General medical services by non-medical health professionals: a systematic quantitative review of economic evaluations in primary care

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Systematic review of economic evaluations: general medical services by non-medical health professionals.

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Abstract (248/250 words)

Background: Previous systematic reviews have found that nurses and pharmacists can provide equivalent, or higher, quality of care for some tasks performed by general practitioners (GPs) in primary care. There is a lack of economic evidence for this substitution.

Aim: To explore the costs and outcomes of role substitution between GPs and nurses, pharmacists and allied health professionals in primary care.

Design and setting: A systematic review of economic evaluations exploring role substitution of allied health professionals in primary care was conducted. Role substitution was defined as 'the substitution of work that was previously completed by a GP in the past and is now completed by a nurse or allied health professional'.

Method: Databases searched: Medline, CINAHL, Cochrane Library, NICE and the Centre for Reviews and Dissemination database. The review followed guidance from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Results: Six economic evaluations were identified. There was some limited evidence that nurse-led care for common minor health problems was cost-effective compared with GP care, and that nurse-led interventions for chronic fatigue syndrome and pharmacy-led services for the medicines' management of coronary heart disease and chronic pain were not. In Korea, community health nurse practitioners delivered primary care services for half the cost of physicians. There was a lack of economic evidence for role substitution by other groups of allied health professionals such as physiotherapists and occupational therapists.

Conclusion: There is limited economic evidence for role substitution in primary care; more economic evaluations are needed.

Keywords: Primary health care, systematic review, economic evaluation, cost-effectiveness, role substitution, general practitioner, nursing practitioner, allied health professional

How this fits in: Previous systematic reviews have found that nurses can provide equivalent, or higher, quality of care for some tasks performed by GPs. Evidence is lacking for role substitution in other allied health professional groups such as physiotherapists and occupational therapists. There is also a lack of economic evidence for this role substitution, and a number of reviews have concluded that future research should address this. Despite the shortage of evidence, role substitution is becoming commonplace in primary care.

Introduction

General practice in the UK faces challenges due to our ageing population and the increasing prevalence of chronic conditions. Additional pressures also come from advances in treatments and technologies and increased public expectations. As demand for general practice rises, workload pressures on GPs and their teams, increase. There is also a recruitment and retention crisis in the GP workforce. In 2016, it was estimated that the NHS in England were approximately 6500 GPs short - this shortage is estimated to rise to 12100 by 2020.[1] The use of nurses and other non-medical health professionals substituting for GPs has been proposed as a potential solution.[2] Physician assistants are a new development in the NHS and have also been presented as a solution to medical staff shortages as they can diagnose, treat and refer patients autonomously.

Previous systematic reviews have found that nurses can provide equivalent, or in some instances higher quality of care compared with GPs in primary care.[3-6] Furthermore, previous reviews have also reported positive results for pharmacist substituting for GPs in primary care.[7,8] Previous reviews have explored the economic impact of task shifting in primary care[3-6] but the majority of studies did not include full economic evaluations. A previous systematic review of economic evaluations explored the substitution of skills between health care professionals across a variety of settings including general practice, hospital and the community[9] but most of the evidence included was of nurses substituting for GPs and only one study was in a general practice setting. Given the limited evidence for full economic evaluations and of allied health professionals, this systematic review focussed on full economic evaluations of role substitution including all allied health professionals with a focus on primary care and serves as a timely update of the evidence.

The aims of this systematic review were to review economic evaluations of nurses and other allied health professionals working in primary care as substitutes for some of the tasks performed by general practitioners.

Methods

Selection of studies

Role substitution was defined as 'the substitution of work that was previously completed by a general medical practitioner in the past and is now completed by a nurse or allied health professional'. Studies were excluded if the authors did not explicitly state within the paper that role substitution was taking place. To be included in the review, the study design of the included papers had to be a full economic evaluation, either cost-effectiveness, cost-benefit, cost-utility, cost-minimisation or cost-consequence analysis. The population assessed was patients consulting in primary care; the intervention was role substitution by allied health professionals including nurses, pharmacists, physiotherapists and occupational therapists; the comparator was GP-led care; the outcomes were economic evaluations; and the setting was primary care.

Identification of studies and quality assessment

A comprehensive search was performed in OVID Medline, CINAHL, Cochrane Library, NICE, and the Centre for Reviews and Dissemination database. Search dates were from May 19th 2017 to July 31st 2017.The search strategy performed in OVID Medline can be seen in Appendix 1. In order to recover a comprehensive set of relevant literature and to increase sensitivity, the searches were purposely broad. The search strategy included the terms 'role substitution', 'task shifting', 'general practice' and 'primary care'. The 'population', 'comparator' and 'outcome' elements were not included in the search strategy to avoid narrowing the strategy and subsequently limiting the search results. The search was not restricted by age, date or country of origin. Additional studies were identified through hand searching the reference lists of included studies and relevant reviews. This review conformed to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidance[10] (Appendix 2 PRISMA checklist). Following the removal of duplicates, two reviewers independently screened titles and abstracts for relevance, subsequently full-paper screening was conducted to retrieve eligible papers (BFA, AS). Discrepancies were resolved through discussion. The same two reviewers independently assessed the quality of the included studies using the Drummond and colleagues'[11] checklist for economic evaluations (Table 1).

Data extraction

Key characteristics from the included study were extracted including sample size of the intervention groups being compared, number and location of practices, study design, type of economic evaluation and perspective, outcomes measured and main findings.

Results

After the removal of duplicates, the search identified 10,261 studies (Figure 1). Most of these were excluded because they did not explicitly state that role substitution had occurred, were not conducted in primary care setting, or were not full economic evaluations. Six studies were included in the review: three used cost-minimisation, two cost-utility and one cost-effectiveness analysis (Table 2). Three studies were good quality and two were moderate quality (Table 1).

