assistant substitutes (Freedman et al., 1986; Goldman et al., 2004).

(text continues on p. 80S)

Table 5
Overall Summary of Evidence Grouped by Type of Role Revision and Type of Nonphysician Clinicians

	Nurse Role Revision (<i>n</i> = 18)	PA Role Revision (<i>n</i> = 5)	Pharmacist Role Revision (<i>n</i> = 4)
Substitution	Adverse events (<i>n</i> = 1), functional status (<i>n</i> = 4), mortality (<i>n</i> = 2), resolution of symptoms (<i>n</i> = 1), quality of life (<i>n</i> = 3), variety of clinical outcomes (not specified) (<i>n</i> = 1)	Adverse events (<i>n</i> = 2)	NA
Findings	No difference between nurses and physicians with regard to any of the included clinical outcome measures	No difference between PAs and physicians with regard to any of the included clinical outcome measures	NA
Supplementation	Adverse events (<i>n</i> = 1), functional status (<i>n</i> = 5), mortality (<i>n</i> = 4), psychological well-being (<i>n</i> = 2), resolution of symptoms (<i>n</i> = 3), quality of life (<i>n</i> = 8)	Functional status (<i>n</i> = 1)	Adverse events (<i>n</i> = 3), functional status (<i>n</i> = 2), quality of life (<i>n</i> = 2), variety of clinical outcomes (not specified) (<i>n</i> = 1)
Findings	No difference between nurses and physicians with regard to effect on psychological well-being. With the exception of effect on quality of life and adverse events, all other clinical outcomes show either no difference or a significant improvement with nurse-led care. Two studies found inconclusive effects on quality of life, but the remainder showed no differences (<i>n</i> = 5) or a significantly improved quality of life in nursing care (<i>n</i> = 1).	No difference between PAs and physicians with regard to any of the included clinical outcome measures	Only functional status significantly improved as a result of pharmacist role revision. No differences between pharmacists and physicians were found with regard to quality of life. Other clinical outcomes were not assessed. The impact on number of complications or adverse events was inconclusive: one study found a decrease in adverse events, while the other found an increase.

(continued)

Table 5 (continued)

	Nurse Role Revision (<i>n</i> = 18)	PA Role Revision (<i>n</i> = 5)	Pharmacist Role Revision (<i>n</i> = 4)
Mixture			
Clinical outcome measures	Functional status (<i>n</i> = 1), mortality (<i>n</i> = 1), resolution of symptoms (<i>n</i> = 1), variety of clinical outcomes (not specified) (<i>n</i> = 1)	Variety of clinical outcomes (not specified) (<i>n</i> = 1)	NA
Findings	Both functional status and (unspecified) clinical outcomes were unaffected by role revision. Nurse role revision significantly reduced the number of symptoms. The effect on mortality was inconclusive. Compliance (<i>n</i> = 1), knowledge (<i>n</i> = 2), satisfaction (<i>n</i> = 5)	No difference between practices with and without physician assistants in terms of (unspecified) clinical outcomes.	NA
Substitution			
Patient outcome measures	Compliance (<i>n</i> = 1), knowledge (<i>n</i> = 2), satisfaction (<i>n</i> = 5)	NA	NA
Findings	No difference was found between nurses and physicians with regard to patients' knowledge or compliance with treatment. Evidence showed that in the majority of studies patients were significantly more satisfied with nurse-led care compared with physician-led care. Only one review found no differences in patient satisfaction with remainder showing increased satisfaction with nurses.	NA	NA
Supplementation			
Patient outcome measures	Compliance (<i>n</i> = 1), knowledge (<i>n</i> = 1), satisfaction (<i>n</i> = 2)	NA	Compliance (<i>n</i> = 3), knowledge (<i>n</i> = 1), satisfaction (<i>n</i> = 1), variety of patient outcomes (not specified) (<i>n</i> = 1)

(continued)

Table 5 (continued)

