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SPECIAL PAPER

Impact of physician assistants on quality of care: rapid review

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ABSTRACT

OBJECTIVE

To determine the impact of physician assistants, compared with physicians, on quality of care in the context of an ongoing UK policy review.

DESIGN

Rapid systematic review.

SEARCH STRATEGY

Keyword search of three databases; search and citation tracking of previous systematic reviews.

ELIGIBILITY CRITERIA

Empirical studies that quantitatively compared care delivered by physician assistants with care delivered by physicians, including residents, in economically developed countries, published between January 2005 and January 2025.

MAIN OUTCOMES OF INTEREST

Measures of outcomes of care, as defined by the Institute of Medicine's definition of quality: safety, effectiveness, patient centredness, timeliness, efficiency, and equity.

METHODS

Eligible studies were categorised as primary care, secondary care, physician assistants versus residents in hospitals, diagnosis/performance, and cost effectiveness. Two reviewers independently extracted data on study design, samples, methods, and findings. Each study was assessed using a risk of bias tool. Owing to the heterogeneity of included studies, a narrative synthesis of the main findings was conducted. An assessment of confidence in the body of evidence for each outcome was based on the number and quality of relevant studies and the consistency of results between similar studies.

RESULTS

Of 3636 studies screened, 167 studies were eligible and 40 met the inclusion criteria. These consisted mainly of retrospective observational studies of weak quality. Most (31/40) were from the US, and no data from a post-covid-19 context were found. The greatest number of studies with the most consistent results were those that found that physician assistants practised safely and effectively when working under direct supervision and in post-diagnostic care. No difference was found in patient satisfaction between physician assistants and physicians. Although adding physician assistants to medical teams increases access to care, this may reflect the benefits of increased staffing rather than the unique contribution of the physician assistant role. Evidence on cost effectiveness is limited. Patients in the UK are more likely to see a physician assistant if they live in a socioeconomically deprived area.

CONCLUSION

The evidence found in this review is limited and does not support the safety or effectiveness of indirect supervision of physician assistants in undifferentiated (pre-diagnosis) settings. National guidance on the supervision and scope of practice for physician assistants can ensure that physician assistants practise safely and effectively.

STUDY REGISTRATION

PROSPERO CRD42024614992.

Introduction

Healthcare systems worldwide face significant workforce challenges.[1] In June 2024 the UK's National Health Service reported 10 745 medical vacancies, equating to around 7% of all medical posts.[2] The number of doctors in primary care, who deal with the vast majority of patient encounters,[3] is falling.[4] These figures are set against a backdrop of population growth, increasing demand, increasing complexity of clinical work owing to multi-morbidity and an ageing population,[5] overcrowding,[6] and increasing staff attrition rates, which further compound staff shortages.[7] Paradoxically, the UK is also experiencing unemployment of doctors, with general practitioners unable to find work,[8] and high competition ratios for entry into postgraduate training programmes, meaning that many residents cannot progress directly to their specialty of choice.[9 10]

Physician assistants were first introduced in the 1960s in the US in response to medical shortages in certain specialties and mainly rural areas.[11] In the US, becoming a physician assistant requires a bachelor's degree and evidence of a strong foundation in science, previous experience in healthcare, a two to three year accredited master's degree in physician assistant studies, successful completion of a national licensing examination, and application for a licence to practice. In many states, physician assistants are required to have a formal agreement with a collaborating physician to be able practise.[12] Physician assistants perform similar roles to physicians, assessing and examining patients, requesting investigations, prescribing, and making diagnoses and treatment plans.

The first physician assistants graduated from UK pilot programmes in 2007.[13] A separate review charting the drivers of the development of the physician assistant role in the UK, including the change of title from assistant to associate, has been published.[14] In the UK, becoming a physician assistant requires a bachelor's degree in a science or a health related discipline, a diploma or master's degree in physician assistant studies, and successful completion of a

national examination.[13] No previous clinical experience is required. In 2010 a voluntary register was created, and in December 2024 the General Medical Council became responsible for the future regulation of physician assistants, including setting standards for course providers.[15] However, no nationally defined scope of practice or requirement for supervision exists, meaning that local employers make decisions, leading to wide variation in how physician assistants are deployed and supervised.[16] In the UK, physician assistants are more likely to be found working in under-resourced areas.[17] They are not able to prescribe or request ionising radiation.