Table 1. Quality appraisal of economic evaluations of role substitution in primary care

Drummond question	**The Community Pharmacy Medicines Management Project Evaluation Team (2007)[16]**	**Dierick-van Daele et al., (2010)[13]**	**Lee et al., (2004)[18]**	**Neilson et al., (2015)[17]**	**Richardson et al., (2013)[14]**	**Turner et al., (2008)[12]**
Was a well-defined question posed in an answerable form?	✓	✓	✓	✓	✓	✓
Was a comprehensive description of the competing alternatives given	✓	✓	✓	-	-	✓
Was the effectiveness of the programmes or services established?	✓	✓	✓	✓	✓	✓
Were all the important and relevant costs and consequences for each alternative identified?	-	✓	✓	×	✓	✓
Were costs and consequences measured accurately in appropriate physical units?	-	✓	✓	✓	✓	✓
Were costs and consequences valued credibly?	✓	✓	✓	✓	✓	✓
Were costs and consequences adjusted for differential timing?	N/A	-	N/A	N/A	✓	✓
Was an incremental analysis of costs and consequences of alternatives performed?	N/A	N/A	N/A	✓	✓	✓
Was allowance made for uncertainty in the establishments of costs and consequences?	×	✓	×	✓	✓	×
Did the presentation and discussion of study results include all issues of concern to users?	✓	✓	✓	✓	✓	✓
Quality assessment score out of a possible 10 (included questions answered N/A).	7	9	9	8	9	9

Note: ✓ = yes; × = no; - = can't tell, N/A = not applicable.
Quality rating based on the number of Drummond questions answered: 0-5 = poor quality, 6-8 = moderate quality, 9+ = good quality

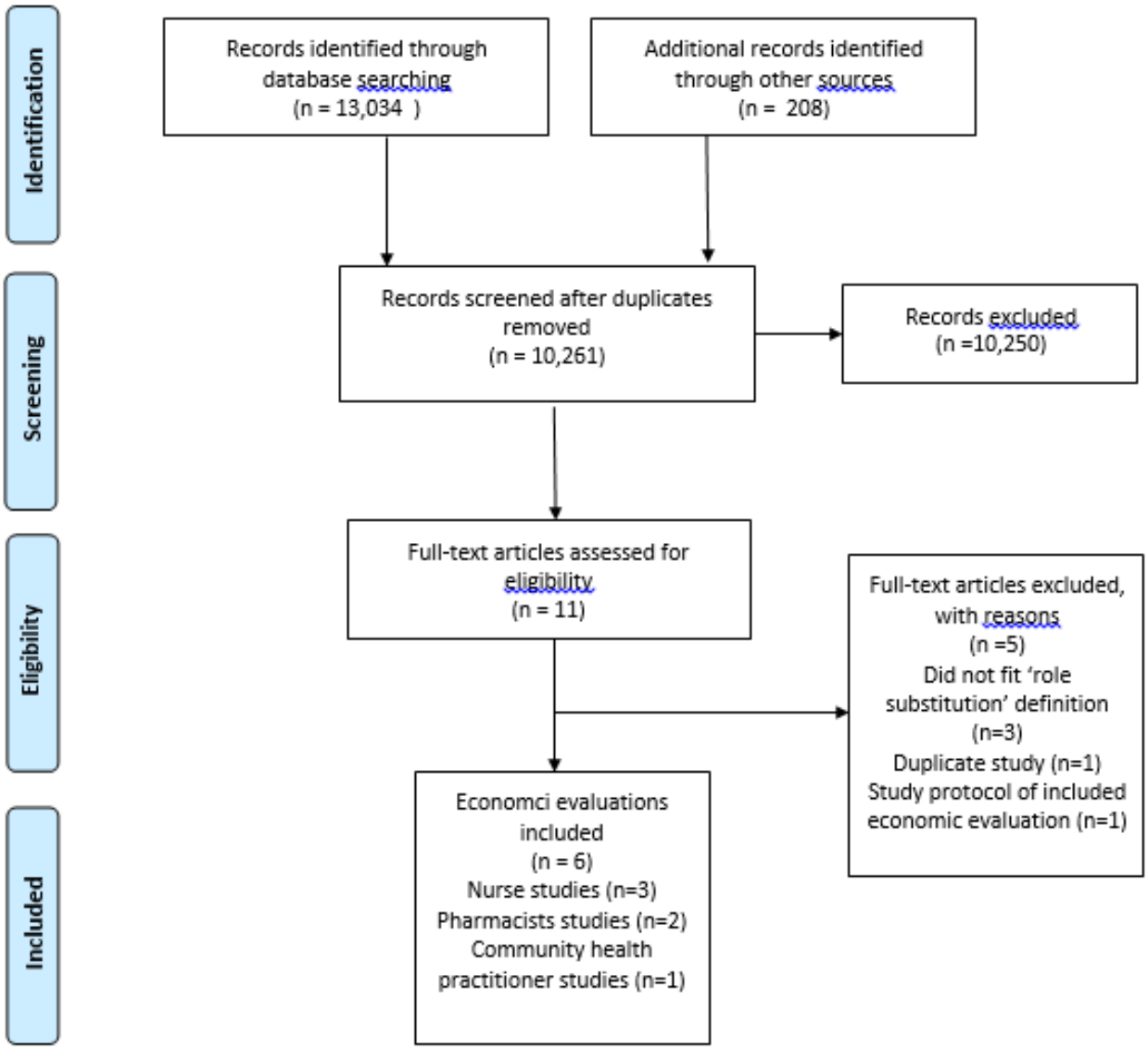

Figure 1. Systematic review flow diagram

Table 2. Characteristics of included studies (n = 6)

Studies	The Community Pharmacy Medicines Management Project Evaluation Team[16]	Dierick-van Daele et al.[13]	Lee et al.[18]	Neilson et al.[17]	Richardson et al.[14]	Turner et al.[12]
Country of origin	England	Netherlands	Korea	United Kingdom	England	United Kingdom
Aims	To assess the cost-effectiveness of a comprehensive community pharmacy medicines management (MEDMAN) service for patients with coronary heart disease.	To assess the difference in costs between general practitioners (GPs) and nurse practitioners (NPs) in treating common conditions.	To assess community health practitioner services in primary care, and to assess the economic impact of these services.	To measure the differences in mean costs and effects of a pharmacy-led service for the management of chronic pain in primary care.	To assess the cost-effectiveness of nurse-led self-help treatments for patients with chronic fatigue syndrome/ myalgic encephalitis in primary care.	To assess health service resource use of a nurse-led disease management for secondary prevention in patients with chronic heart disease and heart failure in primary care.
Type of allied health professional substituting	Pharmacists	Nurse practitioners	Community health practitioners (CHPs)	Pharmacists	Nurses	Nurses
Setting	Nine general practice sites	Fifteen general practices	Random sampling of CHPs working in community health posts	Six general practices	186 general practices	Twenty general practices
Length of follow-up	12 months	2 weeks	6 months	6 months	70 weeks	12 months
Type of economic evaluation conducted	Cost-minimisation analysis	Cost-minimisation analysis	Cost-minimisation analysis	Cost-utility analysis	Cost-effectiveness analysis	Cost-utility analysis
Primary outcome measure	Appropriate treatment and health status (measured using the SF-36 and EQ-5D).	Direct costs within the healthcare sector and costs outside the healthcare sector	Activity measures e.g. consultations and cost measures.	Differences in mean total costs and effects (quality adjusted life years (QALYs)).	Costs and health related quality of life (HRQoL), measured using QALYs	QALYs measured using EQ-5D.