	Nurse Role Revision (<i>n</i> = 18)	PA Role Revision (<i>n</i> = 5)	Pharmacist Role Revision (<i>n</i> = 4)
Findings	No difference between nurses and physicians with regard to effects on psychological well-being. With the exception of effect on quality of life and adverse events, all other clinical outcomes showed either no difference or a significant improvement with nurse-led care. Two studies found inconclusive effects on quality of life but the remainder showed no differences (<i>n</i> = 5) or significantly improved quality with nursing care (<i>n</i> = 1).	NA	All reviews pointed toward a positive effect with pharmacist care on all patient outcomes. Satisfaction was significantly improved (<i>n</i> = 1) and one review showed a significant improvement in patient compliance with pharmacist care.
Mixture			
Patient outcome measures	Compliance (<i>n</i> = 1), knowledge (<i>n</i> = 1), satisfaction (<i>n</i> = 2), variety of patient outcomes (not specified) (<i>n</i> = 1)	Satisfaction (<i>n</i> = 2)	NA
Findings	Knowledge and (unspecified) patient outcomes did not differ between nurse and physician care. Patient compliance significantly improved with nursing care. Patient satisfaction also improved with nurse-led care in the single review that reported this outcome.	Both reviews showed that patients were very satisfied with physician assistants but failed to report the significance of the difference with physician care.	NA
Substitution	Access (<i>n</i> = 4), advice and education (<i>n</i> = 2), diagnostics (<i>n</i> = 4), management/treatment (<i>n</i> = 3), prescriptions (<i>n</i> = 1), record keeping (<i>n</i> = 3), communication (<i>n</i> = 1)	NA	NA
Process of care outcome measures	Process of care generally improved with nurse-led care; some of the improvements (i.e., better advice and education, better record keeping, and quicker access to appropriate treatment) were significantly greater in at		
Findings		NA	NA

(continued)

Table 5 (continued)

	Nurse Role Revision (<i>n</i> = 18)	PA Role Revision (<i>n</i> = 5)	Pharmacist Role Revision (<i>n</i> = 4)
	<p>least one review, while in other reviews the improvements were not statistically significant. Overall management and treatment of patients (not specified) and the appropriateness of prescribing appeared similar with nurse and physician-led care. The findings were inconclusive with regard to the appropriateness of diagnostics and examinations.</p>		
Supplementation	Record keeping (<i>n</i> = 1)	Management/treatment (<i>n</i> = 1)	Advise and education (<i>n</i> = 1), prescriptions (<i>n</i> = 2), quality of care (not specified) (<i>n</i> = 1)
Process of care outcome measures			
Findings	Patients' records were significantly better kept when nurses were involved in clinical care.	Overall the study found no difference in management of patients, although PAs tended to have lower assessment rates than those recommended by clinical guidelines.	Both advice and education improved when pharmacists were involved in clinical care of patient but only the change in education was statistically significant. The significance of differences in other process of care measures was not reported.
Mixture	Advice and education (<i>n</i> = 1), quality of care (not specified) (<i>n</i> = 1)	Access/waiting time (<i>n</i> = 1)	N/A
Process of care outcome measures			

(continued)

Table 5 (continued)

