QUIP Quest for Quality and Improved Performance

Revision of professional roles and quality improvement: a review of the evidence

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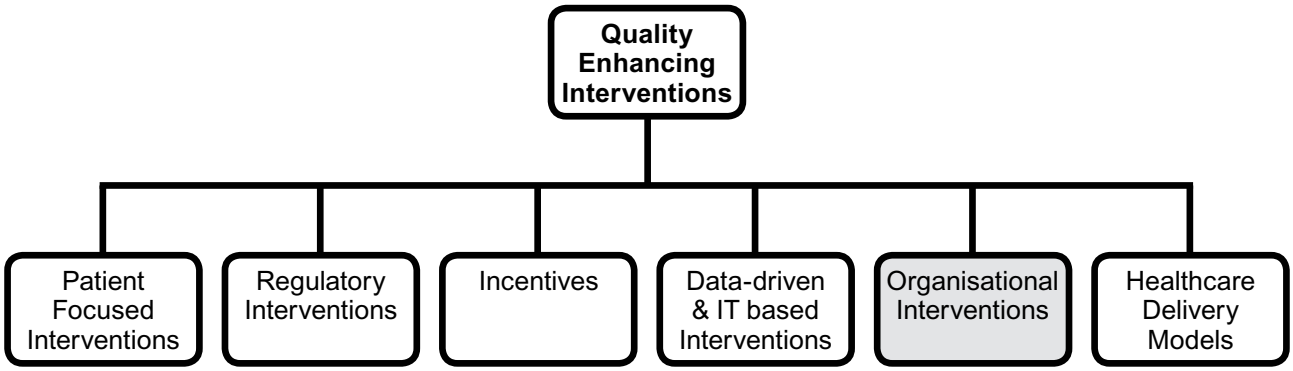
QQUIP and the Quality Enhancing Interventions Project

QQUIP (Quest for Quality and Improved Performance) is a five-year research initiative of the Health Foundation. QQUIP provides independent reports on a wide range of data about the quality of healthcare in the UK. It draws on the international evidence base to produce information on where healthcare resources are currently being spent, whether they provide value for money and how interventions in the UK and around the world have been used to improve healthcare quality.

The Quality Enhancing Interventions component of the QQUIP initiative provides a series of structured evidence-based reviews of the effectiveness of a wide range of interventions designed to improve the quality of healthcare. The six main categories of Quality Enhancing Interventions for which evidence will be reviewed are shown below.



The category ‘Organisational interventions’ focuses on improving managerial, professional and institutional behaviours. It includes initiatives that are concerned with changing organisational culture and professional behaviour, the use of continuous quality improvement (CQI) techniques for improved performance, and the provision of reliable quality assurance and controls. This particular report focuses on ‘Revision of professional roles’: all interventions that involve changing the distribution of tasks or responsibilities between medical professionals and non-medical professionals such as nurses, physician assistants, pharmacists and allied healthcare professionals.

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Background

Developed countries face major challenges due to rising demand for healthcare, unacceptable variations in service access and quality, pressure to contain costs and medical workforce shortages. A common response has been to extend the role of non-physician clinicians into areas that were previously the domain of physicians.

Non-physician clinicians play an increasingly prominent role in the provision of clinical patient care. The expectation is that such revision of roles will improve healthcare effectiveness and efficiency. But does it?

Ideally, role revision should be governed by research-based evidence of how skills may best be distributed among different healthcare professionals (both non-physician clinicians and physicians) in order to optimise the cost-effectiveness of health service delivery and to improve the quality of patient care. However, the evidence base for role revision is generally not robust and has lagged behind service developments.

Objective

We undertook a structured literature review to address the following question: what is the impact of professional role revision on quality of care and outcomes?

Framework

Healthcare professional roles undergo continuous revision in response to technological, economic and social pressures. Changes in professional roles may be grouped according to changing types of professional:

- enhancement: extending the role or skills of a professional group
- substitution: exchanging one type of professional for another
- delegation: shifting care provision from a senior/higher grade to a junior/lower grade within one profession
- innovation: introducing a wholly new type of professional.

Additionally, changes may be grouped by changing health delivery services:

- transfer: moving the provision of a service from one health delivery system to another health delivery system
- relocation: shifting the venue of a service without changing the professional
- liaison: using medical/clinical specialists to educate and support other professionals in the care of patients
- supplementation: extending the range of service provision within one health delivery system.

In practice, revision of professional roles is often complex and involves interdependent changes in a number of the above facets.

Focus of this report

Type of role revision

In this report we are concerned with the subset of revisions in which non-physician clinicians take on defined tasks that were previously the domain of physicians. There are two conceptually different approaches to role revision in this context. The first is to deploy non-physician clinicians as 'supplements' for physicians. Non-physician 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 non-physician clinicians as 'substitutes' for physicians. Non-physician clinicians working in this way provide the same services as physicians in order 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 non-physicians, and instead invest their time in activities that only physicians can perform. A single role revision may combine elements of both supplementation and substitution; we define this as 'mixture'.

Type of non-physician clinicians

This report focuses on the revision of roles between physicians and healthcare professionals without a degree in medicine; we use the term 'non-physician clinician' in this report to describe this. The non-physician clinicians we focus on are:

- advanced practice nurses such as nurse practitioners, specialist nurses, clinical nurses, practice nurses
- physician assistants
- pharmacists
- allied healthcare professionals such as physical therapists (referred to as physiotherapists in this review), speech and language therapists, dietitians and paramedics.

Method

We used a 'best evidence' approach to conduct our literature review. This means that we focused primarily on systematic reviews or reviews of reviews (level A). When these were not available we used (randomised) controlled trials (level B and C) or controlled observational studies (level D).

We searched 13 electronic literature databases using a structured search strategy. Search terms were related to three topic areas: revision of roles, non-physician clinicians and method (that is, systematic review) or design (that is, controlled studies). Two reviewers independently reviewed the references (title/abstract and some full text). Searches extended from inception through to July 2008.

Revision of roles may have an impact on a wide range of outcomes. For the purpose of comparison we grouped the outcomes in structural indicators (setting, clinical domain, country, number of participants, type of role revision), process indicators (process of care, resource utilisation, provider-related outcomes) and outcome indicators (clinical outcomes, patient outcomes, costs and cost-effectiveness).

We did not perform any formal statistical analyses to assess the impact of role revision. We focused on describing the strength of the evidence in terms of effect sizes (for example, odds ratios, relative risk, standardised or weighted mean difference), 95 per cent 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.

Findings

Overall, the evidence available to answer the research question is sparse, with the exception of nurse–physician role revision. In total we included 28 systematic reviews and 3 original studies. The methodological quality of systematic reviews varied as follows: 'good' (n=16), 'moderate' (n=7) and 'poor' (n=5). However, a number of the authors of these reviews described the methodological quality of the original studies they included as 'poor' or 'insufficient'. Only a minority of the authors reported that the methodological quality of the original studies was moderate or good (n=7).

Evidence for nurse role revision

Eighteen reviews reported the effectiveness of nurse role revision: eight studied the effects of substitution, eight evaluated the effects of supplementation and two evaluated a mixture of role revision. Nurses worked as physician substitutes or supplements in a range of healthcare settings. The clinical domain varied from generalist care to specialist care. Nurses working in supplementary roles appear to be limited to a specific clinical domain, whereas substitution may also include more generalist patient care.

The majority of studies were carried out in the USA or the UK. Reviews often lack a clear description of number of patients, nurses and physicians, qualifications of nurses, and a precise account of the tasks and responsibilities of professionals involved in patient care.

The findings suggest that nurses more frequently provide advice and information to patients and can improve access to healthcare services and treatments compared with physicians. There is some indication that the volume of resources used was larger with nurse-led care than with physician-led care, which offsets savings made on salaries. In particular, nurses seemed to order more tests and investigations. The duration of nurse consultations was significantly longer than physician consultations, particularly in primary care settings. Furthermore, the results give some indication that nurse-led care reduces the number of hospitalisations, but the results are inconclusive regarding the duration of hospital stay.

There is evidence to support the conclusion that patients are equally or better satisfied with the care provided by nurses compared with physicians, and clinical outcomes for patients may be improved. Metabolic control of parameters, such as haemoglobin A1c (HbA1c), sometimes improved with nurse care, and mortality rates were no different from those of physicians. The overall effects on the costs of healthcare and cost-effectiveness may therefore vary with the specific context of care.

There were no obvious differences between type of role revisions or type of healthcare setting.

On the basis of these 18 reviews it is reasonable to conclude that, regardless of the healthcare setting and type of role revision, nurses provide the same quality of care and establish similar outcomes to physicians.

Evidence for physician assistant role revision

Two reviews and three controlled observational studies reported the effectiveness of physician assistant role revision: two evaluated the effects of substitution, one studied the effects of supplementation and two were identified as a mixture of role revision. Physician assistants worked in various healthcare settings, predominantly in specialist roles; however, the clinical domain was not specified in the two reviews. The majority of the studies were conducted in the USA.

The reviews often lack a clear description of number of patients, physician assistants and physicians, the qualification of the physician assistants, and a precise account of the tasks and responsibilities of the professionals involved in a patient's care. This information was reported in the three original studies.

The findings suggest that both access to healthcare services and productivity of healthcare services increased. Furthermore, physician assistants reduced the workload of physicians. Despite these positive findings, one original study showed that in general physician assistants adhered less often to guideline recommendations in comparison with physicians working alone.

There is some evidence that physician assistants gain similar clinical outcomes to physicians. One original study found that physician assistants were less likely to achieve the targeted outcome. This may be associated with non-adherence to guideline recommendations. Similar to care provided by nurses, patients seemed very satisfied with care provided by physician assistants. The two reviews concluded that the involvement of physician assistants in patient care resulted in cost savings.

There is remarkably little evidence regarding the impact of physician assistants on quality of care and outcomes. The available evidence is largely based on non-experimental studies and narrative analysis of the data. We recommend more rigorous research in this area.

On the basis of these two reviews and three original studies we conclude that, regardless of the healthcare setting and type of role revision, physician assistants provide the same quality of care and establish similar outcomes to physicians. However, we recommend more rigorous research before drawing firm conclusions.

Evidence for allied healthcare professionals role revision

We identified only one systematic review: this reported on the impact of paramedics, physiotherapists and radiographers. The first two were judged as substitution and the latter was judged as a mixture of substitution and supplementation. Presumably all studies were located in a hospital. The clinical domain varied, but was limited to a specialist area. The majority of studies were conducted in the UK. The number of participants was not reported.

All three types of allied healthcare professionals, when suitably trained, appeared to assess, diagnose and treat patients as safely and effectively as physicians.

One study showed reduced mortality when paramedics administered pre-hospital thrombolysis. Another study showed that patients were more satisfied with physiotherapists. Evidence with regard to costs and cost-effectiveness was inconclusive.

On the basis of only one review we conclude that within a hospital setting paramedics, physiotherapists and radiographers provide the same quality of care and establish similar outcomes to physicians. But we recommend more rigorous research before drawing firm conclusions.

Evidence for pharmacist role revision

Four reviews studied the effectiveness of extended pharmacist roles. They assessed the effectiveness of pharmacist interventions to improve healthcare delivery, in particular the impact on prescription and medication use. Two reviews included various healthcare settings, whereas another one was located in a Veteran's Administration Medical Center in the USA. The pharmacists were involved in only one clinical area. The majority of studies were conducted in the UK. The number of participants varied greatly between different reviews.

The findings suggest that pharmacists improved the quality of care. The evidence showed a reduction in inappropriate prescribing. Further, physicians appeared to accept the involvement of pharmacists and to change their prescribing behaviour according to advice they received from pharmacists.

One review showed improved clinical outcomes, for example, HbA1c readings. There were no differences for other clinical outcomes. Patients seemed satisfied with the involvement of pharmacists. Effects on patient compliance regarding medication intake remained inconclusive. Three reviews showed cost savings due to the fact that unnecessary drug prescriptions were reduced.

On the basis of these four reviews we conclude that the extension of the role of pharmacists in patient care is a promising strategy to improve the quality of healthcare. It may even improve clinical outcomes and result in cost savings. Nevertheless, as the evidence is limited, we recommend that researchers undertake more robust evaluative studies to establish the precise impact of the different roles of pharmacists.

Overall conclusion

The available evidence suggests that non-physician clinicians working either as substitutes or supplements for physicians in defined areas of care can maintain and, for some aspects, even improve the quality of care and the outcomes for patients. Revision of roles appears to be acceptable to patients as well as to physicians. The effect on overall healthcare costs is mixed: savings depend on the context of care and the specific nature of role revision. The evidence did not support the hypothesis that supplementary care increases healthcare costs: six out of nine reviews evaluating this type of role showed a reduction in healthcare costs. On the other hand, substitution did not result in any cost savings.

The evidence base underpinning these conclusions is strongest for nurses as this type of non-physician clinician is studied most frequently. There is a marked paucity of research into pharmacists, physician assistants and allied healthcare professionals. More robust evaluative studies into role revision between those non-physician clinicians and physicians are needed, particularly regarding economic impacts and cost-effectiveness, before firm conclusions can be drawn.

Implications for policy and research

The revision of professional roles does not jeopardise patient care and may sometimes improve its quality. Role revision is therefore a viable strategy to consider when addressing shortages of medical professionals and other challenges in the wider (healthcare) environment, such as an ageing population, new technologies and higher demands, that may threaten the quality of healthcare delivery.

Although not directly derived from the previous reported evidence, other papers have identified some relevant issues to be considered by health planners, policy-makers and providers wishing to implement role revision. The following are known to influence the success of change:

- clear definition of the functions, level of autonomy, lines of accountability, and levels of experience and qualifications of professionals working in revised roles
- development of training programmes for professionals working in revised roles
- systems for the accreditation and licensing of professionals working in revised roles
- revision of regulations regarding the scope of practice of professionals working in revised roles, for example, extending prescribing rights

- professional indemnity insurance for professionals working in revised roles, coupled with clarification of the vicarious liability to employers
- excellent change management skills to address professional resistance to change
- payment systems that provide sufficient reimbursement to encourage multidisciplinary working and collaboration between non-physician clinicians and physicians.

Finally, health planners and policy-makers need to be alert to the potential impact of role revision on other parts of the healthcare system, including attending to any unforeseen consequences. For example, role revision will generally increase the size of healthcare teams as physicians are joined by the non-medical professionals who take over some of their tasks. Larger team sizes may, in turn, increase the difficulties of coordinating care among the various professionals. In general practices, larger team sizes have been shown to increase speed of access to care for patients, but also to reduce continuity of care with a preferred doctor.

To know which components contribute to effectiveness and cost-effectiveness, and how role revision can be optimised, we recommend that evaluations are included alongside quality improvement programmes to enhance role revision. In particular, long-term (at least two years) and robust research designs are urgently needed to address the gaps in current knowledge.

Background

1.1 Introduction

Healthcare is changing rapidly. Inevitably this will lead, and in some countries already has led, to changes in the roles of healthcare professionals. Changes in the workforce are driven by many complex factors. These can be grouped into the following categories:

- wider environment
- policy
- payment systems
- professional regulation and training
- professional attitudes.[1]

Changes in the wider environment – such as an ageing population, ever increasing development of new technologies and treatments, and increased patient demands – are the impetus for changes in the healthcare workforce. Staff may find they are no longer able to fulfil rising demands for care leading to workforce shortages. The labour costs of healthcare may rise to unaffordable levels. Policy-makers may respond with cost-cutting reforms and articulate the benefits of new ways of working more efficiently. Whether or not workforce changes can be implemented successfully in practice will depend on payment systems, regulatory boundaries and professional attitudes (see figure 1).

1.1.1 Factors driving revision of professional roles

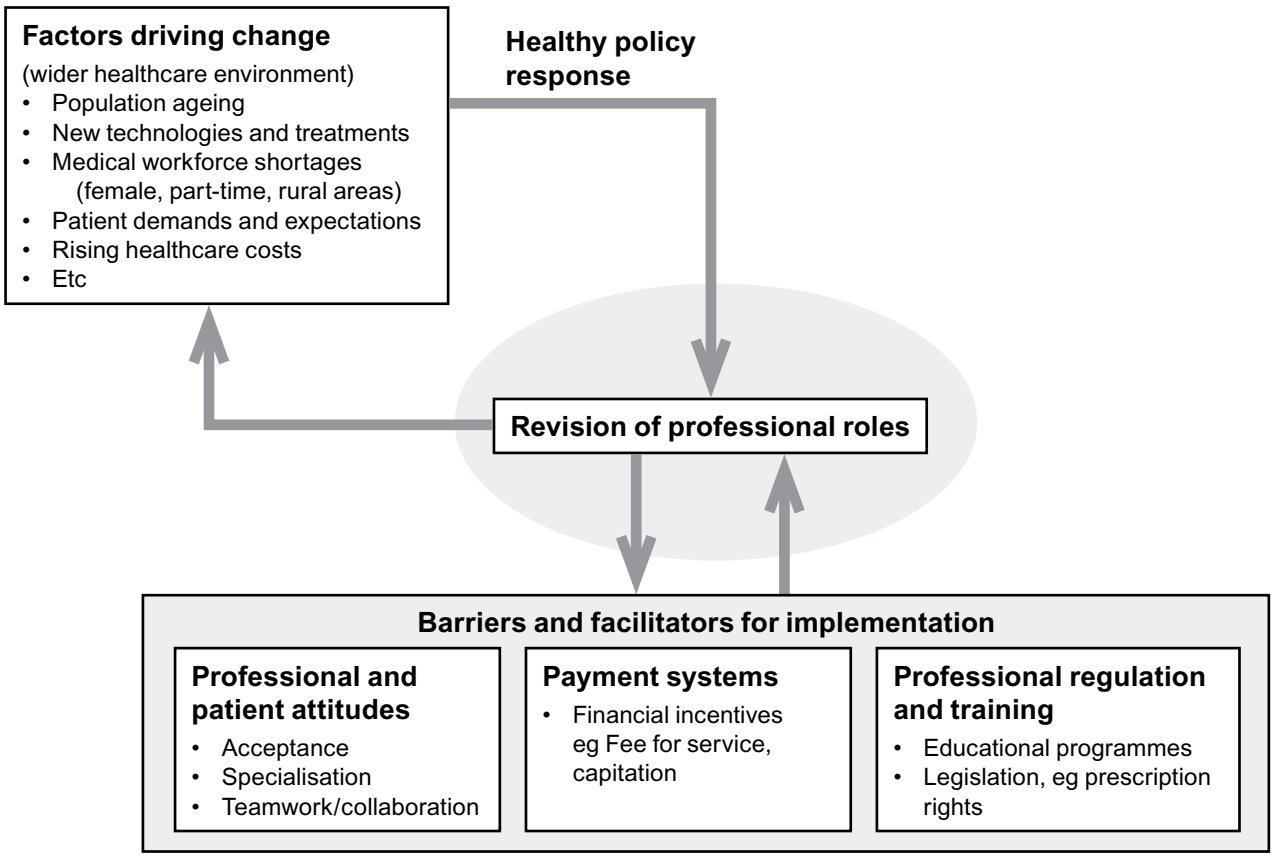
Medical workforce shortages in specific clinical areas and/or geographic populations (for example, rural and remote) were key factors driving the introduction of advanced practice nurses (such as nurse practitioners, clinical nurse specialists, specialist practitioners, nurse therapists and nurse consultants) and physician assistants in the USA in the 1960s.[2] Following the US example nurse practitioners were also introduced in Canada (1970s), the UK (1980s) and, among others, Australia and the Netherlands in the 1990s.[3–8] Physician assistants have been introduced only recently to western countries to improve patient access to care in medically underserved populations.[9]

A second important driver has been the desire to improve the quality of care without increasing the demands on physicians. This was the principal reason behind the growth in nurse practitioner roles in primary care in the UK and the Netherlands from the 1990s.[3,6,7,10] Similarly, extended roles for pharmacists were introduced in the USA, the UK and Canada primarily to improve the quality of patient care.[11,12]

The pace and extent of role revision is modified by factors such as professional and patient attitudes, payment systems, and professional regulation and training. Healthcare professionals' willingness to renegotiate the boundaries between themselves and other disciplines is one important factor that affects the pace of change;[13–15] another is patients' acceptance of these role changes.[16,17] Non-physician clinicians generally have been willing to extend their roles. However, often physicians have opposed this because they see it as 'trespassing' into their territory. Patients' views on non-physicians working in extended roles are shaped by many factors, although physicians' attitudes play a vital role. Physicians need to foster patient acceptance of non-physician clinicians working in new roles if role revision is to succeed.[16,18]

The successful implementation of role revision also requires payment systems that reward, or at least do not penalise, the healthcare professionals and employers who adopt new ways of working. Where health insurance systems prohibit charging for the services provided by non-physician clinicians, role revision is constrained.[19–24] Conversely, role revision may spread rapidly where healthcare organisations are able to realise financial gains. This was the situation in UK 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.[25–27]

Figure 1: Schematic overview of factors governing revision of professional roles



Finally, professional education and regulatory systems have to be adapted to support and facilitate role revision.[1] Non-physician clinicians working in new roles need to be trained and accredited for this work, and it takes time and effort to agree and implement new standards. Regulations governing the scope of practice of health professions may also need to be revised to realise the full benefits of role revision. For example, non-physician 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 healthcare efficiency.[14,28–30]

1.1.2 Terms and definitions

Changes in the workforce, revision of professional roles, skills mix and task transfer are terms that are used interchangeably to express an organisational change of the healthcare system. They may refer to:

- the mix of skills or competencies possessed by an individual

- the ratio of senior to junior grade staff within a single discipline
- the mix of different professions within a multi-professional team.