		(productivity losses).				
Quality assessment score	Moderate (7/10)	Good (9/10)	Good (9/10)	Moderate (8/10)	Good (9/10)	Good (9/10)

Quality rating based on the number of Drummond questions answered: 0-5 = poor quality, 6-8 = moderate quality, 9+ = good quality

Due to the heterogeneity of included studies, a narrative review is presented.

Substitution by nurses

Three economic evaluations investigated the cost-effectiveness of nurses substituting for GPs[12-14] (Table 2). A good quality cost-utility analysis assessed health service resource use of a nurse-led disease management programme for secondary prevention in patients with chronic heart disease and heart failure in primary care, compared to usual GP care.[12] Length of follow-up was 12 months. The nurse-led group was associated with higher costs relating to all categories of resource use, compared with the usual care group ($p<0.001$). A difference of 0.03 QALY value was reported between the nurse-led group and usual care, and the cost per QALY gained in the nurse-led group was £13,158 (£17,694 2016/17 prices[15]). It is unclear whether there was a statistically significant difference in QALYs between the nurse-led disease management program and usual care, as confidence intervals were not reported in the paper (Table 3).

A good quality cost-minimisation analysis conducted alongside a randomised controlled trial (RCT) compared the differences in costs between GPs and nurse practitioners (NPs) in treating common minor health problems.[13] Cost-minimisation was used because the RCT found no significant differences in effectiveness between GPs and NPs. The study had a short follow-up period of two weeks. The costs of NP consultations were significantly lower than with GPs ($p = 0.001$) with a mean difference of €8.21, which equates to £7 inflated to 2016/17 prices.[15] Sensitivity analysis varying GP salary reported significantly lower costs of NP consultations when adjusting to the salary of an employed GP ($p=0.007$) or of a GP employed by other GPs in partnership ($p=0.02$).

A good quality cost-effectiveness analysis of nurse-led pragmatic rehabilitation (PR), and supportive listening (SL), for patients with chronic fatigue syndrome was compared with treatment as usual (TAU) by GPs.[14] Costs and outcomes were discounted at a rate of 3.5% per year; however, with no further detail of how this discounting was performed. Length of follow-up was 70 weeks and patients were asked to recall use of hospital services, day services and contacts made with health professionals during this period. TAU was slightly more effective than PR and SL, at a lower cost, when baseline differences in EQ-5D were adjusted. Richardson et al. reported that all confidence intervals for estimations of costs and effects crossed zero. Imputated results showed that PR = mean ICER QALY of -0.01 (95%

CI = -0.09, 0.07 and SL = mean ICER QALY of -0.04 (95% CI = -0.12, 0.04). SL was no more effective than PR or TAU, but costed more; therefore, SL was not found to be cost-effective. Complete case analysis as part of sensitivity analyses showed PR was associated with slightly higher QALYs than TAU, but confidence intervals crossed zero. Complete case results found that PR = mean ICER QALY of -0.01 (95% CI = -0.08, 0.10) and SR = mean ICER QALY of -0.04 (95% CI = -0.13, 0.045. The nurse-led PR intervention produced a cost per QALY ratio of £39,583 (£44,812 inflated to 2016/17[15]). It was concluded that the nurse-led PR intervention would not be deemed cost-effective in the UK at the current NICE threshold of £20-30,000 per QALY (Table 3).

Substitution by pharmacists

Two moderate quality economic evaluations assessed the substitution of medicines' management by pharmacists instead of GPs[16,17] (Table 2). A cost-minimisation analysis explored the cost-effectiveness of a comprehensive community pharmacy medicines management project[16] service for patients with coronary heart disease. The study follow-up period was 12 months. Total NHS costs at baseline were £852 and £738 for the intervention and control group, respectively. The difference in costs between groups at baseline was £115 ($p<0.0001$), (£139 inflated to 2016/17 prices[15]). Total NHS costs at follow-up were £971 and £835 for the intervention and control groups, respectively. Total NHS costs at follow-up for the pharmacist group were significantly greater than the control group ($p<0.0001$) with a mean difference in costs of £135 (£164 2016/17 prices[15]). This was due to the costs of providing the additional pharmacist training. The differences in QALYs between groups was 0.04, this was non-significant (95% CI = -0.05, 0.13). An ICER was not presented in the paper.

A cost-utility analysis of a pharmacy-led service for the management of chronic pain[17] as part of a three –arm RCT compared pharmacist-led medication review with face to face pharmacist prescribing, pharmacist-led medication review with feedback to GP, and treatment as usual (TAU) from the GP. Study follow-up was 6 months. After baseline costs were adjusted, both pharmacy-led interventions were more costly than TAU. Relative to TAU, the adjusted mean costs differences per patient was £77 for prescribing (95% CI = -82, 237) and £54 for medication review (95% CI = -103, 212). Relative to TAU, the adjusted

mean QALYs was 0.06 for prescribing (95% CI -0.01, 0.02) and 0.01 for medication review (95% CI = -0.01, 0.02).

Community health practitioners

A good quality cost-minimisation analysis from Korea compared the delivery of primary care services by community health practitioners (CHPs) in remote communities with equivalent care delivered by physicians in inner-city clinics (no CHP services)[18] (Table 3). CHPs were described as registered nurses responsible for the delivery of primary care, who had received 6 months of special training. The length of study follow-up was 6 months. The mean total cost of CHP services per month was $2423.7 (£2520 inflated to 2016/17[15]). The total mean costs of no CHP services was $5187.7 (£5394 in 2016/17[15]). Total mean costs were significantly lower for CHP services ($p<0.001$) with a cost ratio of 2.16 (SD=1.24, range = 0.09 to 9.63). Indirect costs were also lower for CHP services group, due to travel costs and loss of earnings for patients in the physician group, who had to travel to inner city clinics to see a physician.