	Nurse Role Revision (<i>n</i> = 18)	PA Role Revision (<i>n</i> = 5)	Pharmacist Role Revision (<i>n</i> = 4)	
Findings	Advice and education were significantly improved when nurses were involved in patient care. One review assessed the effect on quality of care, but found no difference between nurse and physician care.	One review reported that waiting times were reduced as a result of PA involvement in patient care but failed to report the statistical significance of the change.	NA	
Substitution	Resource utilization outcome measures	Consultation rate (<i>n</i> = 1) and length of consultation (<i>n</i> = 4), home visits (<i>n</i> = 1), hospital admissions (<i>n</i> = 3), prescriptions rate (<i>n</i> = 4), referral to other services (<i>n</i> = 3), return visits (<i>n</i> = 5), test and investigation rates (<i>n</i> = 5), use of emergency services (<i>n</i> = 2), use of health care services (<i>n</i> = 2), use of products/aids (<i>n</i> = 1)	NA	NA
Findings	Some of the reviews showed (significantly) increased use of services with nurse-led care (such as return visits, tests, and investigations), while other reviews showed a (significant) decrease or no differences in service use. Evidence is strongest with regard to length of consultations where all showed that nurses had longer consultations than physicians (3 of 4 showed significant differences). The number of home visits tended to be lower with nurse-led care, but no differences were found in the number of consultations, prescriptions, or hospital admissions. One review showed that the use	NA	NA	

(continued)

Table 5 (continued)

	Nurse Role Revision (<i>n</i> = 18)	PA Role Revision (<i>n</i> = 5)	Pharmacist Role Revision (<i>n</i> = 4)	
	of products (e.g., packed cells infusion and blood products) was significantly higher in the nurse-led care group. The evidence was inconclusive with regard to number of referrals, use of emergency services, and use of health care services. Although some reviews found no differences in these outcomes, other reviews were unable to draw conclusions as results of original studies were contradictory.			
Supplementation	Resource utilization outcome measures	Consultation rate (<i>n</i> = 1) and length of consultation (<i>n</i> = 1), hospital admissions (<i>n</i> = 2), length of hospital stay (<i>n</i> = 3), and hospital readmission (<i>n</i> = 2), referral to other services (<i>n</i> = 1), tests and investigations rate (<i>n</i> = 2), use of emergency services (<i>n</i> = 1), use of health care services (<i>n</i> = 2), use of products/aids (<i>n</i> = 1), use of resources (not specified) (<i>n</i> = 2)	NA	Prescriptions rate (<i>n</i> = 1), use of health care services (<i>n</i> = 1)
Findings	Nurse-led care was associated with a decrease in hospital readmissions and a decrease in the use of products/aids (i.e., incontinence pads), although one review did not report the significance of the difference in readmissions. Nurses tended to order more tests (one significant; significance for one not reported). No differences were found with regard to consultation rates or use of	NA	One review showed a significant decrease in use of health care services with pharmacist care. Another review found a reduction in the number of prescriptions with pharmacist care but the significance of the difference was not reported.	

(continued)

Table 5 (continued)

	Nurse Role Revision (<i>n</i> = 18)	PA Role Revision (<i>n</i> = 5)	Pharmacist Role Revision (<i>n</i> = 4)
Mixture	<p>emergency departments. Evidence for other outcomes was inconclusive either due to paucity of evidence or due to contradictory findings among original studies.</p> <p>Consultation rate (<i>n</i> = 1) and length of consultation (<i>n</i> = 1), hospital admissions (<i>n</i> = 2) and length of hospital stay (<i>n</i> = 1), prescriptions rate (<i>n</i> = 1), referral to other services (<i>n</i> = 1), tests and investigations rate (<i>n</i> = 1), use of emergency services (<i>n</i> = 1), use of resources (not specified) (<i>n</i> = 1)</p> <p>Nurses had significantly longer consultations, ordered significantly more tests and investigations, and referred significantly more patients to other health care services compared with physicians. Length of hospital stay decreased with nurse-led care. Other outcomes, such as numbers of consultations and prescriptions, use of emergency services, and overall resource use (not specified) showed no difference between nurses and physicians. It was unclear whether the number of hospital admissions increased: one review found no difference, while another found a significant increase with nurse-led care.</p> <p>Overall health care costs (<i>n</i> = 4)</p>	<p>Length of hospital stay (<i>n</i> = 1), productivity (<i>n</i> = 2)</p>	NA
Resource utilization outcome measures			
Findings		<p>One review reported that PA led to a decreased length of stay in the hospital. Two reviews reported increased productivity with PA involvement as PAs saved physician time that could then be given to treating more patients. The statistical significance of these changes was not reported.</p>	NA
Substitution	Cost outcome measures	NA	NA