Degrees in physician assistant studies focus on foundational knowledge and clinical skills necessary to assist physicians in patient care.[16] Although the physician assistant role is established in several countries, concerns have been raised about the implementation of this role in the UK in six broad areas: scope of practice, patient safety, informed consent, preferential employment conditions, additional workload of physicians supervising physician assistants, and impact on medical training.[14 16 18 -20] Physician assistants see undifferentiated acute presentations in primary care with indirect supervision,[21] they have substituted for doctors in hospital on-call rotas,[22] and Coroners have issued "action to prevent future deaths reports" in relation to the physician assistant role.[23 24] In response, the Academy of Medical Royal Colleges called for a rapid review of the safety, cost effectiveness, and efficiency of physician assistants,[25] and the Secretary of State for Health in England and Wales commissioned an independent review of physician and anaesthesia associates in November 2024.[26] We therefore decided to do a rapid review to answer the question: "What is the impact of physician assistants on quality of care compared with physicians?" A separate review will explore the impact of physician assistants on resident training.

Methods

Rapid reviews are often used to inform health policy. Like systematic reviews, rapid reviews use systematic and explicit methods to appraise, extract, and analyse data, but specific components of the systematic review process are either abbreviated or omitted to provide an evidence synthesis more quickly.[27] Rapid reviews can be enhanced with additional steps included to reduce bias, and they have been found to identify the same studies as systematic reviews.[28] We followed the updated guidance for rapid reviews by the Cochrane Rapid Reviews Methods Group,[27] which includes features enhancing rapid reviews to reduce bias. Our team included an information specialist and experienced systematic reviewers.

Setting the research question

We used the Institute of Medicine's definition of quality in healthcare to assess the impact of physician assistants on quality of care.[29] We chose this definition because it includes the domains of safety and effectiveness but also includes patient centredness, timeliness, efficiency, and equity, which are also important in determining quality (box 1). We chose to restrict our review to economically developed countries (in North America and Europe, plus Israel, Japan, South Korea, Australia, and Aotearoa New Zealand)[30] to ensure that the evidence synthesis would be relevant to the UK and other similar countries developing a physician assistant workforce.

Box 1: Domains of quality in healthcare[29]

Safe

- Avoiding harm to patients from the care that is intended to help them

Effective

- Providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit (avoiding underuse and misuse, respectively)

Patient centred

- Providing care that is respectful of and responsive to individual patient's preferences, needs, and values and ensuring that patients' values guide all clinical decisions

Timely

- Reducing waits and sometimes harmful delays for both those who receive and those who give care

Efficient

- Avoiding waste, including waste of equipment, supplies, ideas, and energy; includes cost effectiveness

Equitable

- Providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographical location, and socioeconomic status

Eligibility criteria

Eligible studies were those that quantitatively compared care delivered by physician assistants with care delivered by doctors (known as physicians in the US), including residents. The outcomes were outcomes of care, as defined by the Institute of Medicine's definition of quality: safety, effectiveness, patient centredness, timeliness, efficiency, and equity. We excluded studies that examined care delivered by nurse practitioners, advanced clinical practitioners, students, anaesthesia associates, surgical care practitioners, radiology assistants, and pharmacists and studies in which physician assistants could not be distinguished from other groups. We also excluded studies comprising descriptive or self-reported processes of care, self-reported competency, or clinical practice in which no objective outcome was measured; studies of physician assistants being added to teams; and studies focusing on educational processes rather than care delivery.

Search strategy

The search strategy was developed with an information specialist (KF). We did a comprehensive search of two major medical electronic databases, Medline and Embase, to January 2025, using the search terms as set out in the supplementary materials. We did a further search using Google Scholar and the search term "impact of physician assistants" limited to the first 200 results. We also hand searched published systematic reviews for eligible studies. Studies were limited to the English language and the past 20 years.