Table 3. Results of included studies (n=6)

	The Community Pharmacy Medicines Management Project Evaluation Team[16]	**Dierick-van Daele et al.**[13]	**Lee et al.**[18]	**Neilson et al.**[17]	**Richardson on et al.**[14]	**Turner et al.**[12]
Year of publication and country	2007; England	2010; Netherlands	2004; Korea	2015; United Kingdom	2013; England	2008; United Kingdom
Intervention groups compared, type of role substitution and setting	Intervention: pharmacist (n=62) Control: GPs (n=164); Pharmacist-led medicines management vs. standard care from the GP in nine general practices.	Intervention: nurse practitioners (n=12) Control: GPs (n=15); Role substitution of nurse practitioners by GPs in 15 general practices.	Intervention: community health practitioner (CHP) (n=600) Control: care delivered by physician; CHP services vs. no-CHP services in primary health care. Postal survey questionnaire sent to a sample of CHPs nationwide.	Intervention 1: pharmacists medication review with pharmacist prescribing (n=70); Intervention 2: pharmacist review only (n=63). Control: treatment as usual from GP (n=63); Pharmacy-led care vs. treatment as usual for the management of chronic pain in six general practices.	Intervention 1: nurse-led pragmatic rehabilitation (PR) (n=85), Intervention 2: nurse-led supportive listening (SL) (n=97). Control: Treatment as usual (TAU) from GP (n=92); Nurse-led supported self-management compared with treatment as usual in 186 general practices.	Intervention: nurse-led care (n=505) Control: usual GP care (n=658); Nurse-led disease management vs. standard GP care in 20 general practices.
Type of economic evaluation	Cost-minimisation analysis	Cost-minimisation analysis	Cost-minimisation analysis	Cost-utility analysis	Cost-effectiveness analysis	Cost-utility analysis
Main outcomes measured, type of costs measured, type of outcomes measured	Total NHS costs; Direct costs of delivering the intervention and NHS treatment costs (e.g. cost of medicines) and indirect costs of	Costs of GP vs. nurse practitioner consultation; Direct costs within the healthcare sector and costs outside of the healthcare sector	Total costs of care between CHP services model and no-CHP services model of care; Direct costs (e.g. personnel costs, materials) and	Differences in mean total costs and effects of pharmacist-led management vs. GP-led management of chronic pain; Direct costs, other costs	Quality Adjusted Life Years (QALYs) derived from the EQ5D; Cost to the NHS (e.g. resource use and unit costs), private expenditures,	Quality Adjusted Life Years (QALYs) derived from the EQ-5D; Direct costs (including travel costs); Health utility

	training (e.g. attendance fees); Appropriate treatment and health status (SF-36 and EQ-5D).	(productivity losses); Process outcomes and outcomes of care.	indirect costs (operational and depreciation costs) of CHP services. Direct costs (e.g. outpatient costs) and indirect costs (travel and loss of earnings) of no CHP services; Outcomes not assessed. The efficacy of the intervention was based on previous findings.	borne by patients and productivity losses; Health utility derived from SF-6D.	informal care costs and loss of production costs; Health-utility measured using EQ-5D.	measured with EQ-5D.
Perspective of analysis	Not stated	Practice and societal	Not stated	NHS	NHS and personal social services	Patient and NHS
Currency and Cost Year	Pounds sterling derived from general practice –held records. Cost year not reported.	Euros (€) derived using the price index of Statistics Netherlands for cost year 2006.	Korean won (₩) converted to US dollars ($) derived from national unit costs for cost year 1999	Pounds sterling (£) derived from Personal Social Services Research Unit (PSSRU) and British National Formulary for prices at cost year 2009/10.	Pounds sterling (£) derived from NHS reference costs and PSSRU at 2008/09 prices.	Pounds Sterling (£) derived from healthcare resource groups (HGRs) for cost year 2003-03 and inflated to 2003/04 prices.
Discounting and sensitivity analysis	Follow-up period 12 months, no discounting, no sensitivity analysis	Sensitivity analysis varying GP salary. No discounting.	6 month time horizon; no discounting, no Sensitivity analysis	6 month time horizon; no discounting. Three sensitivity analyses were conducted with imputed values for SF-36 scores.	Costs and outcomes were discounted at a rate of 3.5% per year. A complete case analysis as part of sensitivity analyses was conducted.	Follow-up period 12 months no discounting discount rate of 6% for equipment and training that would have an expected lifespan of more than one year. No sensitivity analysis

Intervention costs and main findings	Total NHS costs at baseline: intervention group £852.4, control group £737.8. Total NHS costs at follow-up: intervention £970.5, control £835.2; Statistically significant difference ($p<0.0001$) in total NHS costs, due to the costs of providing pharmacists' training. Mean difference in costs of £135.3 (£164 inflated to 2016/17 prices[15]).	Cost per NP consultation €31.94. Cost per GP consultation €40.15; Lower direct consultation costs for NP compared with GP ($p = 0.001$) mean difference €8.21 (£7 inflated to 2016/17 prices[15]).	Mean direct costs CHP $2423.7, SD: $565.6 (£252 inflated to 2016/17 prices[15]). Physician $5187.7, SD: $3262.5 (£5394 inflated to 2016/17 prices[15]). Mean indirect costs CHP ($499.9, SD: $257.8) Physician ($1268.6, SD: $951.7); t-test found a significant difference in the average costs of care between the groups ($p<0.001$ cost ratio of 2.16, with a range of 0.09 to 9.63).	Unadjusted total mean costs: prescribing group £452 (£509 in 2016/17[15]), medication review group £570 (£642 in 2016/17[15]), TAU group £1333 (£1500 in 2016/17[15]); Both pharmacy-led interventions were more costly, with slightly higher QALY gains than TAU.	Excluding intervention costs of SL and PR, at 70 week follow-up, total NHS cost of chronic fatigue syndrome £789 for PR, £916 for SL and £710 for TAU; TAU was slightly more effective than PR and SL, at a lower cost, when baseline differences in EQ-5D were adjusted. The nurse-led PR intervention produced a cost per QALY ratio of £39,583 (inflated to £44,812 in 2016/17[15]).	Total mean NHS delivery costs nurse £1107.81 and GP £660.57, ($p=0.001$); A difference of 0.03 QALY value was reported between the nurse-led group and usual care, and the cost per QALY gained in the nurse-led group was £13,158 (£17,694 inflated to 2016/17 prices[15]).
Conclusions	No change in numbers of patients receiving appropriate treatment. Pharmacy-led group more costly than standard care.	Direct costs of consultations were lower for nurse practitioners than GPs. The differences in costs were mainly due to differences in salary.	Care provided by a physician was twice as costly as the CHP services due to travel costs and loss of earnings for patients who would have had to travel to inner city clinics to see a physician.	Pharmacy-led management is more costly than usual treatment and produce similar QALYs compared with usual treatment.	The nurse-led PR intervention was not cost-effective.	Nurse-led disease management programme was cost-effective.