It is anticipated that a change of professional roles will lead to health gain, more satisfied patients and physicians, better healthcare, reduced workloads for physicians, less use of healthcare services and more cost-effective care (that is, better outcomes for same or lower costs).[1,31,32] However, are these assumptions supported by the evidence?

1.1.3 Objective

We undertook a structured literature review to address the following question: what is the impact of professional role revision on quality of care and outcomes?

This review is part of a broader initiative – the Health Foundation's Quality Enhancing Interventions (QEI) Project – that conducts systematic reviews of peer reviewed and grey literature to assemble evidence on the impact of interventions designed to improve performance and quality of care.

1.2 Focus

1.2.1 Types of non-physician clinicians

Pressures to increase the quality of care and to reduce the costs of healthcare delivery have led to the revision of roles of healthcare professionals and the creation of new roles. Although this development is seen all over the world as a solution to rising demands and costs, there are differences in the types of professionals deployed, and training and financial regulations. Revision of professional roles determines, and is determined by, organisational systems and the wider (healthcare) economy.

For example, the concept of the physician assistant first emerged in the USA in the 1960s as a strategy to cope with a shortage of primary care physicians. From 2000 onwards, it was taken up by the Netherlands, the UK, Taiwan, Canada, Australia and South Africa.[9] Nurse practitioners were also first introduced in the USA (in Colorado University in 1965), and the development of their role was directly shaped by the experiences of physician assistants. Some nurses resisted the development of physician assistant roles, believing that nurses were best able to offset medical shortages and that, compared with physician assistants, they had a higher degree of competency to support medical professionals. This necessitated a shift in roles from care/nursing to cure/medicine. Having proven their competence in primary care, nurse practitioners were well placed to grow and redefine their tasks. They extended their reach into the wider fields of medical care increasingly colonised by physician assistants.[33,34] Nurse practitioners spread to Canada in the 1970s, to the UK in the 1980s, and to Australia, New Zealand and the Netherlands in the (late) 1990s. In Canada, many nurse practitioner initiatives disappeared in the 1980s only to be renewed under health system reforms in the 1990s.[35] In 2004 the International Council of Nurses conducted an internet survey of nurse practitioners (625 respondents from 68 different countries). This showed that at least 42 countries employed nurse practitioners; 15 countries reported that they did not employ nurse practitioners, and responses from 11 countries were inconclusive (one respondent stated that nurse practitioners were employed while the second respondent disagreed).[34] In general, the formal recognition, legislation, training and education of these new healthcare professionals followed years after they were first introduced and had already taken over many of the tasks that had been the province of medical physicians.

This report focuses on the revision of roles between physicians and healthcare professionals without a degree in medicine (that is, non-physician clinicians). The non-physician clinicians of interest are:

- advanced practice nurses, such as nurse practitioners, specialist nurses, clinical nurses and practice nurses
- physician assistants
- pharmacists
- allied healthcare professionals, such as physical therapists (referred to as physiotherapists in this review), speech and language therapists, dietitians and paramedics.

Definition of non-physician clinicians
Advanced practice nurses (such as nurse practitioners, specialist nurses, clinical nurses and advanced practice nurses) are specially trained to assume an expanded role in providing medical care. Depending on the country they work in they may or may not be under the supervision of a physician. For example, in the UK and the USA they are allowed to work independently without the supervision of a physician. They provide a broad range of healthcare services. An advanced practice nurse is a registered nurse who has acquired the expert knowledge base, complex decision-making skills and clinical competencies for expanded practice, the characteristics of which are shaped by the context and/or country in which s/he is accredited to practice. A master's degree is recommended for entry level.[36]
Physician assistants are academically trained, licensed or accredited to provide medical care under the supervision of a physician in person, by a telecommunication system or by another reliable means.[37]
Pharmacists are healthcare professionals who practise the art and science of pharmacy. In their traditional role, pharmacists typically take a request for medicines from a prescribing physician in the form of a medical prescription and dispense the medication to the patient and advise them on the proper use and adverse effects of that medication. One of the most important roles that pharmacists are currently taking on is pharmaceutical care. Pharmaceutical care involves taking direct responsibility for patients and their disease states, medications and management in order to improve the outcome for each individual patient.[11]
Allied health professionals (such as physiotherapists, occupational therapists, dietitians, speech and language therapists, respiratory therapists and dental hygienists) are specially trained and licensed to assist and support the work of other healthcare professionals. Allied health professionals are clinical healthcare professions distinct from medicine and nursing. They are involved with the delivery of health or related services pertaining to the identification, evaluation and prevention of diseases and disorders such as dietary and nutrition services, rehabilitation and health systems management. The precise titles and roles of allied health professionals may vary considerably from country to country.[38]

This revision of roles may take place in different types of settings including primary care, ambulatory or outpatient care, community care, hospital care, inpatient care, and accident and emergency departments, or at the interface between primary and secondary care. The focus of revision of roles could be concerned with prevention of diseases, chronic disease management, minor illnesses and acute illnesses or accidents.

1.2.2 Number of non-physician clinicians

It is difficult to estimate the number of non-physician clinicians who currently perform tasks that were formerly undertaken by medical doctors, as this is not very well reported for most professions and it differs from country to country. The best estimates are for physician assistants and nurse practitioners.

Allied healthcare professionals and pharmacists are expected to perform only a limited number of extended tasks, which are directly linked to their own expertise and specialisms (for example, physical diagnosis/relaxation therapy or pharmacy/prescriptions) whereas physician assistants and nurse practitioners can perform a broad range of tasks that were previously undertaken by physicians only. Allied health professionals and pharmacists therefore appear to have experienced more limited role extension, with the majority of their tasks still located within their own domains of expertise.

Table 1 combines information from different sources to provide a rough estimate of the numbers of non-physician clinicians and physicians in relation to the population of selected countries. It should be noted that, due to different years of publication and synthesis of information from different publications, the figures presented in the table should only be considered as estimates of the number of professionals.

Table 1: Overview of (estimated) number of people, medical physicians and non-physician clinicians by country

	UK[a]	USA	Canada	Netherlands	Australia	South Africa	Taiwan
Population[b]	65,671,164	301,000,000	330,98,932	16,491,461	20,264,082	47,391,900	23,036,087
Medical physicians[b]	146,379	650,000	66,583	50,854	47,875	30,740	24,418
Physician assistants[b]	38	65,000	170	75	2	0	1,400
Advanced practice nurses	3,196[c]	>125,000[d]	878[e]	3,130[f]	-	-	-
Pharmacists	13,800[g]	243,000[h]	-	-	135,000[i]	-	-
Physiotherapists	20,146[g]	-	-	13,335[j,k]	1,650[i]	-	-
Exercise physiologists	-	-	-	940[j]	1,650[i]	-	-
Occupational therapists	17,024[g]	-	-	3,108[j]	-	-	-
Dietitians	3,315[g]	-	-	2,415[j]	4,000[i]	-	-
Podiatrists	3,779[g,l]	-	-	455[j]	3,000[i]	-	-
Speech and language therapists	6,742[g]	-	-	4,410[j]	4,000[i]	-	-
Audiologists	-	-	-	-	1,500[i]	-	-
Orthopaedics and prosthetics	1,653[g]	-	-	329[j]	1,000[i]	-	-

[a] England and Scotland combined
[b] Derived from Hooker et al (2007)[9], p82
[c] Members of the RCN Nurse Practitioner Association[3]
[d] American Academy of Nurse Practitioners: national database 2007[39]
[e] Canadian Institute for Health Information and Canadian Nurse Association[35]
[f] Nurse practitioners and advanced practice nurses/nurse practitioners in primary care, including nurses in training[40,41]
[g] The Information Centre (2008)[42]
[h] Bureau of Labor Statistics (2009)[43]
[i] AHPA (2008)[44]
[j] NIVEL (2004–2007)[45]
[k] Includes primary care physiotherapists but excludes those who work in hospitals and nursing homes
[l] Includes chiropody and podiatry

1.2.3 Types of roles: a framework

Healthcare professional roles undergo continuous revision in response to technological, economic and social pressures. Changes in professional roles may be grouped according to changes in the type of professionals:

- enhancement: extending the skills of a professional group
- substitution: exchanging one type of professional for another
- delegation: shifting care provision from a senior/higher grade to a junior/lower grade within one profession

- innovation: introducing a wholly new type of professional.

Additionally, changes may be grouped by changing healthcare delivery services:

- transfer: moving the provision of a service from one healthcare delivery system to another healthcare delivery system
- relocation: shifting the venue of a service without changing the professional
- liaison: using medical/clinical specialists to educate and support other professionals to care for patients
- supplementation: extending the range of service provision within one healthcare delivery system.

In practice, changing a skills mix is often complex and involves interdependent changes in a number of the above elements. For example, asthma care may be shifted from hospitals to general practice (transfer). As general practitioners become overloaded they substitute the care to a practice nurse. In order to support this change, a practice nurse may acquire specialist skills in asthma care (enhancement) enabling the nurse to extend the range of service provision within the primary care setting and to reduce the demand on general practitioners (supplementation and substitution). Hospital-based specialist nurses or even physicians may continue to advise and support the primary care team in its management of patients with asthma (liaison). It may even be that a new professional is introduced, such as physician assistants in the UK (innovation).

In this review we are concerned with that subset of revisions in which non-physician clinicians take on defined tasks that were previously the domain of physicians. There are two conceptually different approaches to role revision in this context.[1] The first is to deploy non-physician clinicians as ‘supplements’ for physicians. Non-physician 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 to extend the range of services available to patients. The second approach is to deploy non-physician clinicians as ‘substitutes’ for physicians. Non-physician clinicians working in this way provide the same services as physicians in order to reduce physician workload, increase service capacity and/or reduce costs. Gains in service efficiency may be achieved if physicians stop providing the services that are transferred to non-physicians, and instead invest their time in activities that only physicians can perform. A single role revision may combine elements of both supplementation and substitution.

1.3 Format of the report

Chapter 2 presents the method of the review. Chapter 3 reports the results of the review. We report these by type of non-physician clinician, with a brief conclusion for each. In the final chapter we discuss the findings, the strengths and limitations of our study and the implications for practice, healthcare policy and research.

2. Methods

2.1 Outcomes of interest

Revision of roles may have an impact on a wide range of outcomes. Frequently studied outcomes are quality of life, patient satisfaction, prescriptions, and tests and investigations. Outcomes are 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 utilisation outcome, whereas the appropriateness of a prescription may be seen as a process of care outcome. From the descriptions it is not always clear which outcome has been measured. For the purpose of comparison we grouped the outcomes into structural, process and outcome indicators.[46,47] The outcomes reported in the included reviews and original studies were assigned to one of these domains, although the authors from the included papers did not necessarily use the same taxonomy.

Quality indicators		
Structural indicators	Organisational aspects of service provision	For example: • number of non-physician clinicians, physicians, practices, etc • skills of professionals • number of hours worked • type of setting
Process indicators	Process of care (ie quality)	For example: • errors (eg, unscheduled hospital admissions, visits to accident and emergency department) • provision of advice • guideline adherence (eg, appropriate prescriptions, management) • record keeping
	Provider-related outcomes	For example: • subjective workload measures such as stress, burn-out • satisfaction • attitude
	Resource utilisation	For example: • number of prescriptions • number of tests and investigations • number of consultations • number of hospitalisations • duration of hospital stay
Outcome indicators	Clinical outcomes	For example: • morbidity • mortality • physical functioning • quality of life
	Patients' evaluation of care outcomes	For example: • satisfaction • preference • knowledge • compliance/adherence treatment
	Costs and cost-effectiveness	For example: • Quality adjusted life years (QALYs) • (in)direct healthcare costs • staff costs • cost savings

2.2 Types of studies

Given the diffuse nature of professional role revisions and the complex context in which they are implemented, the available evidence is heterogeneous. We adopted a stepped approach to data collection. In line with the search strategy adopted across the Health Foundation's QEI series, we used a 'best evidence' approach to conduct our review, initially searching for systematic reviews. If systematic reviews (level A evidence) were sparse (fewer than four) or out-of-date (published before 2005) we then searched for individual studies within the following hierarchy of evidence:

- (cluster) randomised controlled trial (level B)
- quasi-experimental study (level C)
- controlled observational study (for example, cohort or case-control study) (level D).

We did not include studies of lower methodological quality such as observational studies without control groups or expert opinion (that is, evidence levels E and F). Original studies (levels B, C or D) have only been included in this report when they were not already included in a systematic review (level A).

2.3 Search

We conducted electronic searches for studies published in English and Dutch using the following databases:

- Agency for Healthcare Research and Quality (AHRQ) Electronic Catalogue
- British Library Integrated Catalogue
- Cochrane Database of Systematic Reviews
- Cumulative Index to Nursing & Allied Health Literature (CINAHL)
- Database of Abstracts of Reviews of Effects (DARE)
- Embase
- GLIN (Grey Literature in the Netherlands)
- Joanna Briggs Institute Systematic Review Database
- Medline
- Organization for Economic Cooperation and Development (OECD)
- ProQuest Dissertations and Theses – A&I (PQDT)
- Sociological Abstracts
- World Health Organization (WHO)
- Web of Science.

We adopted broad inclusion criteria owing to the methodological challenges inherent in assessing publications that report on the impact of revisions of professional roles on quality of healthcare in comparison with usual care provided by physicians. The search comprised three phases:

- search I: electronic search of literature databases (see above) focusing on retrieving systematic reviews and/or meta-analyses (see appendix Ia)
- search II: electronic search of Medline, CINAHL and Embase focusing on retrieving original publications that met the study design criteria (levels B, C and D) and reported on the impact of physician assistants and allied health professionals (see appendix Ib)

- search III: utilising the experience of an expert in the field of physician assistants from the USA* to assist us to retrieve original publications that met the study design criteria (levels A, B, C and D) and to report on the impact of physician assistants.

We used a wide range of search terms, combining medical subject headings (MeSH) and free text words. The search terms were grouped into three categories:

- set 1: revision of professional roles
- set 2: type of non-physician
- set 3: design.

The search terms within a set were combined with 'OR'. Subsequently the sets were combined with 'AND'. Searches were adapted to meet the specific requirements of each database.

The initial search covered the period from 1990 to July 2007, the second search covered the period from 1990 to February 2008 and expert contact covered publications from 1961 to July 2008. We relied on systematic reviews to include evidence (that is, original studies) from the early dates to those covered by our review. The earliest evidence we retrieved was from 1961. The searches were not limited by geographical area, although the majority of the evidence is based on literature from the USA and the UK.

2.4 Study inclusion

For the initial search, title and abstracts, and in some cases full texts, were reviewed for relevance independently by two reviewers (ML, MH). A third reviewer (MF) was consulted in the small number of cases in which discrepancies were found. For the additional searches, one reviewer (ML) screened the title and abstracts and, when deemed to be relevant or questionable, obtained the full text papers. Two reviewers (ML, MF) independently reviewed the full text papers. The reviewers discussed any discrepancies and, subsequently, decided on whether or not to include the paper.

We included papers if they met the following criteria:

- description of the effects of non-physician clinicians working as substitutes or non-physician clinicians working as supplements compared with usual, routine, standard care provided by physicians alone
- description of multiple interventions – of which role revision was one of the implemented interventions – needed to include a distinct description of the effects of the revision of roles
- description of the effect of at least one of the outcomes of interest
- systematic literature review including meta-analysis, (semi-)quantitative or qualitative/narrative report of findings (level A evidence)
- randomised controlled trial and quasi-experimental trials (levels B and C evidence) (only when level A evidence not available)
- observational controlled studies, case-control or controlled cohort (level D evidence) (only when level A, B or C evidence not available).

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However, we excluded some papers even when they did meet the above criteria, in particular:

- narrative literature reviews (that is, no description of review method, searches, inclusion and extraction procedure, and outcomes)
- comparisons of non-physician clinicians to the highest ('gold') standard such as evidence-based guidelines, but without a direct comparison with physicians
- reporting on the outcomes of economic models in which the input for the models was derived from database and literature sources, and not from direct comparison with physicians.

2.5 Data extraction

We divided the papers identified by the initial search that met the inclusion criteria between three reviewers (ML (n=9), MH (n=3), MF (n=9)) for full extraction. Papers identified later (during searches II and III) were extracted by only one reviewer (ML (n=10)).