(continued)

Table 5 (continued)

	Nurse Role Revision (<i>n</i> = 18)	PA Role Revision (<i>n</i> = 5)	Pharmacist Role Revision (<i>n</i> = 4)
Findings	Three of four reviews found no difference in overall health care costs, while one review found increased costs (significance not reported)	NA	NA
Supplementation	Overall health care costs (<i>n</i> = 6)	NA	Overall health care costs (<i>n</i> = 3)
Cost outcome measures			
Findings	The evidence is inconclusive. One review showed cost savings with nursing care, one showed no difference, and one showed decreased costs (significance not reported). The findings in other reviews were mixed with some studies pointing to cost savings while others did not.	NA	All reviews concluded that extending the role of pharmacists resulted in cost savings but the statistical significance of the difference was not reported.
Mixture	Overall health care costs (<i>n</i> = 1)	Overall health care costs (<i>n</i> = 2)	NA
Cost outcome measures			
Findings	No difference in overall health care costs was found.	Both reviews concluded that PA involvement resulted in cost savings but the significance of the difference was not reported.	NA

Note: PA = physician assistant; NA = not applicable.

Nurses and physician assistants appeared similar in their impact on clinical outcomes with both producing outcomes equivalent to those of physicians.

The impact of substitution on patient satisfaction, knowledge, and compliance was evaluated only for nurses. Here the evidence suggested that patients were significantly more satisfied with nurse-led care than physician-led care, with only one review finding no difference in outcome. No reviews found differences between nurses and physicians with regard to patients' knowledge or compliance with treatment.

Process of care often was improved in nurse-physician substitution. Reviews on nurse substitution suggested that nurses tended to produce better outcomes than physicians in terms of patient education and advice, record keeping, and speed of access to appropriate treatment. Overall management and treatment of patients (not specified) and the appropriateness of prescribing appeared to be similar in nurse-led and physician-led care. The findings are inconclusive with regard to the appropriateness of diagnostics and examinations.

The impact on resource utilization also was assessed only for nurse substitutes. For some outcomes the evidence was not straightforward. Some reviews showed that nurses used more resources (visits, tests, and investigations) than physicians, while other reviews showed a decrease or no differences in service use. All reviews showed that nurses had longer consultations than physicians. The number of home visits tended to be lower with nurse-led care, but no differences were found in number of visits, number of prescriptions, and number of hospital admissions. One review showed that the use of products (e.g., packed cells infusion and blood products) was significantly higher in the nurse-led group. With regard to number of referrals, use of emergency services, and use of other health care services, the evidence remains inconclusive. Although some reviews found no differences with regard to these outcomes, other reviews were not able to draw conclusions because the findings were contradictory.

The overall impact on health care costs was evaluated only for nurse substitution. Three of four reviews found no difference in cost, while one found increased cost (significance not reported).

Supplementation. Thirteen articles evaluated the impact of nonphysician clinicians working as physician supplements. Eight focused on nurses (Bradley & Lindsay, 2001; Du Moulin et al., 2005; Griffiths et al., 2007; Hearnshaw et al., 2006; Loveman et al., 2003; C. O. Phillips et al., 2005; Smith et al., 2001; Vrijhoef et al., 2000), while one focused on physician assistants (Ohman-Strickland et al., 2008) and four focused on pharmacists (Cotter et al., 1995; Finley et al., 2003; Garcia, 2006; Lindenmeyer et al., 2006).