Discussion

Summary of main findings

Nurse-led care for common, minor health conditions was as effective as and less costly than GP care. Nurse-led preventative care for secondary prevention of heart disease and heart failure was more costly and similar in effectiveness as usual GP care. It is uncertain whether there was a statistically significant difference in the QALY value reported between groups as confidence intervals were not reported in the paper. Nurse-led interventions for chronic fatigue syndrome were more costly and less effective. Pharmacy-led services for the medicines' management of coronary heart disease was as effective as, but more costly than, GP care. For managing chronic pain, pharmacy-led care was slightly more effective than GP care for increased cost. In Korea community health nurse practitioners delivered primary care services for half the cost of physicians. There was a lack of economic evidence for role substitution by other groups of allied health professionals such as physiotherapists and occupational therapists.

Strengths and weaknesses

To our knowledge, this is the first systematic review that identifies full economic evaluations of the substitution of GPs by allied health professionals in a primary care setting. This review undertook extensive literature searches using a well-developed search strategy and robust methodology, and adhered to the PRISMA guidelines[10]. There were no restrictions on date of publication, or country of origin for the included studies. Economic evaluations conducted alongside RCTs are important as they produce reliable estimates of cost-effectiveness at low marginal cost.[19] Of the six studies included in the review, five were concurrent economic evaluations alongside RCTs.[12-14,16,17]

There were a number of limitations in the included studies. Consultation length was not considered in two of the economic evaluations that found role substitution to be cost-effective.[12,18] Although the results reported lower unit costs in these studies, nurse and CHP consultations may have been significantly longer than GP consultations, so actual costs may have been higher for the allied health professional groups. Only one of the included studies explicitly provided information on patient recall including contacts made with health care professionals over the study period.[14] There was a lack of information regarding patient recall in the other included studies, making it difficult to ascertain how information on services

used by patients was gathered, whether the appropriate perspective was chosen to include all relevant costs, and whether the length of time horizon patients were asked to recall was appropriate. The Korean study may not be directly comparable to the UK and other countries with highly developed primary care services. There was a lack of explanatory detail when describing the intervention and control treatments, which might be improved by the inclusion of a concurrent process evaluation. For example, two studies provided only minimal information about usual GP care[14,16] (Appendix 3). In addition, the economic evaluation method can be criticised where no significant differences in outcomes were found between groups, and a cost-minimisation analysis was conducted.[16] Given the lack of a statistically significant effect, a cost-consequence analysis may have been more appropriate. There were inconsistencies in the reporting of findings of the included studies, for example ICER calculations and CIs around small differences in QALYs which make interpreting results difficult. In one study[12] authors' conclusions are not supported by their findings. Despite the higher service use costs reported substituting nurses for GPs, the authors concluded that the nurse-led disease management programme was costs-effective as it fell below the NICE cost-effectiveness threshold of £20-£30,000 per QALY. However, this finding does not provide clear evidence of cost-effectiveness for this intervention given it was more costly than GP-led care. Also there was a lack of clarity about the perspective adopted, with two studies not providing this information (Appendix 3). This lack of clarity makes it difficult to ascertain whether all pertinent costs and outcomes were included in the analysis. Additionally, only two of the included studies[12,14] produced a cost-effectiveness acceptability curve.

There were disparities between the country and the type of role substitution that took place in the included studies. This review used a specific definition of role substitution; however, there were difficulties distinguishing true role substitution in the included studies which makes generalisability difficult. The majority of the included studies assessed novel allied health professional-led interventions, these studies represent a different kind of role substitution whereby allied health professionals are used to replace GP-led care. When reviewing the literature the definition of role substitution was used to uncover economic literature of allied health professionals performing care in place of a GP. In order to better inform current policy with regards to increasing the involvement of allied health professionals in primary care, future studies should assess the cost-effectiveness of all forms of role substitution to better understand the impact of such workforce redesign. From the included studies, generalisability of results is difficult as each study assessed different allied

health professionals, used different interventions, outcome measures and time horizons. There is a larger evidence base for role substitution with nurses, in order to improve the generalisability of role substitution with other allied health professionals further evidence is needed. Finally, the majority of papers were within a one year time horizon (70 week time horizon in one study), none of the studies extrapolated beyond this. Given the range of interventions it would have been useful for the authors to justify their chosen time horizon in order to assess if this was appropriate and relevant for expected outcomes resulting from the intervention. A new, innovative service redesign such as role substitution in primary care may not necessarily show changes in the immediate term; therefore, future studies with longer time horizons are recommended.

Comparison with previous literature

The evidence reported by previous systematic reviews only reported the economic impact of role substitution of GPs by nurses and pharmacists in terms of their costs. These are not considered full economic evaluations as they do not synthesise costs and outcomes.[3-8]

In 2008, Dierick-van Daele et al. reviewed economic evaluations of the substitution of skills between health professionals in a variety of settings including general practice, hospital and community settings. However, the majority of the evidence looked at nurses and only one of the included studies took place in general practices.[20] Dierick-van Daele and colleagues stated this paper was an economic evaluation, but this study did not compare costs and outcomes, and therefore would not be considered a full economic evaluation. The current systematic review serves as a timely update of the evidence and identifies full economic evaluations of role substitution in primary care.