We developed a standardised form to extract and summarise the included studies. The following aspects were extracted:

- first author
- year
- type of the review
- aim of the review
- search period
- data sources
- number of studies
- design of included studies (number of studies for each design)
- procedure for study selection and data extraction
- language (inclusion criteria)
- countries (inclusion criteria and number of studies included for each country)
- brief description of the intervention
- brief description of the control condition
- structural indicators:
    - setting
    - clinical domain
    - organisational aspects (number of professionals, patients, practices)
- process indicators:
    - process of care outcomes
    - resource utilisation outcomes
    - provider-related outcomes

- outcome indicators:
    - clinical outcomes
    - patient outcomes
    - costs and cost-effectiveness
- conclusions reported by the authors
- study limitations reported by the authors.

We performed data extraction in a similar way for original studies (this was only applicable for physician assistants) with the exception that we did not include features that are typical only for systematic reviews (for example, type of review, search period, data resources, number and design of studies, procedure for study selection and data extraction, and language).

2.6 Type of role revision

For the purpose of this study, three reviewers (ML, MH and MF) independently divided the papers, on the basis of the description of the intervention and study design, into one of the following categories of role revision:

- substitution
- supplementation
- a mixture of both.

The reviewers resolved disagreements through discussion.

2.7 Validity assessment

Our searches were targeted to identify systematic literature reviews as these provide the strongest evidence.[48] We excluded narrative reviews as these are subjective and prone to bias and error.[49,50] To assess the methodological quality of the reviews, the methods used by the authors of the literature reviews to identify and critically appraise studies in the review needed to be valid. We asked the following questions to determine the methodological quality of reviews:

- Did the authors specify the search period (yes/no)?
- Did the authors specify the search terms (yes/no)?
- Did the authors specify the databases searched (yes/no)?
- Did the authors report whether the selection and data extraction was carried out independently by at least two reviewers (yes/no)?
- Did the authors report that the methodological quality of included studies was assessed by a specified set of criteria (self-developed or frequently used by others) (yes/no)?
- Did the authors specify the methodological quality by reporting a composite quality score or a quality score for each included study (yes/no)?

We awarded each ‘yes’ response with one point. For each review an overall methodological quality score was calculated (range zero to six points). Subsequently, methodological quality was rated ‘poor’ (overall score zero to two points), ‘moderate’ (three or four points) or ‘good’ (five or six points).

2.8 Data synthesis

We summarised data descriptively according to the type of non-physician clinicians. Where appropriate we made a distinction between healthcare settings and type of role (that is, substitution, supplementation or a mixture of both). Data were considered to be too heterogeneous to allow statistical pooling. The included papers used a wide variation of analytic approaches varying from meta-analyses to qualitative reports of findings. The majority of outcomes were assessed only in a small number of original studies. Although data were analysed qualitatively we used a ‘strongest evidence’ approach and gave more weight to outcomes assessed by more sophisticated analytic techniques and measured in at least three original studies. However, data from less sophisticated analytic techniques, such as qualitative analysis, may reveal relevant information for practitioners and policy-makers. Therefore, we also summarised and reported these data in the main text if appropriate.

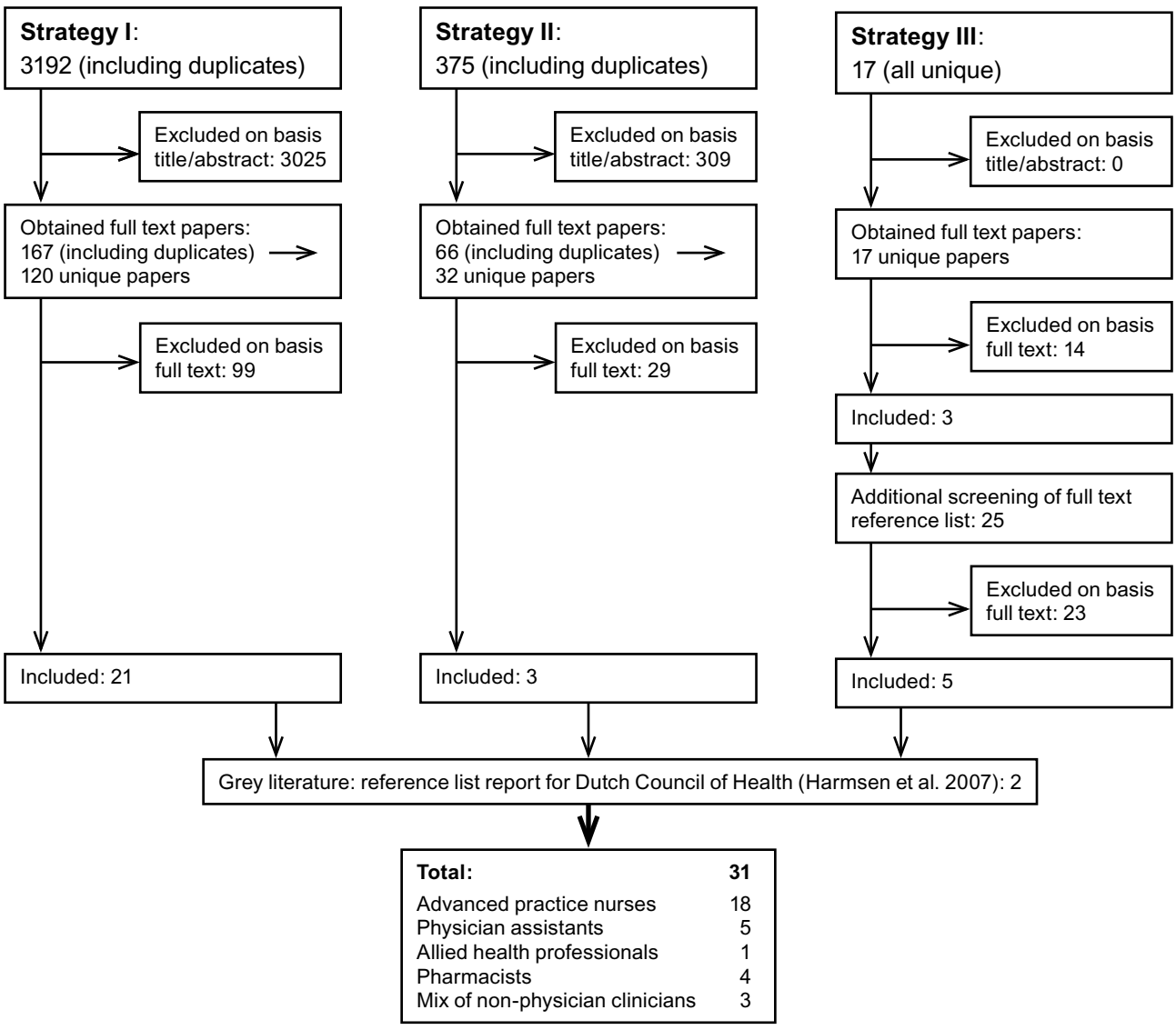
3. Results

3.1 Trial flow

The searches identified 3,584 potentially relevant papers. After first screening of titles and abstracts, 169 papers were obtained for further screening. After full screening we included 29 papers. A report for the Dutch Health Council identified another 2 papers.[51] Therefore, the total number of papers included in this report is 31, of which 28 are systematic reviews and 3 are original studies (see figure 2).

The systematic reviews included randomised controlled trials (RCTs), controlled trials and observational studies; some of the reviews did not report the type of research design. The 28 systematic reviews all included original studies that had not been included in other (previous or later) published reviews, although there was also overlap in the original studies included in reviews regarding nurse role revision and physician assistant role revision (see appendix 2). These differences may be explained partly by differences in search strategies and inclusion criteria. In total, 561 original studies were included; 34 studies were included in 2 reviews, and 5 studies were included in 3 reviews.

Figure 2: Trial flow



3.2 Methodological quality and strength of evidence

Our searches were targeted to identify systematic literature reviews as these provide the strongest evidence.[48] Narrative reviews were excluded as these are subjective and therefore prone to bias and error.[49,50] To be included in this report, reviews had to specify how studies were identified and preferably also use a standardised assessment of the methodological quality of studies. However, as there were very few reviews of role revision involving pharmacists or physician assistants, we included six reviews which did not meet this latter criterion (that is, assessment of methodological quality).

Although independent selection of studies and extraction of data by at least two reviewers increases the objectivity of appraisal, we did not use this as an inclusion criterion. About half of the included reviews (n=14) did use independent study selection and data extraction. In five reviews we assumed study selection and data extraction were conducted by only one reviewer as the paper was written by a single author; nine reviews did not report the method for study selection and data extraction.

The overall methodological quality of included reviews was generally good (n=16). Only two reviews were rated 'poor' (see table 2). The majority of papers reporting the effects of role revision between physicians and physician assistants, allied health professionals or pharmacists were of poor to moderate methodological quality.

Table 2: Methodological quality score of reviews

Author/year	Search period	Search terms	Databases	At least 2 reviewers	Quality assessment	Methodological quality reported	Overall score
Advanced practice nurses							
Brown and Grimes[52]	Yes	No	Yes	Yes	Yes	No	4
Horrocks et al[53]	Yes	Yes	Yes	Yes	Yes	Yes	6
Oakeshot et al[54]	Yes	Yes	Yes	No	Yes	Yes	5
Chapman[55]	Yes	Yes	Yes	No	No	No	3
Laurant et al[56]	Yes	Yes	Yes	Yes	Yes	Yes	6
Du Moulin et al[57]	Yes	Yes	Yes	No	Yes	Yes	5
Dealey[58]	Yes	No	Yes	No	No	No	2
French et al[59]	Yes	Yes	Yes	Yes	Yes	Yes	6
Smallwood[60]	Yes	Yes	Yes	No	Yes	No	4
Philips et al[61]	Yes	Yes	Yes	No	Yes	Yes	5
Griffiths et al[62]	Yes	Yes	Yes	Yes	Yes	Yes	6
Thomas et al[63]	Yes	Yes	Yes	Yes	Yes	Yes	6
Vrijhoef [64]	Yes	Yes	Yes	No	No	No	3
Bradley and Lindsay[65]; Meads et al[66]	Yes	Yes	Yes	Yes	Yes	Yes	6
Loveman et al[67]	Yes	Yes	Yes	Yes	Yes	Yes	6
Hearnshaw et al[68,69]	Yes	Yes	Yes	Yes	Yes	Yes	6
Smith et al[70]	Yes	Yes	Yes	Yes	Yes	Yes	6

Frich[71]	Yes	Yes	Yes	No	Yes	Yes	5
Physician assistants							
Frossard et al[72]	No	No	Yes	No	No	No	1
Buchan et al[73]	Yes	Yes	Yes	No	No	No	3
Allied health professionals							
McPherson et al[86]	No	Yes	No	Yes	Yes	No	3
Pharmacists							
Cotter et al[74]	Yes	Yes	Yes	No	No	No	3
Finley et al[75]	Yes	Yes	Yes	No	No	No	3
Garcia[76]	Yes	Yes	Yes	No	No	No	3
Lindenmeyer et al[69,77]	Yes	Yes	Yes	Yes	Yes	Yes	6
Mixture of non-physician clinicians							
Price[78]	Yes	Yes	Yes	No	Yes	Yes	5
Galloway et al[79]	Yes	Yes	Yes	Yes	No	No	4
Fahey and Schroeder[80]	Yes	Yes	Yes	Yes	Yes	Yes	6

With the exception of role revision between physician assistants and physicians,[81–83] the evidence is based on findings reported in systematic reviews. The majority of research is related to role revision between nurses and physicians.

Because the number of reviews for physician assistants was low we included three controlled studies comparing physician assistant care with physician care. None of these studies used random allocation of patients to either group of healthcare professionals so there is a potential risk of bias. The findings should be interpreted with some caution and not be generalised without consideration of the contextual factors and circumstances in which the intervention (that is, physician assistant care) was implemented.

We found only one review on allied healthcare professionals – including paramedics, physiotherapists and radiologists – and extended searches did not identify any other papers that met the inclusion criterion.

In all included studies the description of the control condition was poorly specified, often being described simply as ‘usual care’, ‘routine care’ or ‘standard care’. In some reviews a clear reference to control condition was lacking, although one may assume that the control condition was physician care. We decided to include those papers.

3.3 Evidence for nurse role revision

Eighteen reviews reported the effectiveness of nurse-led care compared with physician-led care, or care provided by a team (substitution) of nurses and physicians compared with physician-led care (supplementation). With the exception of one review,[52] all were published in the 2000s; four were published in 2005 or later.[57,61,62,68] The original studies included in those reviews covered all previously published relevant research extending back to the 1960s. In total, 199 unique original studies were included; 27 studies were included in 2 reviews and 5 studies were included in 3 reviews.

Table 3 provides an overview of these reviews including structural, process and outcome indicators.