The impact of supplementation on clinical outcomes was generally positive or neutral but differed by type of nonphysician. With one exception (quality of life), the evidence on nurse supplementation suggested that all clinical outcomes showed either no difference or a significant improvement in favor of nurses working with physicians compared with physicians working alone. The findings on quality of

life were mixed: two reviews were inconclusive, five found no differences, and one found a significantly improved quality of life in the nurse–physician team. Physician assistants working with physicians achieved similar clinical outcomes when compared with physicians working alone. The evidence on pharmacist supplementation suggested that pharmacists significantly improved patients’ functional status or metabolic outcome measures but made no difference to patients’ quality of life. The impact on adverse events was inconclusive; one study found a decrease, while the other found an increase. No other clinical outcomes were evaluated.

Patient outcomes were improved. Both nurses and pharmacists working with physicians appeared to have a positive impact on patient knowledge when compared with physicians working alone, but only the pharmacist–physician team appeared to improve patient compliance. Patient satisfaction was significantly higher for pharmacists’ supplement group than physicians working alone in the single review that examined this outcome. Patient satisfaction with the nurse–physician team was found to be higher in one review, but the finding was not confirmed by two others.

The impact on process of care was generally positive. Patient records were significantly better kept when nurses were involved in clinical care. A similar positive effect was found for pharmacists, although the authors failed to report whether the difference with physicians working alone was significant. Patient education was significantly better with pharmacist–physician teams when compared with physicians working alone. The evidence on physician assistants was restricted to only one study (Ohman-Strickland et al., 2008). This study showed that physician assistants working with physicians tended to have lower assessment rates than physicians working alone.

Both nurses and pharmacists often decreased resource utilization. Pharmacist supplementation reduced the number of prescriptions. Nurse supplementation reduced the numbers of hospital readmissions and products/aids (i.e., incontinence pads), although one review did not report the statistical difference on hospital readmissions. However, the evidence also suggested that nurses working with physicians tended to order more tests, with one review reporting a significant difference and the second failing to evaluate the significance of the reported difference. No differences with nurse supplementation were found in regard to number of consultations and use of emergency departments. Evidence on other outcomes is inconclusive either due to the paucity of evidence or contradictory findings among original studies.

The findings do not allow firm conclusions to be drawn with regard to the effect on overall health care costs. The added cost of supplementation may sometimes be offset through reductions in prescriptions and the use of health care services. The available evidence suggests that this is most likely to be true of pharmacists working in extended roles. There is a paucity of evidence regarding other nonphysician clinicians.

Mixture of substitution and supplementation. Four reviews evaluated the impact of nonphysician clinicians working as both substitutes and supplements for physicians. Two focused on nurses (Brown & Grimes, 1995; Frich, 2003) and two focused

on physician assistants (Buchan et al., 2007; Frossard et al., 2007). We were not able to distinguish the effects of the two different roles.

The impact of nurses and physician assistants on clinical outcomes was generally neutral with occasional positive benefits. While nurses appeared to reduce patients' symptoms, the effect on mortality was inconclusive. Both types of nonphysician clinicians had positive (significant) effects on patient satisfaction when compared with physicians working alone. In addition, nurses significantly improved patient compliance, but patient knowledge and other patient outcomes appeared similar to that of physicians working alone.

The impact of nonphysician clinicians on process of care outcomes was generally neutral with occasional positive benefits. Physician assistants reduced patient waiting times (significance not reported). Advice and education was significantly improved when nurses were involved in patient care. One review assessed the effect on quality of care, but it found no difference between patients receiving care from nurses compared to physicians working alone.

The impact of nonphysician clinicians on resource utilization was mixed. Nurses had significantly longer consultations, ordered significantly more tests and investigations, and also referred significantly more patients to other health care services when compared with physicians working alone. On the other hand, hospital stay decreased when nurses or physician assistants were involved in patient care. Other outcomes, such as number of consultations, number of prescriptions, use of emergency services, and overall resource use (not specified), was not different between nurses working alongside or with physicians and physicians working alone. The impact on hospital admissions is unclear. One review found no difference, while another found a significant increase in hospital admissions in the nurse care group.