Implications for research and practice

There is only limited evidence that nurses and allied health professionals can provide a cost-effective alternative to GPs. This evidence is most convincing for the management of common, minor health problems by nurses. However, it is worth acknowledging the majority of included studies in this review assessed novel interventions using allied health

professionals to replace GP-led care. This broadens the use of role substitution which could have implications on evidence as workforce redesign continues to grow. Role substitution is becoming commonplace throughout primary care but there is a lack of economic evidence. More high quality economic evaluations are needed for all of the different roles that nurses and allied health professionals could perform in primary care instead of general practitioners. There is a particular lack of evidence for substitution by physiotherapists, occupational therapists and physician associates in primary care.

The substitution of general practitioners by allied health professionals may have the potential to reduce costs, but this is greatly reliant on salary differences. Furthermore, consultation length and patient recall must also be considered. Although it may seem less costly to employ allied health professionals in general practice in terms of their unit costs, their consultation lengths may be longer, and they also might be associated with higher patient recall to general practice. Consequently, employing allied health professionals to perform roles and duties normally completed by GPs may prove more costly overall.

Conclusion

There is some evidence that the substitution of nurses by GPs when treating common minor health problems is cost-effective. There is some evidence that substitution by pharmacists is not cost-effective, and no evidence for substitution by therapists or physician associates. In order to improve evidence in this field explicit definitions of role substitution are needed. More good quality economic evaluations of role substitution using other allied health professionals such as therapists and physician associates in primary care are needed.

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Ethical approval:

Not applicable as the paper reports a systematic review.

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References

1. Hayhoe B, Majeed A, Hamlyn M, Sinha M. Primary care workforce crisis: how many more GPs do we need. In RCGP Annual Conference, Harrogate 2016.
2. Laurant M, Harmsen M, Wollersheim H, *et al*. The impact of nonphysician clinicians. *Med Care Res Rev* 2009 Dec;66(6_suppl):36S-89S.
3. Laurant MG, Reeves D, Hermens RP, *et al*. Substitution of doctors by nurses in primary care. *Cochrane Database Syst Rev* 2005 Apr 18;2(2):CD001271.
4. Horrocks S, Anderson E, Salisbury C. Systematic review of whether nurse practitioners working in primary care can provide equivalent care to doctors. *BMJ* 2002 Apr 6;324(7341):819-23.
5. Kuethe MC, Vaessen-Verberne AA, Elbers RG, Van Aalderen WM. Nurse versus physician-led care for the management of asthma. Cochrane Database Syst Rev 2013 Feb 28;2(2).
6. Martínez-González NA, Rosemann T, Tandjung R, Djalali S. The effect of physician-nurse substitution in primary care in chronic diseases: a systematic review. *Swiss Med Wkly* 2015 Feb 4;145:w14031.
7. Chisholm-Burns MA, Lee JK, Spivey CA, *et al*. US pharmacists' effect as team members on patient care: systematic review and meta-analyses. *Med Care* 2010 Oct 1;48(10):923-33.
8. Paudyal V, Watson MC, Sach T, *et al.* Are pharmacy-based minor ailment schemes a substitute for other service providers?: A systematic review. *Br J Gen Pract* 2013 Jul 1;63(612):e472-81.
9. Dierick-van Daele A, Spreeuwenberg C, Derckx EW, *et al*. Critical appraisal of the literature on economic evaluations of substitution of skills between professionals: a systematic literature review. *J Eval Clin Pract* 2008 Aug 1;14(4):481-92.
10. Moher D, Liberati A, Tetzlaff J, *et al.* Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009 Jul 21;6(7):e1000097.
11. Drummond MF, Sculpher MJ, Claxton K, *et al*. *Methods for the economic evaluation of health care programmes.* OUP 2015 Sep 24.
12. Turner DA, Paul S, Stone MA, *et al*. Cost-effectiveness of a disease management programme for secondary prevention of coronary heart disease and heart failure in primary care. *Heart* 2008 Dec 1;94(12):1601-6.

13. Dierick-van Daele AT, Steuten LM, Metsemakers JF, *et al*. Economic evaluation of nurse practitioners versus GPs in treating common conditions. *Br J Gen Pract* 2010 Jan 1;60(570):e28-35.
14. Richardson G, Epstein D, Chew-Graham C, *et al*. Cost-effectiveness of supported self-management for CFS/ME patients in primary care. *BMC Fam Pract* 2013 Dec;14(1):12.
15. Curtis, L. and Burns, A. Unit Costs of Health and Social Care 2017, Personal Social Services Research Unit, University of Kent, Canterbury 2017.
16. Community Pharmacy Medicines Management Project Evaluation Team. The MEDMAN study: a randomized controlled trial of community pharmacy-led medicines management for patients with coronary heart disease. *Fam Pract* 2007 Jan 31;24(2):189-200.
17. Neilson, A.R., Bruhn, H., Bond, C.M., *et al.* Pharmacist-led management of chronic pain in primary care: costs and benefits in a pilot randomised controlled trial. *BMJ Open* 2015 5(4), p.e006874.
18. Lee T, Ko IS, Jeong SH. Is an expanded nurse role economically viable? *J Adv Nurs* 2004 Jun 1;46(5):471-9.
19. Petrou S, Gray A. Economic evaluation alongside randomised controlled trials: design, conduct, analysis, and reporting. *BMJ* 2011 Apr 7;342:d1548.
20. Venning P, Durie A, Roland M, Roberts C, Leese B. Randomised controlled trial comparing cost effectiveness of general practitioners and nurse practitioners in primary care. *BMJ* 2000 Apr 15;320(7241):1048-53.

Appendices

- **Appendix 1 –** Search strategy in Medline database
- **Appendix 2** – PRISMA checklist
- **Appendix 3 -** Economic evaluation appraisal tool responses (Drummond et al., 2005).