Study selection

After the removal of duplicates, titles and abstracts were screened by a single reviewer, with 20% independently screened by a second reviewer. Single reviewer screening proceeded owing to a good level of agreement being reached (defined as inter-rater reliability of ≥0.8). Potentially eligible studies were then screened by full text. We excluded studies if they did not meet the inclusion criteria or were not available as full text (for example, conference abstracts).

Data extraction and critical appraisal

We divided included studies into categories by topic. Data extraction was first done by a single reviewer with expertise in that topic and limited to the data relevant to the review question. We piloted the data extraction and summary forms on a small number of included studies and shared them with team members to ensure consistency

(see supplementary materials). A second reviewer then independently verified the data extraction for each study.

We used a critical appraisal/risk of bias tool applicable to each study's design to assess the quality of each included study.[31] For most studies, this was the checklist for cohort studies (prospective or retrospective). We also applied this checklist to database studies. We rated a cohort study as "good" if the answer to all applicable questions was yes, "moderate" if the answer to all applicable questions was yes and one was rated as unclear, and "weak" if the answer to any applicable question was no or more than one was rated as unclear.

Data synthesis

We did not do meta-analysis owing to the heterogeneity of the included studies in terms of scope, outcomes, and statistical analysis. Instead, we did a narrative synthesis of the main findings, in which we categorised the studies as primary care, secondary care, physician assistants versus residents in hospitals, diagnosis/performance, patient satisfaction, and cost effectiveness. To explore patterns in the data, we further grouped studies by country of origin. An assessment of confidence in the body of evidence for each outcome was based on the number and quality of relevant studies and consistency of results between similar studies.

Patient and public involvement

No patients or members of the public were involved in the research, as no funds or time were allocated for patient and public involvement. However, our results have been submitted as evidence to the Leng Review, which includes patient focus groups.

Results

The initial search identified 3639 records. After the removal of duplicates, initial screening by title and abstract resulted in 167 records. Full text screening resulted in 40 studies being included in the review. Figure 1 outlines the search and selection process. Studies were excluded at the full text stage owing to their results not distinguishing physician assistants from other groups (for example, nurse practitioners) (n=61), not meeting the inclusion criteria (for example, not a quantitative empirical study comparing physician assistant care with physician care) (n=62), or data being available only in abstract form (n=4).