The impact of nonphysician clinicians on overall health care costs is uncertain. Physician assistants were reported to increase productivity with consequent cost savings but the significance of this difference was not reported. Nurses did not appear to change overall health care costs but the evidence base was meager.

Conclusion

Nonphysician clinicians may work as substitutes or supplements for physicians in defined areas of care. The intention behind such role revision is generally to maintain or improve the quality of care and outcomes for patients while maintaining or reducing overall health care costs. The available evidence suggests that nonphysician clinicians (nurses, pharmacists, physician assistants) working as substitutes or supplements for physicians in defined areas of care can maintain and often improve the quality of care and outcomes for patients. The effect on overall health care costs is mixed, with savings dependent on the context of care and specific nature of role revision. The evidence base underpinning these conclusions is strongest for nurses with a marked paucity of research into pharmacists and physicians assistants. More robust evaluative studies

into role revision between nonphysician clinicians and physicians are needed, particularly with regard to economic impacts, before definitive conclusions can be drawn.

Discussion

While the revision of professional roles is widespread, the evidence to support such revisions is modest with the exception of role revision between nurses and physicians (both substitution and supplementation). The available evidence suggests that role revision between physicians and nonphysician clinicians does not jeopardize patient care and may sometimes improve its quality. The evidence that role revision increases workforce efficiency or lowers costs is, however, weak and contradictory.

Although a majority of the reviews suggest that role revision may have a favorable impact on the quality and outcomes of care, the findings should be interpreted with caution. Our findings are based on previous systematic literature reviews, supplemented by original controlled studies where existing reviews revealed a paucity of high-quality evidence. These reviews may not have been thorough in their coverage of the relevant literature or conducted to a uniformly high standard. While this introduces the possibility of bias, it seems to us unlikely that we have missed large numbers of relevant controlled studies or grossly misjudged the outcomes of role revision.

Despite the fact that our search was not restricted by country, virtually all the reviews report on studies conducted in the United States and United Kingdom. This is not surprising given that these countries have the longest experience with revision of professional roles. However, as health care systems vary across countries, the results may not be transferable to other countries. Even when health care systems seem alike, differences in training and education of either medical or nonphysician health care professionals may result in different outcomes when a revision of roles is implemented. There is a notable gap in the evidence from developing countries where nonphysician clinicians often play a substantial role in care provision to medically underserved populations (Stark, Nair, & Omi, 1999).

Another cause for concern is the fact that due to the heterogeneity of the reviews we were not able to perform meta-analyses to provide a better synthesis of the results. Instead, we used a combination of semiquantitative and qualitative analyses to draw conclusions, in which quantitative outcome measures reported in at least three reviews were given higher weight in the final conclusions. This will have exaggerated the effects of studies included in more than one review, while at the same time diminishing the effects of qualitative research and quantitative studies reported in only one review. Nonetheless, as the qualitative synthesis often supported the semiquantitative synthesis of the data, we think our conclusions regarding the effects of role revision are valid.

Many of the original studies included in the reviews are now more than 10 or 15 years old. As the roles of nonphysician clinicians will have evolved over the intervening years, the findings from older studies may have limited generalizability to the current

context of care. As the reviews did not distinguish between older and recently published articles, we cannot judge whether measured outcomes have changed over time. Why there is a paucity of research in this area is uncertain. It may be that the revised role is relatively new and so not yet evaluated. While role revision between pharmacists and physicians is relatively recent, the same cannot be said of nurses and physician assistants. The paucity of high-quality evidence on physician assistants is particularly difficult to explain or justify given their long-standing role as physician supplements and growing international distribution (Hooker et al., 2007).

Finally, we encountered various other difficulties that are typical of reviews in this field. These include the lack of precision in defining the professional role revision and heterogeneity in the nature of the intervention (e.g., in terms of clinical focus, health care setting, the precise role and training of the nonphysician clinicians, and nonphysician clinicians–physician ratio). Many studies reported only short-term outcomes. This may have influenced effect sizes if the health professional was new to the role under investigation. It can take a number of months or years for physicians, nonphysician clinicians, and patients to adjust to a role revision; so short term outcomes may not properly reflect longer term performance (Laurant, Hermens, Braspenning, & Grol, 2002; Victorino & Organ, 2003).