Appendix 1 – Search strategy on Medline

Search History

(35)

# ▲	Searches	Results
1	(task* adj5 shift*).ti,ab,kw.	2218
2	(task* adj5 substitut*).ti,ab,kw.	344
3	(role* adj5 shift*).ti,ab,kw.	1528
4	(role* adj5 substitut*).ti,ab,kw.	1106
5	skill mix*.ti,ab,kw.	820
6	exp Delegation, Professional/	537
7	professional delegation.ti,ab,kw.	5
8	nurse-doctor substitut*.ti,ab,kw.	2
9	nurse-physician substitut*.ti,ab,kw.	1

☐	10	((position* or responsibility or part or professional or role* or job* or task* or duty or duties or procedure) adj3 (delegation or allocation or designation or assignment or hand over or handing over or pass on or passing on or give out or giving out or take over or take on or stand in or standby or replace or fill in)).ti,ab,kw.	3563
☐	11	mini doctor*.ti,ab,kw.	12
☐	12	exp Physician Assistants/	5147
☐	13	physician associate*.ti,ab,kw.	100
☐	14	nurse prescribing.ti,ab,kw.	454
☐	15	pharmacist prescribing.ti,ab,kw.	114
☐	16	advanced role*.ti,ab,kw.	83
☐	17	expanded role*.ti,ab,kw.	1174
☐	18	expanded dut*.ti,ab,kw.	148
☐	19	Medical-nursing interface.ti,ab,kw.	1
☐	20	(Nurs* adj5 medical role*).ti,ab,kw.	19
☐	21	nurse-manag*.ti,ab,kw.	3491
☐	22	nurse-led.ti,ab,kw.	2755

☐	23	pharmacist-led.ti,ab,kw.	419
☐	24	pharmacist-manag*.ti,ab,kw.	358
☐	25	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24	23850
☐	26	exp Primary Health Care/	132154
☐	27	primary health care.ti,ab,kw.	22316
☐	28	primary care.ti,ab,kw.	92796
☐	29	exp Family Practice/	64219
☐	30	exp General Practice/	71544
☐	31	general practice.ti,ab,kw.	34181
☐	32	general medical services.ti,ab,kw.	400
☐	33	family clinic*.ti,ab,kw.	399
☐	34	26 or 27 or 28 or 29 or 30 or 31 or 32 or 33	264838
☐	35	25 and 34	2937

Appendix 2 – PRISMA checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3,4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	NA
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	24-26
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4

Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4,5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	NA
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	4,5
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	10

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5,7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8,9
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	NA
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	10-12
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	10-12
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
DISCUSSION			

Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	19
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	16-18
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	19
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	19

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journa

Appendix 3 – Economic evaluation appraisal tool responses (Drummond et al, 2005)

The Community Pharmacy Medicines Management Project Evaluation Team (2007)

Checklist question	Response
Was a well-defined question posed in an answerable form?	Yes, to test the hypothesis that the MEDMAN service would be cost effective.
Was a comprehensive description of the competing alternatives given?	The MEDMAN intervention was well explained, however minimal information was given for usual care. Does not explain specifics with regards to care received from GPs and community pharmacists.
Was the effectiveness of the programmes or services established?	The study set out to measure effectiveness alongside and economic evaluation. The results found no significant effect for the intervention i.e. no statistically significant differences between groups in any of the outcomes chosen.
Were all the important and relevant costs and consequences for each alternative identified?	Authors did not state their perspective, therefore difficult to determine if all relevant costs and consequences were included. Cost were assessed from an NHS perspective.
Were costs and consequences measured accurately in appropriate physical units?	The costs and consequences were measured accurately in appropriate physical units for the research question, however the authors stated they used patient records for NHS resource use, but do not describe how this resource use was costed.
Were costs and consequences valued credibly?	Yes, costs and consequences were clear and appropriately identified for the research question
Were costs and consequences adjusted for differential timing?	Follow-up period was 12 months, therefore discounting was not required.
Was an incremental analysis of costs and consequences of alternatives performed?	Authors reported no significant differences in outcomes between groups and therefore a cost-minimisation analysis was conducted, however given the lack of significant effect for the intervention a cost-consequence analysis may have been more appropriate.
Was allowance made for uncertainty in the establishments of costs and consequences?	Authors did not state any sensitivity analysis they only report undertaking secondary outcomes analysis – 5 year risk of CV death, patient perspectives and patient compliance.
Did the presentation and discussion of study results include all issues of concern to users?	Limitations noted by authors included the choice of condition and risk of bias. Additional limitations include a lack of sensitivity analysis and choice of economic evaluation given the non-significant findings for the effectiveness of the intervention.

Dierick-van Daele et al., (2010)

Checklist question	Response
Was a well-defined question posed in an answerable form?	Yes, to estimate the costs of GPs versus nurse practitioners
Was a comprehensive description of the competing alternatives given?	Yes, details of the external reference group were provided.
Was the effectiveness of the programmes or services established?	Yes, this was established from a RCT (Derick van-Daele et al., 2009).
Were all the important and relevant costs and consequences for each alternative identified?	The economic evaluation was conducted from a societal perspective. Yes, they identified direct costs and identified indirect costs i.e. productivity losses measured in terms of sick leave days.
Were costs and consequences measured accurately in appropriate physical units?	The costs and consequences were measured in accurately in appropriate physical units for the research question, the authors used National information to derive unit costs.
Were costs and consequences valued credibly?	Yes, costs and consequences were clear and appropriately identified for the research question.
Were costs and consequences adjusted for differential timing?	No follow-up period stated for economic analysis, follow-up appointment in the RCT occurred at 2 weeks, therefore discounting was not required.
Was an incremental analysis of costs and consequences of alternatives performed?	No, an incremental analysis of costs and consequences was not appropriate as a cost-minimisation analysis was conducted.
Was allowance made for uncertainty in the establishments of costs and consequences?	Yes, a sensitivity analysis was conducted varying GP salary.
Did the presentation and discussion of study results include all issues of concern to users?	The authors stated that due to pragmatic reasons, it was not possible to gather data for follow-up appointments, length of appointments, or number of days absent in the external reference practices. The authors noted that the study was not powered to assess the impact of adverse events or assess additional consultations.

Lee et al., (2004)

Checklist question	Response
Was a well-defined question posed in an answerable form?	Yes, to perform a cost-minimisation analysis of community health practitioner services in primary care.
Was a comprehensive description of the competing alternatives given?	Yes, the study compares costs between community health practitioners and physicians.
Was the effectiveness of the programmes or services established?	Yes, previous studies have demonstrated that the care provided by CHP is comparable to physicians (Kim et al., 1985, 1991; Song et al., 1988; Kim, 1992,1999).
Were all the important and relevant costs and consequences for each alternative identified?	Yes, they identified direct costs and indirect costs including travel and loss of earnings for patients who would have had to travel to inner city clinics if the CHP model of care was unavailable.
Were costs and consequences measured accurately in appropriate physical units?	The costs and consequences were measured in accurately in appropriate physical units for the research question, the authors used National information to derive unit costs.
Were costs and consequences valued credibly?	Yes, costs and consequences were justified and measured appropriately.
Were costs and consequences adjusted for differential timing?	Economic analysis was conducted using a 6 month time horizon; therefore, discounting rate was required.
Was an incremental analysis of costs and consequences of alternatives performed?	An incremental analysis of costs and consequences was not appropriate, as a cost-minimisation analysis was conducted, this was justified as previous research showed that CHP provide comparable care to physicians.
Was allowance made for uncertainty in the establishments of costs and consequences?	No sensitivity analysis was conducted.
Did the presentation and discussion of study results include all issues of concern to users?	The authors compared their results to other previous cost-effectiveness analyses of nurse practitioners and make suggestions for future research. The authors also note limitations including sample size, self-reported measured to gather CHP activity for costing and did not test underlying assumptions of data.