Table 3: Overview of systematic reviews (n=18) of nurse–physician role revision

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Brown and Grimes[52]	Intervention: nurse practitioners provide primary healthcare Control: physicians provide primary healthcare Type: mixture	Primary healthcare Multiple diagnosis	Patients: intervention 9,773 (10 to 2,329), control 11,488 (10 to 4,429) Nurses, physicians and sites not reported	USA (?) Canada (?)	38 (12) 1971–1989	Process of care: • no difference in quality of care (n=5) • nurse significantly more likely to give advice to patient (ES=0.56, 95%CI 0.26 to 0.85, n=3) Resource utilisation: • nurses had significantly longer consultations (ES=1.02, 95%CI 0.68 to 1.36, n=3) • nurses ordered significantly more tests and investigations • nurses more likely to refer patients or make use of consultants (respectively, ES=0.20; 95%CI 0.10 to 0.29, n=4; ES=0.06, 95%CI 0.01 to 0.11, n=3) • patients significantly less often hospitalised 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) or use of emergency services (n=3)	Clinical outcomes: • resolution of (pathological) conditions (eg HbA1C, blood pressure, symptom relief) significantly improved with nurse-led care (ES = 0.28, 95%CI 0.04 to 0.51, n=6) • no difference in functional status (n=3) Patient outcomes: • nurse-led care had significantly higher levels of patient satisfaction and improved compliance with treatment regimes (respectively, ES=0.30, 95%CI 0.20 to 0.40, n=5; ES=0.36, 95%CI 0.08 to 0.64, n=3) • no difference in patient knowledge (n=3)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Horrocks et al[53]; Hollinghurst et al[84]	Intervention: nurses provide first point of contact for patients, make an initial assessment and manage patients autonomously Control: physicians working in a similar way Type: substitution	Primary healthcare Undifferentiated diagnosis	Patients: intervention 107,850 (9 to 98,338), control 27,535 (9 to 14, 935) (2 studies not reported) Nurses: 202 (1 to 58) (6 studies not reported) Physicians: 246 (1 to 84) (14 studies not reported) Sites: 190 (1 to 60)	Europe (n=?) North America (n=?) Australia (n=?) Israel (n=?) South Africa (n=?) Japan (n=?)	34 (11) 2 (2) 1973–2001	Process of care: • nurse practitioners seemed to offer better care (identified physical abnormalities more often (n=1), gave more information (n=2) and produced more complete records (n=2), although no difference in interpretation of X-rays (n=2)) Resource utilisation: • nurses had significantly longer consultations and ordered more tests and investigations (respectively, WMD=3.67, 95%CI 2.05 to 5.29, p<0.0001, n=5; OR 1.22, 95%CI 1.02 to 1.46, p<0.05, n=5) • no difference in number of prescriptions (n=4), return consultations (n=6) or referrals (n=2) Provider-related: • nurses were better communicators (n=2)	Clinical outcomes: • no difference in health status or quality of life (n=7) Patient outcomes: • patients significantly more satisfied with nurses compared with physicians (SMD=0.27, 95%CI 0.07 to 0.47, p<0.0001, n=5) (continuous data); however, a second approach to measuring found no difference in satisfaction (n=3) (dichotomous data) Costs: • no difference in costs between nurse practitioner and salaried general practitioner (either from general practice or National Health Service (UK) perspective (n=2))
Oakeshot et al[54]	Intervention: nurse-led management Control: not specified (assume usual care by physician) Type: substitution	Primary healthcare Hypertension	Patients: 24,295 (36 to 9,348) (not reported per group) Sites: 225 (1 to 67) Nurses and physicians: not reported	UK (n=10)	10 (10) 1988–2001		Clinical outcomes: • no difference in blood pressure without a change in prescribing (7 of 8 trials)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Chapman[55]	Intervention: nurse provides triage and telephone consultation, practitioner-led care and leads walk-in centre Control: not specified (assume usual care by physician) Type: substitution	Primary healthcare Not specified	Patients: 37,398 (278 to 10,134) (not reported per group) (5 studies not reported) Sites: 120 (4 to 40) (8 studies not reported) Nurses and physicians: not reported	UK (n=14)	14 (5) 1998–2003	Process of care: • improved access in nurse-led care services (n=1) – patients were better monitored (n= 1) and received more information in nurse-led care group (n=1) Resource utilisation: • nurses had longer consultations (n=4) but number of consultations seemed reduced (n=3) • nurses carried out more tests and investigations (n=3) • number of home visits by a general practitioner decreased in nurse-led service group (n=2) • no difference in number of return visits (n=4), number of prescriptions (n=4), number of hospitalisations (n=1), use of emergency services (n=4) or number of referrals (n=4) Provider-related: • workload of general practitioners seemed to be reduced as many of the calls were managed by nurses (n=4)	Clinical outcomes: • no difference in mortality rate (n=1) or other (not specified) clinical outcomes (n=4) Patient outcomes: • patients more satisfied with nurse-led care services (n=6)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Laurant et al[56]	Intervention: nurses work as doctors' substitutes for first contact and ongoing care for all presenting patients, first contact for patients wanting urgent attention and routine management of patients with chronic diseases Control: similar care by physicians Type: substitution	Primary healthcare General	Patients: 26,786 (23 to 10,134) (not reported per group) Nurses: 69 (1 to 20) (3 studies not reported) Physicians: 146 (1 to 55) (8 studies not reported) Sites: 31 (10 to 21) (14 studies not reported)	UK (n=6) USA (n=6) Canada (n=4)	16 (13) 1969–2001	Process of care: • 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) Resource utilisation: • 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), or 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), use of other services (2 of 3) or consultation rate (3 of 3)) Provider-related outcomes: • all 3 outcome measures showed a significant reduction in doctors' workload with nurse-led care (n=1)	Clinical outcomes: • meta-analysis found no difference in physical function (n=3), health status or quality of life (n=11) or mortality rate (n=3) Patient outcomes: • patients significantly more satisfied with nurse-led care (SMD=0.28, 95%CI 0.21 to 0.34, p<0.00001, n=3) • 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) Costs: • no difference in costs with the exception of 1 trial that found a net reduction in direct healthcare costs (n=5)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Du Moulin et al[57]	Intervention: nurses provide care to patients with incontinence – role involved a combination of treatment elements Control: usual care or no treatment Type: supplementation	Primary healthcare Incontinence	Patients: 2634 (42 to 376) (not reported per group) Nurses, physicians and sites not reported	USA (n=7) Canada (n=1) Norway (n=1) Australia (n=1) Mix of countries (n=1)	11 (11) 1998–2003	Resource utilisation: • 2 of 3 trials found a reduction in use of pads ($p<0.05$) • evidence inconclusive regarding length of consultation – in 1 trial nurses had significantly longer consultations, whereas another trial found no difference	Clinical outcomes: • a significant reduction in incontinence episodes in 8 of 11 trials in the nurse-led care group ($p<0.05$ (n=2); $p<0.001$ (n=6)) • no difference in quality of life in 3 of 5 trials, but 2 showed a significant improvement with nurse-led care • no difference in other clinical outcomes (eg bladder capacity, psychological wellbeing) in 3 out of 5 trials Patient outcomes: • patients significantly more satisfied with nurse-led care in 3 of 4 trials ($p<0.001$) Costs: • 1 of 2 trials found a significant reduction in costs as a result of treatment by nurses (no formal cost–utility analysis)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Dealey[58]	Intervention: nurses treating minor injuries autonomously Control: doctors, in particular junior doctors, treating minor injuries Type: substitution	Secondary healthcare Minor injuries	Patients: 4,756 (20 to 2,763) (not reported per group) Nurses: 65 (7 to 58) (7 studies not reported) Physicians: 98 (14 to 84) (7 studies not reported) Sites: 16 (3 to 13) (7 studies not reported)	Not reported	9 (?) 1995–2000	Process of care: • nurses were significantly better at recording an adequate medical history ($p<0.001$, 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), accuracy of examination (n=1) or interpretation of radiographs (n=5) Resource utilisation: • nurses had significantly longer consultations (n=1) • significantly fewer patients had an unplanned return visit with nurse-led care ($p<0.05$, n=1) • no difference in planned follow-up visits (n=1) • findings were inconclusive regarding number of tests and investigations ordered (n=2)	Patient outcomes: • no difference in patient satisfaction in 3 of 4 trials Costs: • no difference in cost of investigations or treatments (n=1)
French et al[59]	Intervention: nurse specialist managing and delivering care autonomously within a specialist clinic Control: physician-led care Type: substitution	Secondary healthcare Bronchiectasis	Patients: intervention 39, control 41 Nurses, physicians and sites not reported	Not reported	1 (1) 2002	Resource utilisation: • 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 (n=1) • no difference in prescriptions (n=1)	Clinical outcomes: • no differences in lung function, exercise capacity, infective flare-ups and quality of life (n=1) Costs: • increased costs with nurse-led care due to hospital admissions and use of intravenous antibiotics (n=1)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Smallwood[60]	Intervention: nurses assess, supply and administer a thrombolytic agent to patients Control: standard process of practice by physicians Type: substitution	Secondary healthcare Myocardial infarction	Patients intervention 667 (20 to 336), control 941 (69 to 463) Nurses, physicians and sites not reported	UK (n=5)	5 (0) 1995–2002	Process of care: • door-to-needle time was reduced in nurse-led care group (from median 15 to 18 minutes in nurse group versus median 20 to 68 minutes in physician group (n=5)) Provider-related outcomes: • attitudes to nurse-initiated thrombolysis appeared to be positive, judging from tone of the articles, although no formal testing was carried out (n=5)	
Phillips et al[61]	Intervention: specialist nurse-led heart failure clinic as part of disease management programmes Control: not specified (assume disease management by physician) Type: supplementation	Secondary healthcare Heart failure	Patients: 949 (98 to 200) (not reported per group) Nurses, physicians and sites not reported	USA (n=1) Sweden (n=3) Ireland (n=1) New Zealand (n=1)	6 (6) 1998–2003	Resource utilisation: • 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 to 1.16, n=6) • heart failure readmission was significantly reduced by 70% ($p<0.01$, n=2) when discharge planning was included in the nurses' disease management protocol and by 35% ($p<0.05$, n=4), when discharge planning was not included in the disease management protocol • 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), but no difference in hospital days without discharge planning (n=4)	Clinical outcomes: • no difference in mortality rate (n=6) or quality of life (n=3) Costs: • no differences between groups (n=3)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Griffiths et al[92]	Intervention: nursing-led inpatient unit – nurse identified as leader of the clinical team or majority of patients in the unit Control: physician-led inpatient unit Type: supplementation	Secondary healthcare Not specified	Patients: intervention 1,109 (9 to 351), control 904 (8 to 188) (1 study not reported) Nurses: 81 (10 to 22) (6 studies not reported) Sites: 9 (2 to 4) (7 studies not reported) Physicians not reported	UK (n=8) USA (n=3)	11 (10) 1975–2001	Resource utilisation: • patients in nursing group had significantly more hospital days (WMD=7.37 days; 95%CI 2.86 to 11.88, p<0.001, n=8) • odds of readmission were reduced for patients in the nurse-led care unit (OR=0.52, 95%CI 0.34 to 0.80, p<0.005, n=5) • discharge to institutional care was significantly reduced in the nurse-led care unit (OR=0.44; 95%CI 0.22 to 0.89, p<0.05, n=7) • no differences were found regarding discharge from intensive care units (n=1) 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<0.05, 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)	Clinical outcomes: • functional status and quality of life or health status improved significantly in nurse-led group (respectively, SMD 0.35, 95%CI 0.16 to 0.53, p<0.0005, n= 6; SMD=0.28, 95%CI 0.09 to 0.48, p<0.005, n=5) • no difference in mortality (n=8) or psychological wellbeing (n=3) Patient outcomes: • no difference in patient satisfaction (n=4) Costs: • 6 of 7 studies showed lower costs of care for nurse-led units • costs after discharge showed no substantial differences at 6 months (n=3)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Thomas et al[63]	Intervention: guidelines used by allied nurses Control: standard physician care (no guidelines) Type: substitution	Mixture of primary and secondary healthcare Not specified	Patients: intervention 1,167 (17 to 491), control 1,136 (19 to 494) Nurses: 45 (1 to 21) (1 study not reported) Physicians: 78 (1 to 32) (2 studies not reported) Sites: 6 (all 1)	USA (n=3) UK (n=1) Australia (n=1) Canada (n=1)	6 (6) 1975–1993	Process of care: • nurse produced a significant reduction in (waiting) time, both time to activate partial thromboplastin (p=0.01, n=1) and time in emergency department (p<0.001, n=1), but no difference in time to perform a coagulation test (n=1) • nurses produced a significant improvement in record keeping in 3 areas of activity (urine tests, pulse at each visit and weight (p<0.01)), but record keeping in 2 areas of activity (smoking habits and blood pressure) were not significantly improved (n=1) • findings inconclusive regarding diagnosis – one trial showed no difference while a second trial showed significantly higher rates of muscle headache diagnosis with nurse-led care (p<0.001, n=1) • no difference in patient management (eg medical history, results of physical examination, therapy and referral and laboratory analysis) (n=1) Resource utilisation: • nurses ordered significantly more tests and investigations (p<0.05, n=2 of 3, for X-rays, but no significant difference for coagulation tests) • significantly more patients in nurse-led care group had an unplanned return visit (p<0.05, n=1) • patients in nursing group were significantly more likely to receive packed cells infusion and blood (products) transfusions (p<0.05, n=1) • no difference in prescriptions with the exception of minor tranquillizers which were less frequently prescribed by nurses (p<0.05, n=1) • no difference in hospitalisation (n=1)	Clinical outcomes: • no difference in reduction of symptoms (n=3), metabolic measures (eg blood pressure, sterile urine samples) (n=2), complications or adverse effects (n=3), or (postoperative) blood loss (n=1) Patient outcomes: • patients significantly more satisfied with nurse-led care compared with physician-led care (2 of 3) • no difference in knowledge (n=1)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Vrijhoef et al[64]	Intervention: specialist nurse as main caregiver in chronic care model Control: usual care Type: Supplementation	Mixture of primary and secondary healthcare Diabetes, COPD	Patients: intervention 1,587 (12 to 920), control 1,471 (30 to 918) Nurses, physicians and sites not reported	USA (n=5) UK (n=3) Canada (n=1) Ireland (n=1)	10 (10) 1987–1998	Resource utilisation: • 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 the nurse group • one of these trials found that patients consumed less of some services and more of others	Clinical outcomes: • significant improvement in survival in favour of specialist nurses (n=2, both COPD) • quality of life was significantly improved in favour of the specialist nurses in 3 trials, whereas 3 trials found no difference • no difference in clinical parameters in 4 of 7 trials, but another 2 trials (both COPD) found significant improvements in favour of nurses Patient outcomes: • self-care and knowledge improved significantly in the specialist nursing group in 4 out of 5 trials • findings regarding patient satisfaction were inconclusive – 2 trials found significantly higher patient satisfaction in the nursing group, but another 2 found no difference Costs: • significant decrease in costs for nurse-led care (n=1)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Bradley and Lindsay[65]; Meads et al[66]	Intervention: specialist epilepsy nurse performed interviews with patients and follow-up of patients in addition to usual care Control: routine care Type: supplementation	Mixture primary and secondary healthcare Epilepsy	Patients: intervention 339 (23 to 135), control 344 (19 to 153) Sites: 12 (1 to 6) (1 study not reported) Nurses and physicians: not reported	UK (n=4)	4 (4) 1992–2000	Process of care: • specialist nurses significantly more likely to record in medical notes that they had given advice to patients (p<0.001, n=1) Resource utilisation: • significant increase in serum concentration measurement in the nursing group (p<0.01, n=1) • significant decrease in out-patient hospital attendance with doctors in the nursing group (p<0.01, n=1) • no difference in general practice consultations (n=1)	Clinical outcomes: • no differences in seizure frequency (n=1), psychosocial functioning (2 of 3), social functioning (n=1) or quality of life (n=1) Patient outcomes: • no overall difference in knowledge (2 of 3) but the subgroup of patients with little knowledge at the start of the study showed significant improvement (p<0.01, n=1) • second study showed significantly improved knowledge (p<0.05, n=1) • no differences in sick leave (n=1) Costs: • specialist nurse care was cheaper compared with usual care, although differences in costs were not significant (n=1)
Loveman et al[67]	Intervention: diabetes specialist nurses or nurse case managers Control: routine care Type: supplementation	Mixture of primary and secondary healthcare Diabetes mellitus type 1 and type 2	Patients: 1,074 (27 to 748) (not reported per group) Nurses, physicians and sites not reported	USA (n=4) Canada (n=1) Australia (n=1)	6 (6) 1993–2002	Resource utilisation: • no difference in hospitalisations (n=2) or emergency admissions (n=2)	Clinical outcomes: • no difference in HbA1c in 5 of 6 studies while the remaining study found a significant decrease in HbA1c (p<0.01) with nurse-led care • in the subgroup of patients with initial levels of HbA1c > 8, nurses significantly decreased HbA1c (p<0.05) • inconclusive findings regarding number of hypoglycaemic episodes and complications – 1 trial showed significantly fewer episodes (p<0.001) with nurse-led care, whereas another found no difference in episodes • no difference in quality of life (n=1)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Hearnshaw et al[68]; Vermeire et al[69]	Intervention: nurse-led interventions Control: primary healthcare, outpatient, community or hospital setting Type: supplementation	Mixture of primary and secondary healthcare Diabetes mellitus type 2	Patients: intervention 693 (23 to 295), control 685 (23 to 290) Nurses, physicians and sites not reported	USA (n=4)	4 (4) 1995–2001	Resource utilisation: • 1 trial found increased number of tests and investigations with nurse-led care (eg 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)	Clinical outcomes: • no difference in HbA1c (n=2), although 1 trial showed a significant reduction in HbA1c in patients with an initial level of ≥ 8 ($p<0.05$, n=1) • 1 trial found a significant reduction in serum glucose in nurse-led care group, whereas the reduction in the usual care group was not significant – the difference between groups was not reported (n=1) • 1 trial found diabetes-related symptoms decreased in the nurse-led care group (–10%), but increased in the control group (+10%) – the significance of the difference between groups was not reported • no difference in metabolic outcome measures (eg blood pressure, lipid profile, renal functions, weight) (n=1) or quality of life (n=1) Patient outcomes: • no differences in compliance with medication and/or tests (n=1)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Frich[71]	Intervention: specialised nursing interventions provided during home visits to older people or patients with chronic conditions Control: not specified (assume usual care by physician) Type: mixture	Home care Older people; chronic conditions	Patients: intervention 2,523 (16 to 369), control 2,377 (10 to 527) Nurses, physicians and sites not reported	Not reported	15 (15) 1986–2002	Resource utilisation: • no difference in resource use (n=2) and hospitalisation (n=2) • 1 trial showed significantly shorter hospital stays with nurse-led care	Clinical outcomes: • no difference for the majority of clinical outcomes (n=13) such as metabolic measures, quality of life, wellbeing and functional status • an exception was mortality where findings were inconclusive – 1 trial found significantly lower mortality with nurse-led care whereas another trial found no difference Patient outcomes: • although there was a tendency towards 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 Costs: • no differences in costs (n=8)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Smith et al[70]	Intervention: home care by a respiratory nurse or similar respiratory health worker to facilitate healthcare, provide education, provide social support, identify respiratory deteriorations promptly and reinforce correct technique with inhaler therapy Control: routine care without respiratory nurse/health worker input Type: supplementation	Home care COPD	Patients: intervention 364 (42 to 201), control 260 (33 to 100) Nurses, physicians and sites not reported	USA (n=1) UK (n=2) Australia (n=1)	4 (4) 1987–1999	Resource utilisation: • increased admission rates and longer duration of stay in nurse-led care group (statistics not reported, n=1)	Clinical outcomes: • no differences in mortality (n=4), pulmonary function (n=2), exercise tolerance/walking distance (n=1) • findings inconclusive regarding quality of life – 1 trial using a disease-specific instrument found significantly improved quality of life with nurse-led care ($p<0.05$), whereas 2 trials using a generic instrument found no differences except for the physical dimension, which was better in the nursing group ($p<0.01$) Costs: • higher overall medical costs in nurse-led care group (statistics not reported, n =1)

Note: ‘n=?’ means that the review does not report how many studies were conducted in each of the countries; ‘unknown’ means that we do not know in which countries the studies were conducted

3.3.1 Structural indicators

Setting

Nurses worked as physician substitutes and/or supplements in a range of healthcare settings. Six reviews studied the impact of role revision in primary healthcare settings such as general practice, family medicine, ambulatory or outpatient care, and community care.[52–57] Five reviews focused on secondary healthcare settings such as hospitals and accident and emergency departments.[58–62] The remaining reviews included research in either primary healthcare and secondary healthcare settings,[63–65,67,68] or a home care setting.[70,71]

Clinical domain

The clinical domain varied from generalist care, undifferentiated care or care for patients with multiple diseases,[52,53,55,56] to care for a specific patient group such as patients with diabetes,[67,68] chronic obstructive pulmonary disease (COPD),[70] hypertension or other cardiovascular diseases,[54,60,61] and minor injuries.[58] The clinical domain was not specified in two reviews.[62,63]

Country

The majority of original studies were carried out in the USA or the UK. Exact figures for each country are difficult to give as five authors failed to report this information.[52,53,58,59,71]

Number of participants

All reviews reported the number of patients included in the original studies. However, three reviews did not describe this for all original studies;[53,55,62] in two of these reviews only the number of patients in the control group was missing.[53,62] On the basis of the reviews that provided at least some numbers, the total number of patients included in the reviews varied from 80 to 135,389. There were 10 reviews that included 3,000 or fewer patients,[57,59–63,65,67,68,70] and 5 reviews that included more than 20,000 patients.[52–56] The number of patients included in original studies varied from 17 to 113,273.

Five reviews reported the number of nurses but not for all included original studies.[53,56,58,62,63] On the basis of the reviews that provided the number of nurses, the total number included in a review varied from 45 to 202. The number of nurses included in original studies varied from 1 to 58, although the majority of original studies included only a few nurses (fewer than 5).

Four reviews reported the number of physicians but not for all original studies.[53,56,58,63] On the basis of these reviews, the total number of physicians included varied from 78 to 246. The number of physicians included in the original studies varied from 1 to 84.

Seven reviews reported the number of sites (for example, general practices, hospitals) but not for all original studies.[53–56,58,62,63] The total number of sites included varied from 6 to 225. The number of sites included in the original studies varied from 1 to 67.

Owing to the large amount of missing data, it was not possible to calculate a nurse:patient ratio or nurse:physician ratio.

Type of role revision

Eight reviews studied the effects of substitution.[53–56,58–60,63] Both primary healthcare and secondary healthcare 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.[57,61,62,64,65,67,68,70] Both primary and secondary care settings were represented. Nurses' clinical domain was often focused on patients with a specific condition (for example, diabetes, COPD, cardiovascular diseases, incontinence or epilepsy). Two reviews were identified as a mixture of substitution and supplementation.[52,71] An exact description of nurses' roles was lacking in the majority of reviews.

3.3.2 Process indicators

Process of care outcomes

Table 4 gives an overview of the effects of nurse–physician role revision on process of care outcomes.

Eight out of eighteen reviews included process of care outcomes.[52,53,55,58,60,63,65,85] Brown and Grimes[52] and Laurant et al[56] included meta-analysis or quantitative analysis of at least three or more original studies to assess the effect of nurse role revision on process of care outcomes. The others included only qualitative analysis; (semi-)quantitative data were limited to one or two original studies. The following outcomes were assessed:

- appropriate diagnosis
- appropriate tests and investigations
- appropriate prescriptions
- appropriate health education and health promotion
- appropriate overall management
- record keeping
- lapses in care
- access to care and waiting times
- quality of healthcare without further specification.

The evidence was strongest for health promotion and giving advice and information to patients. This outcome was assessed only in the primary healthcare setting. Both Brown and Grimes[52] and Laurant et al[56] found that nurses were significantly more likely to give advice and information to patients than physicians working alone (meta-analysis). This finding was verified by Horrocks et al[53] and Chapman et al (2004).[55]

The evidence also showed that nurse role revision did not jeopardise appropriate diagnosis of abnormalities. Laurant et al[56], Dealey[58] and Horrocks et al[53] showed that there was no difference between nurses and physicians regarding appropriate assessments and examinations. Thomas et al[63] could not confirm this finding: one trial found significantly higher rates of muscle headache diagnosis, whereas another trial found no difference.

Furthermore, access to healthcare services seemed better with nurse-led care.[55,58,60,63] Three reviews,[55,58,63] which studied the impact on access in the hospital emergency setting, showed significantly shorter waiting times and faster administration of appropriate life-saving medication with nurse-led care.[60] Chapman[55] found that walk-in centres located in primary healthcare settings enhanced access to healthcare, but only for a minority of the population.