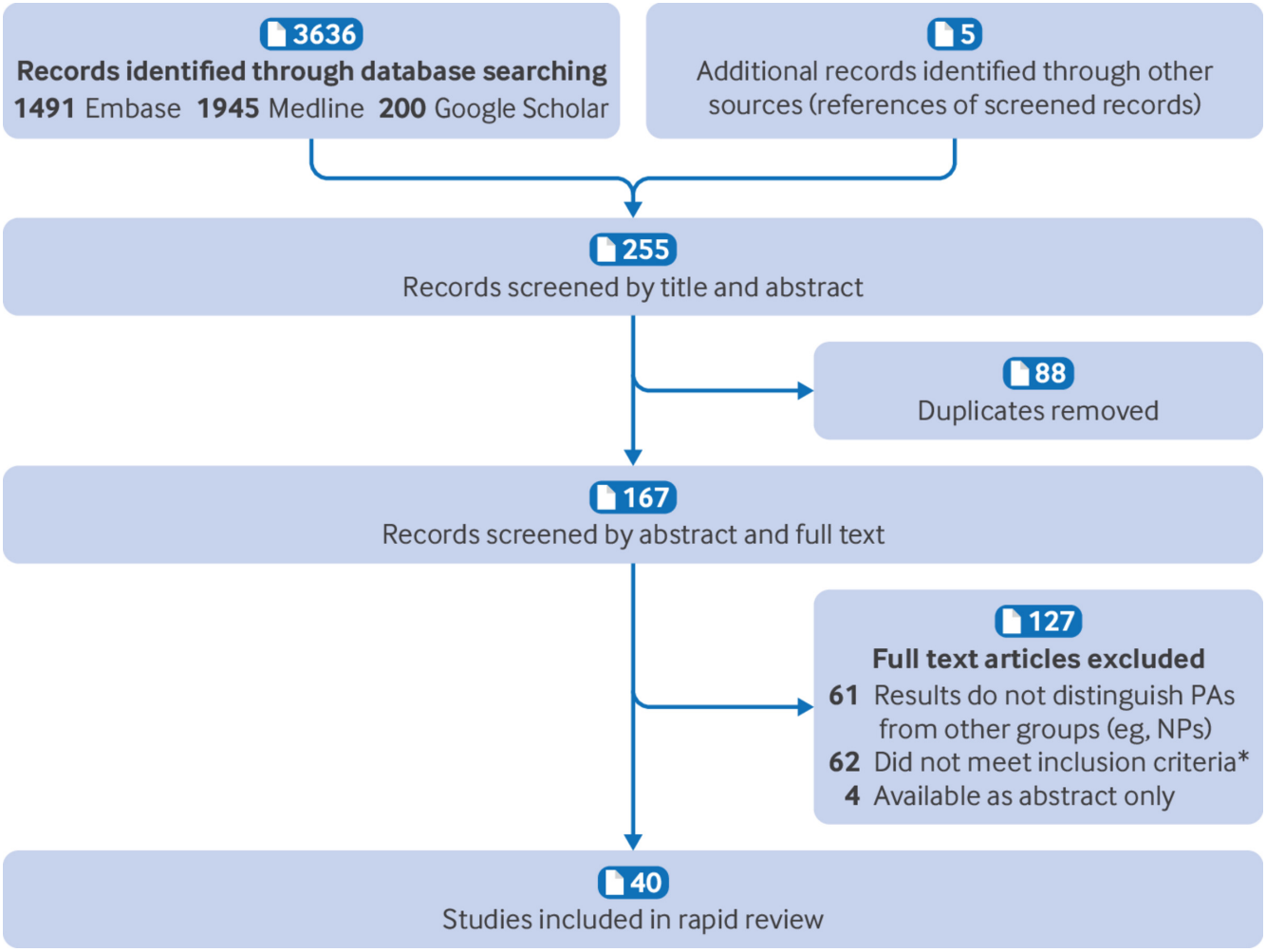

Fig 1 | PRISMA diagram. *Did not meet inclusion criteria: not comparing physician assistant (PA) care with physician care (n=6); comparing different PA staffing models (n=1); reporting impact of PAs being added to medical teams (n=23); describing processes of care (n=18); self-reported competence/outcomes (n=6); systematic review (n=5). NP=nurse practitioner

The included studies were in the following categories: primary care (6); secondary care (5); physician assistants versus residents in hospitals (14); diagnosis/performance (8); patient satisfaction (3); cost effectiveness (4). The categories were not discrete as several studies had overlapping themes. Of the 40 studies, 31 were conducted in the US, four in the Netherlands, four in the UK, and one in Ireland. The tables summarise the included studies, including details of the setting, study design, data analysed, outcome measures, results (including statistical analysis, where present), and quality assessment. The following narrative presents an overview of key findings.

Primary care

Five studies were conducted in the US (table 1).[32-36] All were retrospective cohort studies involving hundreds of thousands of patient records. Of these, one study investigated adoption of new chronic disease medications and found that physicians were significantly more likely to prescribe newly approved drugs for chronic diseases than were physician assistants and nurse practitioners.[32] Three studies looked at diabetes care and used glycated haemoglobin (HbA1c), systolic blood pressure, and low density lipoprotein cholesterol as surrogates for quality of care.[33-35] These found no clinically significant differences in outcomes between physician assistants, nurse practitioners, and physicians as the primary care provider. The fifth study compared the practice patterns and quality of care of physician assistants, nurse practitioners, and physicians in community health centres.[36] It found no differences in the outcomes studied, apart from that patients were more likely to have smoking cessation and education/counselling services documented if seen by a physician assistant or a nurse practitioner than by a physician. We judged all of these studies to be of weak quality owing to their non-randomised, retrospective design that did not account for potential confounders, such as differences in patients' characteristics, team care, and visits to other providers.