Neilson et al., (2015)

Checklist question	Response
Was a well-defined question posed in an answerable form?	Yes, to measure the differences in mean costs and effects of a pharmacy-led service for the management of chronic pain in primary care compared to GP usual care.
Was a comprehensive description of the competing alternatives given?	Yes, details of the two interventions were provided however usual care was not explained.
Was the effectiveness of the programmes or services established?	Yes, this was established in the PIPPC pilot RCT (Bruhn et al., 2013). The results found a positive benefit for pharmacists prescribing, however authors noted that a larger trial was needed.
Were all the important and relevant costs and consequences for each alternative identified?	The economic analysis was undertaken from a NHS perspective. Other costs borne by patients, carers and productivity losses were deemed outside the remit of the NHS perspective, though given the condition would argue these would have been relevant.
Were costs and consequences measured accurately in appropriate physical units?	Yes, costs and consequences were measured accurately in appropriate physical units for the research question and were sourced from the British National Formulary, Scottish Health Service Cost book and the Personal Social Services Unit.
Were costs and consequences valued credibly?	Yes, costs and consequences were clearly identified, and appropriate for the research question.
Were costs and consequences adjusted for differential timing?	Economic analysis was conducted using a 6 month time horizon; therefore, discounting rate was not required.
Was an incremental analysis of costs and consequences of alternatives performed?	Yes, incremental analysis of costs and QALYs was performed.
Was allowance made for uncertainty in the establishments of costs and consequences?	Yes, three sensitivity analyses were conducted. Authors conducted sensitivity analyses; with imputed values for SF-36 scores, excluding hospital inpatient costs deemed unassociated with chronic pain, and controlling for baseline differences e.g. sociodemographic and economic factors.
Did the presentation and discussion of study results include all issues of concern to users?	Limitations noted by authors included high uncertainty of results, which should be viewed with caution due to small samples size. The authors discussed using alternative methods to elicit QALYs. The authors concluded a future larger trial is needed.

Richardson et al., (2013)

Checklist question	Response
Was a well-defined question posed in an answerable form?	Yes, to assess the cost-effectiveness of nurse-led pragmatic rehabilitation and supportive listening for patients with chronic fatigue syndrome/myalgic encephalitis in primary care.
Was a comprehensive description of the competing alternatives given?	Details of the two nurse-led interventions were provided however no information provided for usual care.
Was the effectiveness of the programmes or services established?	Clinical effectiveness was based on a three armed RCT (Wearden et al., 2010). Cost-effectiveness uses QALYs as their measurement of effect.
Were all the important and relevant costs and consequences for each alternative identified?	The economic analysis was conducted from a NHS and personal social services perspective. The authors assessed costs to the NHS at 2008/09 prices. The study assessed HRQol (measured by QALYs), resource use and unit costs. The authors also considered private expenditures, informal care costs and loss of production costs. Social care costs such as family support workers were not included.
Were costs and consequences measured accurately in appropriate physical units?	The costs and consequences were measured accurately in appropriate physical units for the research question, the authors used NHS prices to calculate costs.
Were costs and consequences valued credibly?	Yes, costs and consequences were clear and appropriately identified for the research question
Were costs and consequences adjusted for differential timing?	Yes, costs and outcomes were discounted at a rate of 3.5% per year, however the paper was unclear whether all follow-up costs and outcomes were discounted or only the costs and outcomes that fell outside of the 1 year time horizon.
Was an incremental analysis of costs and consequences of alternatives performed?	Yes, however results found treatment as usual had lower costs and better outcomes than both interventions.
Was allowance made for uncertainty in the establishments of costs and consequences?	Yes, authors conducted a complete case analysis as part of sensitivity analyses.
Did the presentation and discussion of study results include all issues of concern to users?	Authors concluded that the benefit of the intervention was very small, if not non-existent. Authors also noted using multiple imputation could have resulted in over or under estimation of EQ-5D scores and service use costs. Authors compared their results to existing literature and make suggestions for future research.

Turner et al., (2008)

Checklist question	Response
Was a well-defined question posed in an answerable form?	Yes, to assess health service resource use of a nurse-led disease management for secondary prevention in patients with chronic heart disease and heart failure in primary care compared with usual care.
Was a comprehensive description of the competing alternatives given?	Both the intervention group and control group are described.
Was the effectiveness of the programmes or services established?	Yes, this was established from a RCT (Khunti et al., 2007).
Were all the important and relevant costs and consequences for each alternative identified?	The study adopted a patient perspective for outcomes. Costs were measured from the perspective of both the NHS and patients (including travel costs).
Were costs and consequences measured accurately in appropriate physical units?	The costs and consequences were justified and appropriate for the research question.
Were costs and consequences valued credibly?	Yes, costs and consequences were clearly identified, and appropriate for the research question.
Were costs and consequences adjusted for differential timing?	Follow-up period was 12 months therefore discounting was not needed. However, the authors applied a discount rate of 6% for equipment and training that would have an expected lifespan of more than one year.
Was an incremental analysis of costs and consequences of alternatives performed?	Yes, the additional costs in the nurse-led clinic service compared with the control group were calculated, as well as the additional benefits of the service.
Was allowance made for uncertainty in the establishments of costs and consequences?	Authors used bootstrapping to obtain bootstrapped p values for use in the analysis. Sensitivity analysis was not reported.
Did the presentation and discussion of study results include all issues of concern to users?	Limitations noted by the authors included low participation rates and that all practices were taken from one locality. Additionally, authors noted length of follow up of 12 months as a study limitation.