Although measured in a small number of original studies, record keeping seemed significantly improved in nurse-led care.[53,58,63,65] Furthermore, Brown and Grimes[52] showed that the quality of healthcare

provided by nurses or a nurse–physician team was comparable to the quality of care provided by physicians (effect size –0.06; 95%CI –0.20 to 0.07; p=0.30; n=5). The evidence regarding other process of care outcomes is scarce, but the findings suggest that nurse-led care is at least as good as physician-led care.

There were no obvious differences between healthcare settings. In the majority of the studies nurses worked as physicians' substitutes. The one review that evaluated the supplementation role only assessed the impact on record keeping.[65] This finding was similar to the findings in the three reviews on substitution.[53,58,63]

Table 4: Overview of effects on process of care outcomes

Reference (total number of studies; type of role revision)	Appropriate diagnosis	Appropriate tests and investigations	Appropriate prescriptions	Appropriate health education and promotion	Appropriate overall management	Record keeping	Lapses in care	Access/ waiting time	Quality of care (not specified)
Primary care									
Brown and Grimes[52] (n=38; mixture)				B (MA) (n=3)					A (MA) (n=5)
Horrocks et al[53] (n=34; substitution)	V (n=3)			W (n=2)		W (n=2)			
Chapman[55] (n=14; substitution)				W (n=1)	W (n=1)			W (n=1)	
Laurant et al[56] (n=16; substitution)	A (n=3)		V (n=2)	C (n=3)	V (n=1)		V (n=1)		
Secondary care									
Dealey[58] (n=9; substitution)	V (n=5)	V (n=1)			V (n=1)	Y (n=1)		W (n=3)	
Smallwood[60] (n=5; substitution)								W (n=5)	
Mixture of settings									
Thomas et al[63] (n=6; substitution)	? (n=2)				V (n=1)	W (n=1)			
Bradley and Lindsay[65] (n=4; supplementation)						W(n=1)			

Legend

MA Meta-analysis
(n=x) Number of original studies assessing the outcome
? Inconclusive evidence due to opposite directions of effects

Quantitative analysis in at least 3 original studies, including meta-analysis

A No difference between groups
B Significantly **favour intervention** in 100% of the studies assessing the outcome/meta-analysis
C Significantly **favour intervention** in at least 50% of the studies assessing the outcome
D Significantly **favour control** in at least 50% of the studies assessing the outcome
E Significantly **favour control** in 100% of the studies assessing the outcome/meta-analysis

Qualitative analysis (regardless of number of included studies) or quantitative analysis in fewer than 3 original studies

V No difference between groups
W Significantly or tendency in **favour of intervention** in 100% of the studies assessing the outcome
X Significantly or tendency in **favour of intervention** in at least 50% of the studies assessing the outcome
Y Significantly or tendency in **favour of control** in at least 50% of the studies assessing the outcome
Z Significantly or tendency in **favour of control** in 100% of the studies assessing the outcome

Provider-related outcomes

Provider-related outcomes were assessed in only a minority of the included reviews.[53,56,60]

Horrocks et al[53] showed that nurses tend to be better communicators compared with physicians. Laurant et al[56] and Chapman[55] included the impact of nurse substitution on physicians' workload; both showed a (significant) reduction in physicians' workload. Smallwood (2004)[60] showed that professional attitudes to nurse-initiated thrombolysis appeared to be positive. There is little evidence regarding provider-related outcomes.

Resource utilisation outcomes

Table 5 shows the effects on resource utilisation outcomes. Resource utilisation was measured in 16 reviews.[52,53,55–59,61–65,67,68,70,71] Brown and Grimes,[52] Horrocks et al,[53] Laurant et al,[56] Phillips et al[61] and Griffiths[62] used meta-analysis techniques to assess the impact of role revision on resource use. All other reviews included a small number of studies, which made it possible to assess this data qualitatively. We assessed the following outcomes:

- number of consultations
- duration of consultations
- number of (unplanned) return visits
- number of home visits
- number of tests and investigations
- number of prescriptions
- number of referrals
- number of hospitalisations or hospital attendance
- duration of hospital stay
- number of patients discharged to institutional care
- number of general and disease-specific readmissions
- number of aids/products used
- use of emergency services
- use of other (non-specified) services
- resource use without specification.

The reviews focusing on primary healthcare settings included resource utilisation outcomes more frequently than those focusing on secondary healthcare settings or a mixture of healthcare settings. This may be explained by the fact that most of these reviews evaluated the impact of nurses working as physician substitutes rather than nurses working in supplementary roles.

The evidence is strongest for number of tests and investigations, number of prescriptions and number of referrals (limited to primary healthcare settings). The last two outcomes showed no differences between nurse substitution or supplementation compared with physicians working alone; this was evaluated in six[52,53,55,56,59,63] and four[52,53,55,56] reviews, respectively. The number of tests and investigations was studied in eight reviews.[52,53,55,56,58,63,65,68] Meta-analysis showed that nurses ordered significantly more tests and investigations than did physicians (respectively, ES=0.20, 95%CI 0.10 to 0.29, $p<0.001$, n=4; OR=1.22, 95%CI 1.02 to 1.46, $p<0.05$, n=5).[52,53] This was confirmed by semi-quantitative and qualitative analysis by Bradley and Lindsay,[65] Chapman et al,[55] Hearnshaw et al[68] and Thomas et al[63] who each reviewed

three or fewer original studies. However, other reviews found no difference between nurses and physicians, or inconclusive results.[56,58]

The number of hospital admissions or attendance was the most frequent outcome studied.[52,55,56,59,63,65,67,70,71] The findings are mixed, although the majority of reviews found no difference in hospitalisation or hospital attendance. However, Brown and Grimes[52] (meta-analysis) and Bradley and Lindsay[65] found a reduction in the number of hospital admissions when nurses were involved in patient care. Smith et al[70] found an opposite effect. It should be mentioned that, although this outcome was studied most frequently, the impact on hospitalisation was assessed only in a few original studies.

A key finding in primary healthcare settings was that the duration of consultations was significantly longer for nurses than for physicians.[52,53,55–57] Dealey[58] also found an increased duration of consultations. Evidence is inconclusive regarding the duration of hospital stay: two reviews found a decreased number of hospital days,[61,71] whereas another two found an increased number of hospital days.[62,70] The number of (disease-specific) readmissions seemed to be reduced in the intervention group.[61,62]

For all other outcomes the studies found no appreciable difference between nurses working either as physicians' substitutes or supplements and physicians working alone.

Table 5: Overview of effects on resource utilisation outcomes

Reference (total number of studies; type of role revision)	Number of consultations	Duration of consultations	Number of return visits	Number of home visits	Number of tests and investigations	Number of prescriptions	Number of referrals	Number of hospital admissions/ attendances	Duration of hospital stay	Discharge to institutional care	Number of readmissions – general	Number of readmissions – disease-specific	Number of aids	Use of emergency services	Use of other services	Resource use (not specified)
Primary care																
Brown and Grimes[52] (n=38; mixture)	A (MA) (n=3)	B (MA) (n=3)			B (MA) (n=4)	A (MA) (n=3)	B (MA) (n=3)	E (MA) (n=3)						A (MA) (n=3)		
Horrocks et al[53] (n=34; substitution)		B (MA) (n=5)	A (MA) (n=6)[a]		B (MA) (n=5)	A (MA) (n=4)	A (MA) (n=2)									
Chapman[55] (n=14; substitution)	Y (n=3)	W (n=4)	V (n=4)[a,b]	Z (n=2)	X (n=3)	V (n=4)	V (n=4)	V (n=1)						V (n=4)		
Laurant et al[56] (n=16; substitution)	A (n=3)	B (n=3)	A (MA) (n=3)[b]		A (n=4)	A (MA) (n=3)	A (MA) (n=3)	A (MA) (n=3)						A (MA) (n=3)	A (n=3)	
Du Moulin et al[57] (n=11; supplementation)		? (n=2)											D (n=3)			
Secondary care																
Dealey[58] (n=9; substitution)		W (n=1)	Y (n=1)[a]; V (n=1)[b]		? (n=2)											
French et al[59] (n=1; substitution)						V (n=1)		V (n=1)								
Phillips et al[61] (n=6; supplementation)									E (MA) (n=2)[d]; A (MA) (n=4)		A (MA) (n=6)	E (MA) (N=6)				
Griffiths et al[62] (n=11; supplementation)									B (MA) (n=8)	E (MA) (n=7)	E (MA) (n=5)				V (n=4)	

Reference (total number of studies; type of role revision)	Number of consultations	Duration of consultations	Number of return visits	Number of home visits	Number of tests and investigations	Number of prescriptions	Number of referrals	Number of hospital admissions/ attendances	Duration of hospital stay	Discharge to institutional care	Number of readmissions – general	Number of readmissions – disease-specific	Number of aids	Use of emergency services	Use of other services	Resource use (not specified)
Mixture of settings																
Thomas et al[63] (n=6; substitution)			W[a] (n=1)		C (n=3)	V (n=1)		V (n=1)					W (n=1)			
Vrijhoef[64] (n=10; supplementation)																? (n=8)
Bradley and Lindsay[65] (n=4; supplementation)	V (n=1)				W (n=1)			Z (n=1)								
Loveman et al[67] (n=6; supplementation)								V (n=2)						V (n=2)		
Hearnshaw et al[68] (n=4; supplementation)					W (n=1)										V (n=1)	
Frich[71] (n=15; mixture)								V (n=2)	Z (n=1)							V (n=2)
Smith et al[70] (n=4; supplementation)								W (n=1)	W (n=1)							

Legend
MA Meta-analysis
(n=x) Number of original studies assessing the outcome
? Inconclusive evidence due to opposite directions of effects
[a] Unplanned return visits
[b] Planned return visits (monitoring)
[c] No distinction between planned and unplanned return visits
[d] Disease management including discharge planning
[e] Disease management without discharge planning

Quantitative analysis in at least 3 original studies, including meta-analysis (MA)
A No difference between groups
B Significantly more use of resources in intervention group in 100% of the studies assessing the outcome/meta-analysis
C Significantly more use of resources in intervention group in at least 50% of the studies assessing the outcome
D Significantly more use of resources in control group in at least 50% of the studies assessing the outcome
E Significantly more use of resources in control group in 100% of the studies assessing the outcome/meta-analysis

Qualitative analysis (regardless of number of included studies) or quantitative analysis in fewer than 3 original studies
V No difference between groups
W Significantly or tendency towards more use of resources in intervention group in 100% of the studies assessing the outcome
X Significantly or tendency towards more use of resources in intervention group in at least 50% of the studies assessing the outcome
Y Significantly or tendency towards more use of resources in control group in at least 50% of the studies assessing the outcome
Z Significantly or tendency towards more use of resources in control group in 100% of the studies assessing the outcome

3.3.3 Outcome indicators

Clinical outcomes

Table 6 gives an overview of the effects on clinical outcomes. Sixteen reviews assessed clinical outcomes.[52–57,59,61–65,67,68,70,71] Meta-analyses were performed in five reviews for at least one of the outcomes.[52,56,61,62,70] Semi-quantitative analyses for at least three original studies were available for eleven reviews.[53,54,56,57,63–65,67,68,70,71] The others only included semi-quantitative analyses from one or two original studies or qualitative data. The reviews reported the following outcomes:

- mortality
- pathological outcomes – such as HbA1c, lung function and incontinence episodes – and symptoms
- quality of life or health status
- functional status or physical functioning
- mental/psychological wellbeing or functioning
- social functioning
- complications and adverse events
- other clinical outcomes or non-specified clinical outcomes.

The evidence is strongest for quality of life or health status, which was measured in 11 systematic reviews.[53,56,57,59,61,62,64,65,67,68,70] Griffiths et al[62] and Phillips et al[61] conducted meta-analyses. Griffiths et al[62] showed significant improvements in quality of life or health status in favour of the nurse-led care group (SMD 0.35, 95%CI 0.16 to 0.53, p<0.0005, n=6), whereas the other reviews found no difference between nurse-led care and physician-led care. The majority of the other reviews found no differences between groups. Two reviews showed inconclusive findings.[64,70] 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 two trials included in both reviews).

Reduction of symptoms or improvement in pathological condition (metabolic parameters such as HbA1c and lung function) was measured in nine systematic reviews.[52,54,57,59,63,65,67,68,70] Only Brown and Grimes[52] conducted a meta-analysis, which showed a significant improvement in pathological condition (ES=0.28; 95%CI 0.04 to 0.51, p=0.01, n=6). Du Moulin et al[57] showed a significant reduction in the number of incontinence episodes in eight out of eleven original studies. Hearnshaw et al[68] showed a significant reduction in HbA1c in two original studies assessing this outcome, and one original study found a reduction of diabetes-related symptoms. All other reviews, each including one to eight original studies, found no differences between groups.

The evidence is the strongest for mortality. This outcome was assessed in seven reviews;[55,56,61,62,64,70,71] of these, three conducted a meta-analysis. With the exception of two semi-quantitative analyses, the evidence suggested there was no difference between nurse-led care and physician-led care.[64,71] Vrijhoef[64] found increased survival rates in the intervention group and the findings from Frich[71] are inconclusive.

There is also strong evidence to establish the effect on functional status. This outcome was assessed in five reviews;[52,56,59,62,70] of these, three conducted a meta-analysis. Griffiths et al[62] found a significantly favourable result, which indicated that functional status improved greatly when nurses were involved in patient care. The others did not find an effect on functional status: nurse-led care was equal to physician-led care.[52,56] This latter finding was also reported in two semi-quantitative analyses by French et al[59] and Smith et al[70].

For all other clinical outcomes the reviews found no differences between nurses and physicians.

The findings were quite similar across different healthcare settings. In general, nurses working in substitution roles had equal effects on clinical outcomes compared with physicians working alone. However, nurses working as physicians' supplements may achieve greater improvements in clinical outcomes compared with physicians working alone.

Table 6: Overview of effects on clinical outcomes

Reference (total number of studies; type of role revision)	Mortality	Pathological outcomes/ symptoms	Quality of life/ health status	Functional status/ physical functioning	Mental wellbeing/ functioning	Social functioning	Complications/ adverse effects	Other and non-specified clinical outcomes
Primary care								
Brown and Grimes[52] (n=38; mixture)		B (MA) (n=6)		A (MA) (n=3)				
Horrocks et al[53] (n=34; substitution)			A (n=7)					
Oakeshot et al[54] (n=10; substitution)		A (n=8)						
Chapman[55] (n=14; substitution)	V (n=1)							V (n=4)
Laurant et al[56] (n=16; substitution)	A (n=3)		A (n=11)	A (MA) (n=3)				
Du Moulin et al[57] (n=11; supplementation)		C (n=11)	A (n=5)					A (n=5)
Secondary care								
French et al[59] (n=1; substitution)		V (n=1)	V (n=1)	V (n=1)				V (n=1)
Phillips et al[61] (n=6; supplementation)	A (MA) (n=6)		A (MA) (n=3)					
Griffiths et al[62] (n=11; supplementation)	A (MA) (n=8)		B (MA) (n=5)	B (MA) (n=6)	A (MA) (n=3)			
Mixture of settings								
Thomas et al[63] (n=6; substitution)		A (n=4)					A (n=3)	V (n=1)
Vrijhoef[64] (n=10; supplementation)	W (n=2)		C (n=6)					A (n=7)
Bradley and Lindsay[65] (n=4; supplementation)		V (n=1)	V (n=1)		A (n=3)	V (n=1)		
Loveman et al[67] (n=6; supplementation)		A (n=6)	V (n=1)				? (n=2)	
Hearnshaw et al[68] (n=4; supplementation)		B (n=3)	V (n=1)					

Reference (total number of studies; type of role revision)	Mortality	Pathological outcomes/ symptoms	Quality of life/ health status	Functional status/ physical functioning	Mental wellbeing/ functioning	Social functioning	Complications/ adverse effects	Other and non-specified clinical outcomes
Frich[71] (n=15; mixture)	? (n=2)							V (n=13)
Smith et al[70] (n=4; supplementation)	A (MA) (n=4)	V (n=2)	? (n=3)	V (n=1)				

Legend
MA Meta-analysis
(n=x) Number of original studies assessing the outcome
? Inconclusive evidence due to opposite directions of effects

Quantitative analysis in at least 3 original studies, including meta-analysis (MA)
A No difference between groups
B Significantly **favour intervention** in 100% of the studies assessing the outcome/meta-analysis
C Significantly **favour intervention** in at least 50% of the studies assessing the outcome
D Significantly **favour control** in at least 50% of the studies assessing the outcome
E Significantly **favour control** in 100% of the studies assessing the outcome/meta-analysis

Qualitative analysis (regardless of number of included studies) or quantitative analysis in fewer than 3 original studies
V No difference between groups
W Significantly or tendency in **favour of intervention** in 100% of the studies assessing the outcome
X Significantly or tendency in **favour of intervention** in at least 50% of the studies assessing the outcome
Y Significantly or tendency in **favour of control** in at least 50% of the studies assessing the outcome
Z Significantly or tendency in **favour of control** in 100% of the studies assessing the outcome

Patient outcomes

Table 7 gives an overview of the effects on patient outcomes. Twelve reviews measured patient outcomes such as patient satisfaction, compliance, knowledge and a number of other or non-specified patient outcomes.[52,53,55–58,62–65,68,71]

The evidence was the strongest for patient satisfaction. Three out of four reviews using meta-analysis techniques showed that patients were significantly more satisfied with nurse-led care than with physician-led care;[52,53,56] all of these were conducted in the primary healthcare setting. This finding was supported by two other reviews using quantitative or qualitative analysis techniques.[55,57] Reviews conducted in hospitals found at best no difference in satisfaction between nurses or nurse–physician teams and physicians working alone.[58,62] Two out of three reviews, including a mixture of different healthcare settings, found higher levels of patient satisfaction when nurses worked either as physician substitutes or supplements.[63,64,71]

There is some evidence for significant improvement of patient adherence to treatment regimes. One review using meta-analysis techniques,[52] and one review including semi-quantitative analyses of two original studies,[71] reported this. However, three other reviews found no differences between groups.[56,63,68]

Knowledge was measured in six reviews.[52,56,63–65,71] Two reviews found increased patient knowledge in at least half of the original studies.[64,71] The remainder, including meta-analysis,[52] found no difference in knowledge.

No differences in other or non-specified patient outcomes were found between nurses and physicians, which suggests that care provided by both these groups is equally safe and effective. There are no obvious differences between types of role revision.