Implications for Practice and Health Policy

The revision of professional roles between physicians and nonphysicians is a viable strategy for improving the quality of care and outcomes for patients. It also may be an effective strategy for increasing service capacity in the context of medical shortages or rising demand for care. It should, however, be recognized that deploying more nonphysician clinicians does not eliminate the need to increase physician numbers as nonphysicians cannot substitute for physicians across the full spectrum of care provided by physicians (Dill & Salsberg, 2008).

The evidence that role revision increases health care efficiency or lowers costs is weak and contradictory. Health care planners need to be alert to the possibility that, while nonphysicians cost less to employ than physicians, savings on salaries may be offset by lower productivity and less efficient use of nonstaff resources. Cost savings may therefore be nonexistent. The evidence for this was strongest in relation to nurses. Physician assistants appeared to increase health care productivity, but the overall impact on health care costs was not evaluated (Grzybicki, Sullivan, Miller-Oppy, Bethke, & Raab, 2002; Larson, Hart, & Ballweg, 2001; Record, McCally, Schweitzer, Blomquist, & Berger, 1980).

Policy makers seeking to improve the quality of health care and/or reduce demand on physicians through role revision will need to consider the wider range of factors that are known to affect the success of implementation (Sibbald, Laurant, & Scot, 2006; Sibbald, Laurant, & Reeves, 2006; Sibbald, Shen, & McBride, 2004). These include the following:

- Clear definition of the functions, level of autonomy, lines of accountability, and levels of experience and qualifications of professionals working in revised roles (American College of Physicians [ACP], 2009; Avery & Pringle, 2005; Christian, Dower, & O'Neil, 2007; Coombes, 2008)
- Development of training programs for professionals working in revised roles (ACP, 2009; Avery & Pringle, 2005; Department of Health, 2006; Hooker et al., 2007; Royal College of Nursing, 2005)
- Systems for the accreditation and licensing of professionals working in revised roles (ACP, 2009; Christian et al., 2007; Coombes, 2008)
- Revision of regulations regarding the scope of practice of professionals working in revised roles, for example, extending prescribing rights (Avery & Pringle, 2005; Broers et al., 2007; Christian et al., 2007)
- Professional indemnity insurance for professionals working in revised roles, coupled with clarification of the vicarious liability to employers (Christian et al., 2007)
- Excellent change management skills to address professional resistance to change (Broers et al., 2007; Van Offenbeek & Knip, 2008)
- Payment systems that provide sufficient reimbursement to encourage multidisciplinary working and collaboration between nonphysician clinicians and physicians (ACP, 2009)

Finally, health care planners and policy makers need to be alert to the potential impact of role revision on the wider health care system. Revision of roles in one part of the health care system may result in unforeseen consequences in other parts of the system (Sibbald et al., 2004, Sibbald, Laurant, & Scot, 2006, Sibbald, Laurant, & Reeves, 2006). For example, role revision will generally increase the size of health care teams as physicians are joined by nonphysician clinicians. Larger team sizes may, in turn, increase the difficulties of coordinating care among the various professionals and reduce personal continuity of care for patients. Without expansion of the nonphysician workforce, the recruitment of nonphysician clinicians into advanced roles in one health care sector (e.g., primary care) may lead to shortages in another health care sector (e.g., hospital care).

Policy makers need to keep an open mind as to whether revision of profession roles is the best strategy for improving workforce effectiveness or efficiency. The likely benefits outlined here need to be weighed against the effort required to effect change and the wider impacts on health care systems. The cost–benefit balance then needs to be weighed alongside other possible strategies before a final decision is made.

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