Table 7: Overview of effects on patient outcomes

Reference (total number of studies; type of role revision)	Satisfaction	Compliance	Knowledge	Other and non-specified patient outcomes
Primary care				
Brown and Grimes[52] (n=38; mixture)	B (MA) (n=5)	B (MA) (n=3)	A (MA) (n=3)	
Horrocks et al[53] (n=34; substitution)	B (MA) (n=5)[a] A (MA) (n=3)[b]			
Chapman[55] (n=14; substitution)	W (n=7)			
Laurant et al[56] (n=16; substitution)	B (MA) (n=3)	A (n=3)	V (n=2)	
Du Moulin et al[57] (n=11; supplementation)	C (n=4)			
Secondary care				
Dealey[58] (n=9; substitution)	A (n=3)			
Griffiths et al[62] (n=11; supplementation)	A (MA) (n=3)			
Mixture of settings				
Thomas et al[63] (n=6; substitution)	C (n=3)	V (n=1)	V (n=1)	
Vrijhoef[64] (n=10; supplementation)	C (n=4)		C (n=5)	
Bradley and Lindsay[65] (n=4; supplementation)			A (n=3)	V (n=1)
Hearnshaw et al[68] (n=4; supplementation)		V (n=1)		
Frich[71] (n=15; mixture)	V (n=6)	W (n=2)	X (n=3)	V (n=3)

Legend
MA Meta-analysis
(n=x) Number of original studies assessing the outcome
? Inconclusive evidence due to opposite directions of effects
[a] Continuous data
[b] Dichotomous data

Quantitative analysis in at least 3 original studies, including meta-analysis (MA)
A No difference between groups
B Significantly **favour intervention** in 100% of the studies assessing the outcome/meta-analysis
C Significantly **favour intervention** in at least 50% of the studies assessing the outcome
D Significantly **favour control** in at least 50% of the studies assessing the outcome
E Significantly **favour control** in 100% of the studies assessing the outcome/meta-analysis

Qualitative analysis (regardless of number of included studies) or quantitative analysis in fewer 3 original studies
V No difference between groups
W Significantly or tendency in **favour of intervention** in 100% of the studies assessing the outcome
X Significantly or tendency in **favour of intervention** in at least 50% of the studies assessing the outcome
Y Significantly or tendency in **favour of control** in at least 50% of the studies assessing the outcome
Z Significantly or tendency in **favour of control** in 100% of the studies assessing the outcome

Costs and cost-effectiveness

Eleven reviews included economic outcomes, but none included a formal cost-effectiveness analysis. The findings were inconclusive. Three reviews showed cost savings,[57,62,64] whereas two others showed increased costs.[59,70] All other reviews found no difference in the cost of healthcare.[56,58,61,65,71,84]

3.3.4 Conclusions

In terms of the revision of roles between non-clinicians and clinicians, nurses are studied most frequently. On the basis of 18 reviews it is reasonable to conclude that, regardless of the healthcare setting and role, nurses provide the same quality of care and achieve similar outcomes as physicians.

In terms of the process of care, the findings suggest that nurses more frequently provide advice and information to patients, and can improve access to healthcare services and treatments. There is some indication that nurse-led care is more expensive than physician-led care, which would offset savings on salaries. In particular, nurses seemed to order more tests and investigations and, especially in primary care settings, undertake consultations that are significantly longer than those of physicians. Furthermore, the results give some indication that the number of hospitalisations is reduced in favour of the nurse-led care group, but results are inconclusive regarding the duration of hospital stay.

There is also evidence to support the conclusions that patients are equally or better satisfied with the care provided by nurses, and that clinical outcomes for patients may be improved. Metabolic control of parameters, such as HbA1c, is sometimes improved by nurses, and mortality rates are no different compared with physicians. The overall effects on the costs of healthcare and cost-effectiveness may therefore vary with the specific context of care.

Reviews often lack a clear description of number of patients, nurses and physicians, qualifications of nurses and a precise description of the tasks and responsibilities of the professionals involved in patients' care. Nurses working in supplementary roles appear to be limited to a specific clinical domain, whereas substitution may also include more generalist patient care.

3.4 Evidence for physician assistant role revision

The mix of searches (electronic databases, expert contact and reference lists) identified two systematic reviews (including one unpublished).[72,73] We also identified three original studies that were not included in these.[81–83] One of the original studies was carried out in the mid-1980s; the others were conducted in 2004 and 2008. The studies included in both reviews go back to the late 1960s. In total, forty-six unique original studies were included, of which seven appeared in both reviews.

Table 8 gives an overview of the reviews and original studies, including structural, process and outcome indicators.

Table 8: Overview of systematic reviews (n=2) and original studies (n=3) of physician assistant–physician role revision

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention** **Control** **Type of role revision**	**Setting** **Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs)** **Years of publication**	**Process of care outcomes** **Resource utilisation outcomes** **Provider-related outcomes**	**Clinical outcomes** **Patient outcomes** **Costs and cost-effectiveness**
Frossard et al[72]	Intervention: physician assistants Control: not specified (assume physician care) Type: mixture	Mixture of primary, secondary or tertiary care Not specified	Patients, physician assistants, physicians and sites not reported	USA (n=12) Europe (?) Africa (?)	38 (?) 1971–2007	Resource utilisation: • physician assistant contributed to increased productivity (n=1)	Clinical outcomes: • no differences in clinical outcomes (not specified) (n=10) Patient outcomes: • high level of satisfaction with physician assistant (n=5) Costs: • cost savings in physician assistant group (n=1)
Buchan et al[73]	Intervention: physician assistants Control: not specified (assume physician care) Type: mixture	Not specified Not specified	Patients, physician assistants, physicians and sites not reported	USA (n=15)	15 (?) 1978–2007	Process of care: • decreased transfer time in physician assistant group (n=1) Resource utilisation: • physician assistant contributed to increased productivity (n=2) • decreased duration of stay in hospital in physician assistant group (n=1) Provider-related outcomes: • 4 to 5 hours saved per day per physician in physician assistant group (n=1)	Patient outcomes: • high level of satisfaction with physician assistant (n=4) Costs: • cost savings in physician assistant group (n=7)
Freedman et al[81]	Intervention: surgical abortion by physician assistants Control: surgical abortion by physician Type: substitution	Hospital Abortion	Patients: (procedures) intervention 1,285, control 1,173 Sites: 1 Physician assistants and physicians not reported	USA	Not reported 1986		Clinical outcomes: • no differences between procedures performed by physician assistants and physicians with respect to overall, immediate or delayed complication rates

Goldman et al[82]	Intervention: surgical abortion by physician assistants Control: surgical abortion by physician Type: substitution	Hospital Abortion	Patients: (procedures) intervention 546, control 817 Physician assistants: 3 Physicians: 3 Sites: 2	USA	Not reported 2004		Clinical outcomes: • no differences between procedures performed by physician assistants and physicians with respect to overall, immediate or delayed complication rates
Ohman-Strickland et al[83]	Intervention: general practices with physician assistant Control: general practices without physician assistant Type: supplementation	Family practice Diabetes	Patients: 846 (but this includes the 9 practices with nurse practitioners) Physician assistants: 17 Sites: 37 Physicians not reported	USA	Not reported 2008	Process of care: • physician assistants were significantly (67%) less likely to assess micro-albumin levels compared with physicians ($p<0.05$) • no significant differences in assessment of HbA1c, blood pressure and lipids, although physician assistants tended to have lower assessment rates	Clinical outcomes: • physician assistants were 32% less likely than physicians to have patients attain targeted low-density lipoprotein cholesterol ($p<0.001$) • no significant difference regarding targeted HbA1c or micro-albumin levels

Note: ‘n=?’ means that the review does not report how many studies were conducted in each of the countries; ‘unknown’ means that we do not know in which countries the studies were conducted

3.4.1 Structural indicators

Setting

Two original studies on physician assistant–physician role revision were conducted in hospitals.[81,82] Ohman-Strickland and colleagues[83] evaluated the impact of physician assistant care in family practice settings. The setting of the review by Frossard et al (unpublished)[72] was a mixture of primary, secondary and tertiary care. The review by Buchan et al[73] did not specify the settings in which the studies were conducted, but we assume that physician assistants were working in a range of healthcare settings.

Clinical domain

In all three original studies the tasks of the physician assistants were limited to one specific clinical domain: diabetes in the first paper[83] and surgical abortion in the other two papers.[81,82] The two review papers did not specify the clinical domain.[72,73]

Country

The majority of the studies were conducted in the USA. Only the review by Frossard et al[72] was unclear about the countries where the included studies were performed, although it reported that the majority of studies were conducted in the USA and a small number in Europe and Africa.

Number of participants

Both reviews did not report on numbers of patients, physicians or sites.[72,73] The number of patients in the original studies varied from 546 to 1,285 in the intervention groups, and from 817 to 1,173 in the control groups.

Only the study by Goldman et al (2004)[82] reported on the number of physicians (there were 3). The number of physician assistants varied between 3 and 17. Freedman et al[81] did not report on numbers of physicians or physician assistants.

The number of sites varied between 1 and 37.[81–83]

Because of the large amount of missing data, it was not possible to calculate a physician assistant:patient ratio or physician assistant:physician ratio.

Type of role revision

The role of the physician assistants studied by Ohman-Strickland et al[83] was classified as supplementation. The other two papers studied the effects of substitution.[81,82] In these the roles of physician assistants were not clearly described, but were judged to include a mixture of substitution and supplementation.[72,73]

3.4.2 Process indicators

Process of care outcomes

Two papers included process of care outcomes. Buchan et al[73] showed a lower transfer time in the physician assistant care group compared with physicians working alone. Patients were transferred much more quickly to operating theatres. This outcome was assessed only in one original study. Ohman-Strickland et al[83] found that, despite guideline recommendations for diabetic care, physician assistants were 67 per cent less likely to assess micro-albumin levels compared with physicians ($p<0.05$). There

were no significant differences in the assessment of HbA1c, blood pressure and lipids, although physician assistants tended to have lower assessment rates.

Resource utilisation outcomes

Both reviews reported that physician assistants contributed to increased productivity.[72,73] In addition, one study showed a shorter length of hospital stay in the physician assistant group.[73] None of the original studies included in our review evaluated the impact on resource utilisation outcome measures.[81–83]

Provider-related outcomes

Buchan et al[73] showed a reduction of physicians' workload from four to five hours a day when physician assistants were involved in patient care. None of the other studies included provider-related outcomes.

3.4.3 Outcome indicators

Clinical outcomes

Frossard et al[72] reported that there was no difference in clinical outcomes between patients cared for by physician assistants or by physicians (finding appeared in ten original studies).

Two out of three original studies also found no differences between physician assistants and physicians regarding the overall complications rate and the rates of immediate or delayed complications following surgical abortion.[81,82] Ohman-Strickland et al[83] found the opposite effect. Physician assistants were 32 per cent less likely than physicians to have patients attain targeted low-density lipoprotein cholesterol ($p<0.001$). No significant differences were found regarding targeted HbA1c or micro-albumin levels.

Patient outcomes

Both systematic reviews reported that patients were very satisfied with physician assistants. Findings were chiefly drawn from the same original studies.[72,73] None of the three original studies included other patient outcome measures.[81–83]

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 the original studies (n=4) on which this conclusion was based.[72,73] None of the original studies included cost-effectiveness measures.[81–83]

3.4.4 Conclusions

There is remarkably little evidence regarding the impact of physician assistants on process or outcome indicators. The two systematic reviews gave only a qualitative description of results and did not present exact effect sizes or level of significance. Nevertheless, these reviews concluded that physician assistant care is as safe and cost-effective as physician care. This conclusion is confirmed by the findings of two original studies that compared complication rates of surgical abortion procedures.[81,82] Both studies revealed no differences between physician assistants and physicians. As the evidence was largely based on non-experimental studies and narrative analysis of the data we recommend more rigorous research.

3.5 Evidence for allied health professional role revision

We identified only one systematic review.[85] Additional searches to identify other relevant papers that compared care provided by allied healthcare professionals (such as physiotherapists, occupational therapists and speech and language therapists) with physicians did not yield any additional original comparative studies.

We included only the impact of paramedics, physiotherapists and radiographers as the other two allied healthcare professionals (occupational therapists, and speech and language therapists) did not compare extended care with (usual) care performed by a physician.

Table 9 gives an overview of the studies of allied healthcare professionals, including structural, process and outcome indicators.

Table 9: Overview of sa ystematic review of allied healthcare professional–physician role revision

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention** **Control** **Type of role revision**	**Setting** **Clinical domain**	**Number of patients, nurses, physicians, sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs)** **Years of publication**	**Process of care outcomes** **Resource utilisation outcomes** **Provider-related outcomes**	**Clinical outcomes** **Patient outcomes** **Costs and cost-effectiveness**
McPherson et al[85] Paramedics	Intervention: pre-hospital thrombolysis by paramedics Control: Usual care Type: substitution	(Pre) Hospital Thrombolysis	Patients, allied health professionals, physician and sites not reported	UK (n=2) multiple countries (n=1) unknown (n=1)	6 (0) – this report includes 4 papers 1990–2003	Process of care: • paramedics were able to identify patients who might benefit from thrombolysis (n=2) • significant improvement in call-to-needle time when paramedics were involved in pre-hospital thrombolysis (n=3) • involvement of paramedics in pre-hospital thrombolysis increased adherence to time-to-treatment guidelines (n=4)	Clinical outcomes: • reduction in hospital mortality in favour of intervention (n=1)
McPherson et al[85] Physiotherapists	Intervention: triage of orthopaedic outpatient referrals by physiotherapists Control: triage of orthopaedic outpatient referrals by consultant surgeons Type: substitution	Setting not reported Orthopaedic patients	Patients, allied health professionals, physicians and sites not reported	UK (n=1)	5 (1) – this report includes 1 (1) paper 1999	Process of care: • no difference in appropriate assessment and management of referrals (n=1)	Patient outcomes: • patients were more satisfied with physiotherapists compared with orthopaedic consultant surgeons (n=1) Costs: • physiotherapists performing a triage role were cheaper compared with orthopaedic consultant surgeons (n=1)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention** **Control** **Type of role revision**	**Setting** **Clinical domain**	**Number of patients, nurses, physicians, sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs)** **Years of publication**	**Process of care outcomes** **Resource utilisation outcomes** **Provider-related outcomes**	**Clinical outcomes** **Patient outcomes** **Costs and cost-effectiveness**
McPherson et al[85] Radiographers	Intervention: extended scope practice by radiographers (eg screening examinations, interpretation or radiographs) Control: usual care by radiologists Type: mixture	Setting not reported Clinical domain not specified	Patients, allied health professionals, physicians and sites not reported	UK (n=4)	7 (0) – this report includes 4 papers 1985–1998	Process of care: • no difference in appropriate assessment between radiographers and physicians (n=3), although 1 trial found some indication that radiographers tend to diagnose more false positives Resource utilisation: • radiographers use the same dose area products for screening examinations, but need to produce extra films for reporting to radiologists (n=1)	

Note: ‘n=?’ means that the review does not report how many studies were conducted in each of the countries; ‘unknown’ means that we do not know in which countries the studies were conducted

3.5.1 Structural indicators

Setting

The settings were not reported for the three allied healthcare professionals, but presumably all studies were conducted in a hospital.

Clinical domain

The role of paramedics was extended to pre-hospital thrombolysis for patients who had a myocardial infarction. The physiotherapists were involved in triage of orthopaedic patients. Two out of four original studies concerned the extended role of radiographers to evaluate mammograms and to interpret chest radiographs. Clinical domain was not specified for the other two studies, although one involved barium enema examinations.

Country

The majority of studies were conducted in the UK. One study[86] was situated in different countries and the location of another study[87] was unknown. The location of two original studies, both on paramedics, was unknown.

Number of participants

The number of patients, allied healthcare professionals, physicians and sites were not reported.

Type of role revision

The roles of both paramedics and physiotherapists were judged as substitution by replacing the care provided by physicians. The roles of radiographers included aspects of both substitution and supplementation.

3.5.2 Process indicators

Process of care outcomes

Paramedics were able to identify patients who might benefit from pre-hospital thrombolysis (n=2). By doing so, the call-to-needle time improved significantly (n=3) and adherence to guidelines was met without increasing the risk for patients (n=4). The actual time saving varied across studies: the median time saving was 28 to 73 minutes in urban and rural areas, respectively,[88] with an average time saving of 41 minutes.[89]

Triage of orthopaedic outpatient referrals by physiotherapists, when suitably trained, was comparable to consultant surgeons (n=1).

Radiographers appear able to be trained in both diagnostic and therapeutic skills to a level of performance comparable with radiologists. In general, assessment and treatment were equally safe and effective compared with physicians (n=4).

Resource utilisation outcomes

Radiographers use the same dose area products for screening examinations, but they needed to produce extra films for reporting to radiologists. Therefore, overall there was a significant increase in the use of dose area products (n=1).[90]

Provider-related outcomes

All three allied healthcare professionals appear to be able to be trained in the extended role.

3.5.3 Outcome indicators

Clinical outcomes

Only one study included clinical outcomes; this showed that hospital mortality was reduced when paramedics treated patients with pre-hospital thrombolysis.[86]

Patient outcomes

Patients were more satisfied with physiotherapists compared with orthopaedic consultant surgeons.

Costs and cost-effectiveness

Two studies reported the effect on costs.[90,91] Initial direct hospital costs were cheaper when physiotherapists conducted the triage of orthopaedic outpatient referrals compared with physicians. The other study found that, overall, higher use of dose area products by radiographers as a result of extra filming for radiologists resulted in higher costs. This is an argument against extending the role of radiographers.

3.5.4 Conclusions

The evidence for role revision between allied healthcare professionals and physicians is sparse. Evidence was limited to paramedics, physiotherapists and radiographers. As only a few original studies were included, and the conclusions were largely based on narrative analysis of the data, the findings should be interpreted with caution. The findings of the single available systematic review suggest that allied healthcare professionals (paramedics, physiotherapists and radiographers) are able to apply advanced (medical) skills in routine practice and may provide quicker access to relevant treatment, particularly call-to-needle-time, for patients. More robust evaluative studies are needed to establish the impact of different types of allied healthcare professionals working in extended roles on process and outcome indicators.

3.6 Evidence for pharmacist role revision

Searches identified four reviews that reported the effectiveness of pharmacist interventions to improve healthcare delivery, in particular the impact on drug prescriptions and medication use. Although the reviews included studies comparing pharmacist-led care with physician-led care, their primary aim was to assess the impact of pharmacist interventions on prescribing and medication use (such as computer alerts, medication review, and training of physicians and other staff members). In this report we included only those interventions where pharmacists had an indirect (for example, advice to physicians related to prescription patterns) or direct (for example, teaching self-management skills to patients) responsibility in patient care. In total 191 unique original studies were included. There was no overlap in the studies included in the four reviews.

Table 10 gives an overview of these reviews, including structural, process and outcome indicators.

3.6.1 Structural indicators

Setting

Two reviews included studies conducted in different types of healthcare settings (such as primary healthcare, hospitals, outpatient clinics and nursing homes),[75,77] whereas Cotter et al[74] included only studies conducted in hospitals. Garcia[76] included a study conducted in a Veteran's Administration Medical Center in the USA.

Clinical domain

With the exception of Cotter et al,[74] the work of pharmacists was targeted to a specific patient group: people with mental health concerns,[75] older people[76] or patients with diabetes.[77]

Country

The majority of original studies were located in the UK,[74] and the remainder were in the USA.[76,77] Finley et al[75] failed to report the countries where the studies took place.

Patient outcomes

Three reviews included outcome measures.[74,75,77] Patient satisfaction was assessed by Finley et al.[75] Three studies included in this review showed that depressed patients were significantly more satisfied with pharmacist services.

Two reviews included patients' compliance regarding medication intake. The findings are inconclusive: one trial included by Lindenmeyer et al[77] showed a significant improvement in patient compliance in the pharmacist group, but another trial included in this review showed no difference. Cotter et al[74] found that patient compliance improved when pharmacists provided services directly to patients. This review also showed improvements in knowledge in favour of pharmacist-led care.

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 healthcare services.[74,75,77]

Table 10: Overview of systematic reviews of pharmacist–physician role revision

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention** **Control** **Type of role revision**	**Setting** **Clinical domain**	**Number of patients, nurses, physicians, sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs)** **Years of publication included studies**	**Process of care outcomes** **Resource utilisation outcomes** **Provider-related outcomes**	**Clinical outcomes** **Patient outcomes** **Costs and cost-effectiveness**
Cotter et al[74]	Intervention: various interventions with extended roles for pharmacists in patient care Control: not specified (assume usual care by physician alone) Type: supplementation	Hospital Not specified	Patients, pharmacists, physicians and sites – not reported in the vast majority of studies	UK (n=169)	169 (?) 1965–1994	Process of care outcomes: • medication monitoring seemed to improve quality of care, but improvements were rarely significant • provision of advice to healthcare providers and integration into healthcare teams seemed to improve quality of care Provider-related outcomes: • pharmacists' recommendations to alter therapy were accepted by doctors • pharmacists' participation was viewed as useful • pharmacists' medication histories were more complete compared with those of junior doctors	Patient outcomes: • several studies showed an improvement in patient compliance and knowledge (patient-directed interventions and provision of clinical service to primary care recipients), and this may improve (unspecified) patient outcomes Costs: • medication monitoring, provision of advice to healthcare providers, integration into healthcare teams and provision of clinical pharmacy services to primary care recipients all showed potential cost savings as they promoted the economic use of medicines and reduced drug expenditure

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention** **Control** **Type of role revision**	**Setting** **Clinical domain**	**Number of patients, nurses, physicians, sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs)** **Years of publication included studies**	**Process of care outcomes** **Resource utilisation outcomes** **Provider-related outcomes**	**Clinical outcomes** **Patient outcomes** **Costs and cost-effectiveness**
Finley et al[75]	Intervention: various interventions with extended roles for pharmacists in patient care Control: not comparable pharmaceutical care (assume usual care by physician) Type: supplementation	Mixture of settings (inpatient clinics, outpatient clinics, primary care clinics and nursing homes) Mental health	Patients: 29,158 (19 to 23,340) (2 studies not reported, reported number of prescriptions (n=178) and number of visits (n=7,396)) Physicians: 30 (only reported in 1 study) Sites: 73 (1 to 33) Pharmacists not reported	Not reported	16 (3) 1977–2003	Process of care: • prescribing improved in the pharmacist care group through reduction in the dosage and absolute number of psychotropic drugs (significance not reported) (n=16)	Clinical outcomes: • no difference in 2 of 3 trials, but 1 trial showed significant improvements in clinical outcomes Patient outcomes: • adherence to drugs regimes significantly improved in patients treated by pharmacists (n=3) • patients were significantly more satisfied with pharmacists' services compared with usual care (n=3) Costs: • pharmacists' services reduced healthcare costs as drug acquisition costs decreased, and reduced the number of hospitalisations and number of consultations (significance not reported) (n=8)
Garcia[76]	Intervention: pharmacist participated in the care of older people Control: not specified (assume usual care by physician) Type: supplementation	Veteran's Administration Medical Center Older people	Patients: 208 Sites: 1 Pharmacists and physicians not reported	USA (n=1)	1 (1) 1996	Process of care: • inappropriate prescribing and the number of drugs prescribed reduced by 24% in pharmacist-led group versus 6% in usual care group (n=1) Provider-related outcomes: • physicians were receptive to the recommendations • recommended changes were significantly more frequently enacted in the pharmacist group (55% versus 20%, p=0.001)	Clinical outcomes: • 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)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention** **Control** **Type of role revision**	**Setting** **Clinical domain**	**Number of patients, nurses, physicians, sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs)** **Years of publication included studies**	**Process of care outcomes** **Resource utilisation outcomes** **Provider-related outcomes**	**Clinical outcomes** **Patient outcomes** **Costs and cost-effectiveness**
Vermeire et al[69], Lindenmeyer et al[77]	Intervention: diabetes care interventions delivered by pharmacists Control: standard care Type: supplementation	Mixture of settings (primary healthcare, outpatient, community and hospital setting) Diabetes	Patients: intervention 324 (15 to 180), control 209 (0 to 92) Pharmacists, physicians and sites not reported	USA (n=5)	5 (5) 1993–2000	Process of care: • pharmacists' recommendations were significantly more often related to patient education (47% versus 12%) (n=1) Resource utilisation: • significant decrease in use of other services in the pharmacist-led group (n=1)	Clinical outcomes: • HbA1c significantly decreased in pharmacist-led group (n=3) • more patients in the pharmacist group experienced serious adverse events (hypoglycaemic episodes) – 17 versus 2 (significance not reported) (n=1) • no difference in quality of life (n=2) or other pathological/ metabolic outcome measures (eg blood pressure, weight) (n=2) Patient outcomes: • results were inconclusive regarding patients' drug compliance – 1 trial showed no difference, whereas another trial showed a significant increase in medication possession rate in the pharmacist-led group Costs: • costs reduced by US$68 per capita (significance not reported) (n=1)

Note: 'n=?' means that the review does not report how many studies were conducted in each of the countries; 'unknown' means that we do not know in which countries the studies were conducted

Number of participants

The number of patients varied from 208 to 29,158.[75–77] Cotter et al[74] did not report the numbers of patients. Finley et al[75] was the only study that reported on the number of physicians (30). The number of pharmacists was not reported by any study.

Cotter et al[74] and Lindenmeyer et al[77] did not report the number of sites. The number of sites in the other two studies was 1 for the study by Garcia[76] and 73 for the study by Finley et al.[75]

Type of role revision

The interventions in which pharmacists had an indirect (for example, prescribing advice to physicians) or direct (such as teaching self-management skills to patients) impact on patient care were included. In this context the role of the pharmacists for all four reviews is best described as supplementation.

3.6.2 Process indicators

Process of care outcomes

Two reviews assessed the impact on prescribing patterns.[75,76] Garcia[76] showed that inappropriate prescribing was reduced by 24 per cent in the pharmacist-led group compared with 6 per cent in the usual care group. Finley et al[75] reported that pharmacist interventions improved prescribing, most commonly by reducing the dosage and number of psychotropic drugs (n=16, retrospective studies).

Lindenmeyer et al[77] reported that 42 per cent of the recommendations regarding diabetes therapy made by pharmacists were related to patient education compared with 12 per cent in the usual care group.

Resource utilisation outcomes

Resource use was only evaluated in one trial, which was included in Lindenmeyer et al.[77] This study showed a significant decrease in the use of other services in the pharmacist-led group.[92]

Provider-related outcomes

Cotter et al[74] and Garcia[76] included some provider-related outcomes. These reviews showed that pharmacists' recommendations to alter drug therapy were accepted by the physicians. Pharmacists were viewed as useful professionals.

3.6.3 Outcome indicators

Clinical outcomes

Two reviews included clinical outcomes.[76,77] Lindenmeyer et al[77] showed a significant decrease in HbA1c levels as a result of the pharmacist intervention, but the impact on other clinical outcomes (for example, quality of life and other metabolic outcome measures such as blood pressure and weight) remained unclear. Garcia[76] also found no difference in quality of life but did report fewer serious adverse drug reactions in the pharmacist intervention group. However, the difference between groups was not statistically significant. In contrast, Lindenmeyer et al[77] found the opposite: the number of hypoglycaemic episodes was higher in the pharmacist-led group (significance not reported).

3.6.4 Conclusions

All four reviews showed that the extension of the role of pharmacists in patient care is a promising strategy to improve the quality of care. The evidence is strongest for the effect on prescribing appropriateness. A majority of the included studies show a significant reduction in inappropriate prescribing. Although there is limited evidence, physicians appear to accept the involvement of pharmacists and to change their prescribing according to pharmacists' advice. One review showed a significant decrease in HbA1c levels as a result of integrated pharmacist care programmes, but the impact on other clinical outcomes, patient outcomes and cost-effectiveness remains unclear.[69,77] More robust evaluative studies are needed to establish the impact of different types of pharmacists' roles in patient care on clinical outcomes, patient outcomes, quality of care and cost-effectiveness.

3.7 Evidence for mixed group of non-physician clinicians role revision

Searches identified three systematic reviews.[78–80] These reviews included a variety of non-physician clinicians, but did not report separately the outcomes for each type of non-physician clinician.

Table 11 gives an overview of these reviews and includes structural, process and outcome indicators.

3.7.1 Structural indicators

Setting

Two reviews included studies from primary healthcare settings,[79,80] while Price[78] focused on critical care units.

Clinical domain

All reviews focused on one specialist domain: patients with respiratory problems,[78] dental problems[79] and hypertension.[80]

Country

The majority of original studies included in the reviews were carried out in the USA (n=78), followed by the UK (n=28).

Number of participants

The number of patients included in the reviews varied enormously: 284 to 94,242 patients. The variation in each of the original studies was also large; the range of patients included was particularly large for Galloway et al[79] (2 to 25,000). Approximately half of the original studies in this review failed to report the number of enrolled patients.

The numbers of non-physician clinicians and physicians was not reported by Price[78] or Fahey and Scroeder.[80] Galloway et al[79] included 5,059 non-physician clinicians (such as dental nurses, dental hygienists, dental therapists and dental technicians) (range was 1 to 915) and 9,187 physicians (such as dentists and orthodontists) (range was 1 to 3,980). In approximately one-fifth of the original studies the number of professionals was not reported.

The number of sites was reported in all three reviews, and varied from 4 to 816.

Due to the large number of missing data, it was not possible to calculate a non-physician clinician–patient ratio or non-physician clinician–physician ratio.

Type of role revision

The role of specialist nurses or respiratory therapists was defined as substitution,[78] whereas the other two reviews included a mixture of both substitution and supplementation.[79,80]

Table 11: Overview of systematic reviews (n=3) of mixed group of non-physician clinicians–physician role revision

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Price[78]	Intervention: specialist nurses or respiratory therapist-led weaning strategies, giving mechanical ventilator support autonomously Control: physician-led care Type: Substitution	Critical care units Patients needing assistance with respiratory function	Patients: 284 (only reported in 1 study) Sites: 4 (only reported in 1 study) Non-physician clinicians and physicians not reported	USA (n=3)	3 (1) 1995–1997	Resource utilisation: • significant reduction in ventilation time in favour of nurse-led care, although according to figures no difference in total weaning time (–32.6; 95%CI –32.6 to –1.8; p<0.079; n=1) • no difference in ventilation time in the other 2 studies, although 1 found a non-significant reduction in ventilation time in favour of the nurse-led weaning group • significant reduction in hours before weaning commenced in favour of nurse-led care group (–18.7; 95%CI –40.2 to 2.8; p=0.016; n=1) • no difference in duration of hospital stay (n=1)	Clinical outcomes: • no difference in mortality (n=1) or complication rates (n=2) Costs: • reduction in hospital costs (significance not reported) (n=1)

	Structural indicators					Process indicators	Outcome indicators
Study	**Intervention Control Type of role revision**	**Setting Clinical domain**	**Number of patients, nurses, physicians and sites (practices/ hospitals) (range)**	**Countries included (number of studies)**	**Number of studies (number of RCTs) Years of publication**	**Process of care outcomes Resource utilisation outcomes Provider-related outcomes**	**Clinical outcomes Patient outcomes Costs and cost-effectiveness**
Galloway et al[79]	Intervention: non-medical professionals (dental nurses, hygienists, therapists, technicians, assistants) performing dental procedures as professions complementary to dentists (PCDs) Control: dental procedures performed by dentist or dental students Type: mixture	Primary dental care Dentistry	Patients: 94,242 (2 to 25,000) (56 studies not reported) Non-physician clinicians: 5,095 (1 to 915) (23 studies not reported) Physicians: (dentists/ orthodontists): 9,187 (1 to 3,980) (31 studies not reported) Sites: 816 (1 to 137) (96 studies not reported)	USA (n=71) UK (n=13) Sweden (n=9) Canada (n=7) Finland (n=6) Netherlands (n=5) Norway (n=4) Australia (n=4) Zimbabwe (n=1) Singapore (n=1) Thailand (n=1) Switzerland (n=1) Mixed (n=2)	125 (6) 1963–2000	Process of care: • trained PCDs can perform screening and diagnosis as well as dentists can (24 out of 26 studies) • trained PCDs can undertake health promotion activities as well as dentists can (all 10 studies) • PCDs can perform a wide variety of dental procedures as well as dentists can (40 out of 41 studies)	Patient outcomes: • patients accept procedures carried out by PCDs (response rate surveys varied from 5% to 66%) (all 13 studies) Costs: • PCDs are cost-effective (all 53 studies) • meta-analysis of 17 studies showed that productivity increases by 45% (35% to 53%) by adding one extended duty dental nurse, by 35% (95%CI, 7% to 64%) by adding one dental hygienist, and by 18% (95%CI, 11% to 25%) by adding one basic dental nurse to a single-handed dental practice previously without a PCD
Fahey and Schroeder[80]	Intervention: health professional (nurse or pharmacist) led care to help improve blood pressure control Control: no intervention or usual care Type: mixture	Primary care, outpatient and community setting Hypertension	Patients: intervention 1,313 (17 to 574), control 1,287 (19 to 574) Sites: 28 (1 to 12) (1 study not reported) Non-physician clinicians and physicians not reported	USA (n=4) UK (n=1) Mexico (n=1) Unknown (n=1)	7 (7) 1981–2004	Process of care: • significantly better blood pressure control in health professional-led care group (OR 0.24; 95%CI 0.18 to 0.32; p<0.00001, n=5), but heterogeneous (p<0.00001)	Clinical outcomes: • significantly lower systolic blood pressure in health professional-led care group (WMD: –2.37; 95%CI –3.79 to –0.95; p=0.001; n=6), but heterogeneous (p=0.001) • significantly lower diastolic blood pressure in health professional-led care group (WMD: –1.53; 95%CI –2.09 to –0.97; p<0.00001; n=7), but heterogeneous (p<0.00001)

Note: 'n=?' means that the review does not report how many studies were conducted in each of the countries; 'unknown' means that we do not know in which countries the studies were conducted

3.7.2 Process indicators

Process of care outcomes

Two reviews included process of care outcomes.[79,80] The majority of the outcomes were analysed qualitatively. Only Fahey and Schroeder[80] used meta-analyses to assess the impact on management of blood pressure. Meta-analyses of five trials showed significantly better blood pressure control when this task was carried out by nurses or pharmacists compared with physicians working alone. Galloway et al[79] showed that non-physician clinicians can perform screening and diagnostics equally well compared with dentists. They found a similar effect for health promotion activities and performance of dental procedures.

Resource utilisation outcomes

Resource utilisation was assessed in one review.[78] Nurse-led weaning strategies resulted in a significant reduction in ventilation time in favour of the intervention group in one trial, whereas in two other trials the ventilation time was not reduced significantly. Furthermore, it showed that time to start ventilation was reduced significantly (n=1). This did not result in a reduction of hospital days.

Provider-related outcomes

None of the reviews included provider-related outcomes.

3.7.3 Outcome indicators

Clinical outcomes

Clinical outcomes were measured in two reviews.[78,80] Fahey and Schroeder[80] used meta-analyses to assess the effect on blood pressure, which showed that nurses and pharmacists significantly improved both diastolic and systolic blood pressure compared with physicians.

The effect on the number of deaths was assessed in one review and showed no differences between the groups (n=1).[78] There was some evidence that no difference existed between the groups regarding the number of adverse events.[78]

Patient outcomes

One review included the impact on patient outcomes, in particular whether or not the revision of professional roles was acceptable for patients.[79] Outcomes were analysed only qualitatively and showed a positive trend. All original studies (n=13) showed that patients accepted non-physician clinicians such as dental nurses and dental therapists as care providers.

Costs and cost-effectiveness

Costs were assessed in two reviews and both showed cost savings.[78,79]

3.7.4 Conclusions

Three reviews including different types of non-physician clinicians showed quite similar results compared with the reviews focusing on a single type of non-physician clinician. Although the evidence is scant, it could be concluded that non-physician clinicians provide safe and effective care.

4. Conclusion and discussion

4.1 Conclusion

The available evidence suggests that non-physician clinicians working either as substitutes or supplements for physicians in defined areas of care can maintain – and for some aspects even improve – the quality of care and outcomes for patients.

Revision of roles appears to be acceptable for patients as well as for physicians.

The effect on overall healthcare costs is mixed: savings depend on the context of care and the specific nature of role revision. The evidence did not support the hypothesis that supplementary care increases healthcare costs; in fact, six out of nine reviews evaluating this type of role showed a reduction in healthcare costs. However, substitution did not result in cost savings.

The evidence base underpinning these conclusions is strongest for nurses as this type of non-physician clinician is studied most frequently. There is a marked paucity of research on the effectiveness of role revision for pharmacists, physician assistants and allied healthcare professionals. More robust evaluative studies into role revision between those non-physician clinicians and physicians are needed, particularly regarding economic impacts and cost-effectiveness, before firm conclusions can be drawn.

Despite the limitations, we conclude that suitably trained non-physician clinicians without a medical qualification are capable of undertaking tasks that were previously performed only by physicians without reducing the quality of care or detrimentally affecting clinical outcomes.

4.2 Discussion

Although the revision of professional roles is widespread, the evidence to support this is modest with the exception of the revision of roles between nurses and physicians. Our in-depth analysis of the available evidence proved to be valuable: it showed some clear, albeit small, outcomes of role revision as well as some specific uncertainties that need to be addressed by future research.

We are uncertain as to why there is a paucity of research in this area. One reason may be that the revised role is relatively new and so not yet evaluated. Although this may be true for pharmacists and allied health professionals, it is not the case for nurses or physician assistants. There is remarkably little evidence regarding role revision between physician assistants and physicians even though they were first introduced in the USA in the early 1960s and have become widespread since then. Although the evidence base on role revision between nurses and doctors is more extensive, many extended nursing roles have yet to be evaluated. A second reason for the dearth of robust research may be the lack of funding in this area, with priority given to clinical research rather than health services research. However, both these reasons are pure speculation as we did not collect the information that we would need to test the validity of such hypotheses.

4.2.1 Methodological strengths and limitations

Our study has several limitations. First, 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. Although 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.

Second, although our search was not restricted by country, virtually all the reviews report on studies conducted in the USA and the UK. This is unsurprising given that both countries have the longest experience with revision of professional roles. However, as healthcare systems vary across countries, the results may not be transferable. Even when healthcare systems seem similar, differences in training and education of medical or non-medical healthcare 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 non-physician clinicians, in particular nurses, play a substantial role in providing care to people who are medically underserved.[93]

Third, because of the heterogeneity of the articles we were not able to perform meta-analyses to provide a better synthesis of the results. Instead, we used a qualitative approach to synthesise the evidence. This approach gave higher weight to findings from more sophisticated analysis techniques (such as meta-analysis) in our final conclusions. As some of the original studies were included in more reviews and included in more than one meta-analysis – for example, Horrocks et al[53] and Laurant et al[56] – this may 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 less sophisticated synthesis often supported the more sophisticated synthesis of the data we think our conclusions regarding the effects of role revision are valid.

Fourth, many of the early studies included in the reviews are now more than 10 or even 15 years old. As roles of nurses and physician assistants, and to a lesser extent allied healthcare professionals and pharmacists, will have developed over the intervening years, the findings from older studies may have limited generalisability to current healthcare policy. As the reviews did not distinguish between older and recently published articles, we cannot judge whether measured outcomes have changed over time. However, when we included only the findings from recently published reviews (2004 and onwards) we came up with the same conclusions, so we think the findings are still applicable to current practice.

Fifth, the review did not allow us to see how role revisions would affect the healthcare system. For example, as non-physician clinicians take on more enhanced roles this may lead to gaps in their previous roles and responsibilities. In turn, this may result in junior providers enhancing their role and taking over responsibilities and tasks from senior providers. Another cause of concern may be that it will lead to a shortage of staff. In particular, this may be a major issue for the nursing profession as it already faces a substantial shortfall in the number of nurses that are required.[94,95]

Finally, we encountered various other difficulties that are typical of reviews in this field. These include a lack of precision in defining the professional role revision, and heterogeneity in the nature of the intervention (for example, in terms of clinical focus and the training and education of non-medical healthcare professionals). Furthermore, many original studies reported only short-term outcomes. This may have influenced effect sizes if the non-physician clinician was new to the role under investigation. It can take a number of months for physicians, non-physicians and patients to adjust to a role revision so short-term outcomes may not properly reflect longer-term performance.[96,97] Another limitation is the lack of a thorough description of participants included in the original studies, such as number of patients, non-physician clinicians, physicians and sites, but also age, gender and education. For this reason we could not calculate the most effective patient:non-physician clinician:physician ratio. In general, we did not find a difference in effects between role revision in primary and secondary healthcare settings.

4.2.2 Implications for practice and health policy

The main conclusion is that the revision of professional roles does not jeopardise patient care; in fact, sometimes it may even improve the quality of patient care. It is therefore a viable strategy for healthcare services to consider when they are faced with shortages of medical professionals. However, the evidence that role revision increases workforce productivity or reduces costs is very weak and sometimes contradictory. Health planners should not assume therefore that role revision will improve cost-effectiveness.

It should be recognised that deploying more non-physician clinicians does not eliminate the need to increase physician numbers, as non-physician clinicians cannot substitute for physicians across their full spectrum of care responsibilities.[98]

Despite the fact that non-physician clinicians have been introduced into healthcare systems, health decision-makers still face major challenges such as maintaining the quality of healthcare, constraining the costs of healthcare and solving workforce shortages. Responding adequately to these challenges will require healthcare systems that have efficient, effective and high-quality workforces. Further implementation of a policy of using non-physician clinicians for different clinical domains and in different healthcare settings may be one solution.[99]

But the widespread introduction of non-physician clinicians is a challenge in itself. Although not directly derived from the previously reported evidence, other papers have identified some relevant issues to be considered by health planners, policy-makers and providers wishing to implement role revision. They cite the following as influencing the success of change:[1,100,101]

- clear definition of the functions, level of autonomy, lines of accountability, and levels of experience and qualifications of professionals working in revised roles[102–104]
- development of training programmes for professionals working in revised roles[9,102,105–107]
- systems for the accreditation and licensing of professionals working in revised roles[103]
- revision of regulations regarding the scope of practice of professionals working in revised roles, for example, extending prescribing rights [28,102]
- professional indemnity insurance for professionals working in revised roles, coupled with clarification of the vicarious liability to employers
- excellent change management skills to address professional resistance to change[28,108]
- payment systems that provide sufficient reimbursement to encourage multidisciplinary working and collaboration between non-physician clinicians and physicians.[109]

Finally, health planners and policy-makers need to be alert to the potential impact of role revision on other parts of the healthcare system, including attending to any unforeseen consequences.[1] For example, role revision will generally increase the size of healthcare teams as physicians are joined by the non-medical professionals who take over some of their tasks. Larger team sizes may, in turn, increase the difficulties of coordinating care among the various professionals. In general practices larger team sizes have been shown to increase speed of access to care for patients, but also to reduce continuity of care with a preferred doctor.[1,100,101]

4.2.3 Implications for research

Productivity and cost-effectiveness are arguably the two outcomes of greatest importance to healthcare planners, but are also those that are the least well researched. More research, preferably measuring

longer-term outcomes (ideally longitudinal information for a minimum period of two years), is urgently needed to address these gaps in knowledge.

In general, all research into the revision of professional roles would benefit from a more precise definition of the role revision under investigation, including the specific training, qualifications, length of experience and supervision of the professionals concerned. It is generally impossible at present to assess the extent to which the prior training and experience of professionals working in revised roles affects healthcare processes and outcomes. Including this kind of information would allow researchers and others to analyse more precisely the factors that contribute to the effects.

The evidence base is limited by the narrow range of roles that have been rigorously evaluated. Non-physician clinicians manage a more diverse range of patient problems than is currently represented in the research literature. Furthermore, research is often limited to a small number of non-physician clinicians' and practitioner-related variations in outcomes have hardly been taken into account. Patient samples have generally been too small to detect rare, but potentially serious, health outcomes such as missed diagnoses. Future research should therefore be aimed at a larger sample size, including more non-physician clinicians and more patients. The current studies often include a small number of nurses and physicians. This may bias the results due to factors related to those persons, for example, their level of training and experience, and other 'affecting' factors such as sensitivity and empathy.

Finally, as the revision of roles has an impact on the healthcare system as a whole future research should also pay attention to factors at the systems level that may influence the success of change, for example, team size, continuity of care, coordination of care and care pathways.

We recommend that, whenever possible, researchers use cluster randomised trials to establish the effectiveness and cost-effectiveness of non-physician clinicians, including a comparison between non-physician clinicians and physicians. We also recommend that researchers compare the care provision of both professionals to evidence-based standards, guidelines or protocols so that their work can identify gaps in the quality of care.

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Appendices

Appendix 1. Search strategy

a. Search I

#24	#23 and (PY:MEDS = 1990-2007)
#23	#20 and ((#21 or #22) or ((meta-anal* or (review of reviews) or (systematic review) or (literature review)) in TI))
#22	“Review-Literature” / WITHOUT SUBHEADINGS in MIME,MJME,PT
#21	“Meta-Analysis” / WITHOUT SUBHEADINGS in MIME,MJME,PT
#20	((“Occupational-Therapy” / all SUBHEADINGS in MIME,MJME,PT) or (“Emergency-Medical-Technicians” / all SUBHEADINGS in MIME,MJME,PT) or (“Pharmacists-” / all SUBHEADINGS in MIME,MJME,PT) or (“Physician-Assistants” / all SUBHEADINGS in MIME,MJME,PT) or (“Nurses-” / all SUBHEADINGS in MIME,MJME,PT) or ((nurse) or (practice assistant) or (physician assistant) or (triage) or (triagist) or (pharmacist) or (physical therapist) or (paramedical personnel) or (allied health personnel) or (speech language therapist) or (occupational therapist)) or (“Speech-Language-Pathology” / all SUBHEADINGS in MIME,MJME,PT) or (“Physical-Therapy-Specialty” / all SUBHEADINGS in MIME,MJME,PT)) and ((deleg* or clinical practice) or (role* or cooper*) or (transfer or relocation or liaison) or (enhancement or substitut* or innovation) or ((organisational intervention*) or (skill mix) or (revision of roles)) or (“Clinical-Competence” / all SUBHEADINGS in MIME,MJME,PT) or (“Job-Description” / all SUBHEADINGS in MIME,MJME,PT) or (“Cooperative-Behavior” / WITHOUT SUBHEADINGS in MIME,MJME,PT) or (“Professional-Autonomy” / WITHOUT SUBHEADINGS in MIME,MJME,PT))
#19	(“Occupational-Therapy” / all SUBHEADINGS in MIME,MJME,PT) or (“Emergency-Medical-Technicians” / all SUBHEADINGS in MIME,MJME,PT) or (“Pharmacists-” / all SUBHEADINGS in MIME,MJME,PT) or (“Physician-Assistants” / all SUBHEADINGS in MIME,MJME,PT) or (“Nurses-” / all SUBHEADINGS in MIME,MJME,PT) or ((nurse) or (practice assistant) or (physician assistant) or (triage) or (triagist) or (pharmacist) or (physical therapist) or (paramedical personnel) or (allied health personnel) or (speech language therapist) or (occupational therapist)) or (“Speech-Language-Pathology” / all SUBHEADINGS in MIME,MJME,PT) or (“Physical-Therapy-Specialty” / all SUBHEADINGS in MIME,MJME,PT)
#18	(deleg* or clinical practice) or (role* or cooper*) or (transfer or relocation or liaison) or (enhancement or substitut* or innovation) or ((organisational intervention*) or (skill mix) or (revision of roles)) or (“Clinical-Competence” / all SUBHEADINGS in MIME,MJME,PT) or (“Job-Description” / all SUBHEADINGS in MIME,MJME,PT) or (“Cooperative-Behavior” / WITHOUT SUBHEADINGS in MIME,MJME,PT) or (“Professional-Autonomy” / WITHOUT SUBHEADINGS in MIME,MJME,PT)
#17	(nurse) or (practice assistant) or (physician assistant) or (triage) or (triagist) or (pharmacist) or (physical therapist) or (paramedical personnel) or (allied health personnel) or (speech language therapist) or (occupational therapist)
#16	“Speech-Language-Pathology” / all SUBHEADINGS in MIME,MJME,PT
#15	“Physical-Therapy-Specialty” / all SUBHEADINGS in MIME,MJME,PT
#14	“Occupational-Therapy” / all SUBHEADINGS in MIME,MJME,PT
#13	“Emergency-Medical-Technicians” / all SUBHEADINGS in MIME,MJME,PT
#12	“Pharmacists-” / all SUBHEADINGS in MIME,MJME,PT
#11	“Physician-Assistants” / all SUBHEADINGS in MIME,MJME,PT
#10	“Nurses-” / all SUBHEADINGS in MIME,MJME,PT
#9	“Clinical-Competence” / all SUBHEADINGS in MIME,MJME,PT
#8	“Job-Description” / all SUBHEADINGS in MIME,MJME,PT
#7	“Cooperative-Behavior” / WITHOUT SUBHEADINGS in MIME,MJME,PT
#6	“Professional-Autonomy” / WITHOUT SUBHEADINGS in MIME,MJME,PT
#5	deleg* or clinical practice
#4	role* or cooper*
#3	transfer or relocation or liaison
#2	enhancement or substitut* or innovation
#1	(organisational intervention*) or (skill mix) or (revision of roles)

b. Search II

#28 ("Allied-Health-Personnel" / all SUBHEADINGS in MIME,MJME,PT) and (("Research-Design" / all SUBHEADINGS in MIME,MJME,PT) or ("Single-Blind-Method" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or (("Randomized-Controlled-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Controlled-Clinical-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT)) or (interrupted time series) or (comparative stud*) or ("Clinical-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ((randomised controlled trial*) or (randomized controlled trial*)) or ("Double-Blind-Method" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or (randomised controlled trial) or ("Evaluation-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Follow-Up-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Prospective-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Random-Allocation" / WITHOUT SUBHEADINGS in MIME,MJME,PT)) and ((role* or cooper* or substitut* or multidisciplin*) or (innovation or relocation or patient counse*ling or team* or health promotion) or (triage or liaison or enhancement or transfer) or (organisational intervention* or skill mix or revision of roles) or ("Clinical-Competence" / all SUBHEADINGS in MIME,MJME) or ("Job-Description" / all SUBHEADINGS in MIME,MJME) or ("Cooperative-Behavior" / WITHOUT SUBHEADINGS in MIME,MJME) or ("Professional-Autonomy" / WITHOUT SUBHEADINGS in MIME,MJME) or (deleg* or clinical practice))
#27 "Allied-Health-Personnel" / all SUBHEADINGS in MIME,MJME,PT
#26 ("Physician-Assistants" / all SUBHEADINGS in MIME,MJME,PT) and (("Research-Design" / all SUBHEADINGS in MIME,MJME,PT) or ("Single-Blind-Method" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or (("Randomized-Controlled-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Controlled-Clinical-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT)) or (interrupted time series) or (comparative stud*) or ("Clinical-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ((randomised controlled trial*) or (randomized controlled trial*)) or ("Double-Blind-Method" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or (randomised controlled trial) or ("Evaluation-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Follow-Up-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Prospective-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Random-Allocation" / WITHOUT SUBHEADINGS in MIME,MJME,PT)) and ((role* or cooper* or substitut* or multidisciplin*) or (innovation or relocation or patient counse*ling or team* or health promotion) or (triage or liaison or enhancement or transfer) or (organisational intervention* or skill mix or revision of roles) or ("Clinical-Competence" / all SUBHEADINGS in MIME,MJME) or ("Job-Description" / all SUBHEADINGS in MIME,MJME) or ("Cooperative-Behavior" / WITHOUT SUBHEADINGS in MIME,MJME) or ("Professional-Autonomy" / WITHOUT SUBHEADINGS in MIME,MJME) or (deleg* or clinical practice))
#25 ("Research-Design" / all SUBHEADINGS in MIME,MJME,PT) or ("Single-Blind-Method" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or (("Randomized-Controlled-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Controlled-Clinical-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT)) or (interrupted time series) or (comparative stud*) or ("Clinical-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ((randomised controlled trial*) or (randomized controlled trial*)) or ("Double-Blind-Method" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or (randomised controlled trial) or ("Evaluation-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Follow-Up-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Prospective-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Random-Allocation" / WITHOUT SUBHEADINGS in MIME,MJME,PT)
#24 (role* or cooper* or substitut* or multidisciplin*) or (innovation or relocation or patient counse*ling or team* or health promotion) or (triage or liaison or enhancement or transfer) or (organisational intervention* or skill mix or revision of roles) or ("Clinical-Competence" / all SUBHEADINGS in MIME,MJME) or ("Job-Description" / all SUBHEADINGS in MIME,MJME) or ("Cooperative-Behavior" / WITHOUT SUBHEADINGS in MIME,MJME) or ("Professional-Autonomy" / WITHOUT SUBHEADINGS in MIME,MJME) or (deleg* or clinical practice)
#23 interrupted time series
#22 comparative stud*
#21 (randomised controlled trial*) or (randomized controlled trial*)
#20 randomised controlled trial
#19 "Clinical-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT
#18 "Double-Blind-Method" / WITHOUT SUBHEADINGS in MIME,MJME,PT
#17 "Evaluation-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT
#16 "Follow-Up-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT
#15 "Prospective-Studies" / WITHOUT SUBHEADINGS in MIME,MJME,PT
#14 "Random-Allocation" / WITHOUT SUBHEADINGS in MIME,MJME,PT
#13 "Research-Design" / all SUBHEADINGS in MIME,MJME,PT
#12 "Single-Blind-Method" / WITHOUT SUBHEADINGS in MIME,MJME,PT
#11 ("Randomized-Controlled-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT) or ("Controlled-Clinical-Trial" / WITHOUT SUBHEADINGS in MIME,MJME,PT)

Searches and results below from saved search history 20060907_Taakherschikking 7a_tbv artikel

#10 "Clinical-Competence" / all SUBHEADINGS in MIME,MJME
#9 "Job-Description" / all SUBHEADINGS in MIME,MJME
#8 "Cooperative-Behavior" / WITHOUT SUBHEADINGS in MIME,MJME
#7 "Professional-Autonomy" / WITHOUT SUBHEADINGS in MIME,MJME
#6 deleg* or clinical practice
#5 innovation or relocation or patient counse*ling or team* or health promotion
#4 innovation or relocation or patient counse*ling or team* or health promotion
#3 triage or liaison or enhancement or transfer
#2 organisational intervention* or skill mix or revision of roles
#1 "Physician-Assistants" / all SUBHEADINGS in MIME,MJME,PT

Appendix 2. References included in studies; unique and duplicate references

Please note that indent references starting with * are secondary papers and indicates that the findings of a single trial are reported in two or more publications. Duplicate references are marked***.

a. Nurse–physician role revision

Overview of unique and duplicate number of controlled trials included in reviews			
Author	Number of trials	Unique number trials	Duplicate number trials
Brown and Grimes[52]	38	23	15
Horrocks et al[53]	34	13	21
Oakeshot et al[54]	10	8	2
Chapman[55]	14	10	4
Laurant et al[56]	16	4	12
Du Moulin et al[57]	11	11	0
Dealey[58]	9	5	4
French et al[59]	1	1	0
Smallwood[60]	5	5	0
Phillips et al[61]	6	6	0
Griffiths et al[62]	11	11	0
Thomas et al[63]	6	5	1
Vrijhoef[64]	10	7	3
Bradley and Lindsay[65]; Meads et al[66]	4	4	0
Smith et al[70]	4	2	2
Frich[71]	15	13	2
Loveman et al[67]	6	5	1
Hearnshaw et al[68,69]	4	3	1

1. Brown and Grimes (1995) (n=38): Search from inception through to May 1992

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b. Physician assistant–physician role revision

Overview of unique and duplicate number of controlled trials included in reviews			
Author/year	Number of trials	Unique number trials	Duplicate number trials
Frossard et al[72]	38	31	7
Buchan et al[73]	15	8	7

Duplicate references are marked***

1. Frossard et al (unpublished) (n=38): Search period not reported

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2. Buchan et al (2007) (n=15): Search from 1990 through to 2005

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c. Pharmacist–physician role revision

[None of the reviews included similar original studies]

1. Cotter, McKee and Barber (1995) (n=169): Search from inception through to June 1994

For references of included studies, see original paper.

2. Finley, Crisom and Rush (2003) (n=16): Search from January 1972 through to March 2003

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3. Garcia (2006) (n=1): Search from January 1990 to January 2006

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4. Lindenmeyer et al (2006) (n=5): Search from inception to 2001, and monitoring of literature to end of 2005

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d. Mixture of non-physician healthcare professionals–physician role revision

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