Table 1 | Summary of results—primary care

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Marcum et al, 2016[32]	USA. Primary care	Retrospective cohort study. Adoption of new chronic disease medication. Physicians *v* NPs *v* PAs	All prescriptions of 5 new chronic disease medications dispensed in Pennsylvania between 1 Jan 2007 and 31 Dec 2011	Three measures of prescriber adoption during 15 month post-FDA approval period: time to first prescription of new medication (speed of adoption); any prescription of new medication in final year of study period (extent of adoption); proportion of prescriptions of new medication in that class (extent of adoption)	>30 million prescriptions were analysed (data for each drug not presented here for brevity). Physicians adopted new drugs faster than NPs and PAs. Physicians prescribed larger share of new medications in final year of study. Physicians prescribed larger share of new medications in that class. P<0.001 for comparisons across providers for all variables	Weak. Non-randomised retrospective design. Confounders: possible differences in patient characteristics by provider type not accounted for
Jackson et al, 2018[33]	USA. Primary care (VHA)	Retrospective cohort study. Intermediate diabetes outcomes. Physicians *v* NPs *v* PAs	Review of 368 481 patient records meeting inclusion criteria: adults with diabetes treated with medication, with >1 primary care visit and >1 outpatient visit during study period with same provider	Patient characteristics. HbA1c control. Systolic blood pressure. LDL cholesterol concentrations. A priori thresholds were set for clinical significance of observed differences in clinical outcomes (0.3% for HbA1c, 3 mm Hg for SBP, and 0.13 mmol/L (5 mg/dL) for LDL cholesterol	Main care provider was provider most often visited at patient's "home" clinic. These were physicians (n=3487), NPs (n=1445), and PAs (n=443) for 74.9% (n=276 009), 18.2% (n=67 120), and 6.9% (n=25 352) of patients, respectively. No statistically significant difference found in patient characteristics by provider type. No clinically significant differences found in HbA1c, systolic blood pressure, or LDL cholesterol concentrations by provider type	Weak. Non-randomised retrospective design. Confounders: team care and visits to other clinics not accounted for
Yang et al, 2018[34]	USA. Primary care	Retrospective cohort study. First 5 years of diabetes management. Physicians *v* NPs *v* PAs	Review of 19 238 records of patients with newly diagnosed diabetes who saw same provider type >75% of time, followed over 4 years	Patient characteristics. Prescriptions of oral antihyperglycaemic drug or insulin. Referral to diabetes clinic. HbA1c control	78.2% (n=15 050) of patients managed by physicians, 14.7% (n=2821) by NPs, and 7.1% (n=1367) by PAs. Concordance with being seen by same provider was 92% for physicians, 82.3% for NPs, and 78.9% for PAs. No statistically significant difference in patient characteristics by provider type, apart from physicians statistically more likely to care for black/African American patients (P=0.02). Physicians referred 7.6% of patients to diabetes clinic, NPs 7.0%, and PAs 4.8% (P<0.001). No statistically significant differences in HbA1c at diagnosis, initiation of first and second oral drug, or after 4 years, after adjustment for patient characteristics. Statistically significant differences found in insulin prescriptions (physicians 14.6% of patients, NPs 14.1%, and PAs 12.5% (P=0.09)	Weak. Non-randomised retrospective design. Confounders: not clear whether or how often physician had input into NP and PA care. Race/ethnicity data not available for 10.1% of patients. Fewer insulin prescriptions and diabetes clinic referrals among PA cohort may suggest PAs saw less complex patients

Table 1 | Summary of results—primary care *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Everett et al, 2019[35]	USA. Primary care (VHA)	Retrospective cohort study. Intermediate diabetes outcomes. Physician only *v* primarily physician with NP *v* primarily physician with PA *v* primarily NP with physician *v* primarily PA with physician *v* NP *v* PA	Review of 609 668 records of patients with diabetes assigned to different primary providers	Patient characteristics. HbA1c. Systolic BP. LDL cholesterol. A priori thresholds were set for clinical significance of observed differences in clinical outcomes (0.3% for HbA1c, 3 mm Hg for SBP, and 0.13 mmol/L (5 mg/dL) for LDL cholesterol	66.9% (n=408 009) of patients managed by physicians only, 6.5% (n=39 861) by primarily physician with NP, 4.1% (n=24 692) by primarily physician with PA, 5.3% (n=32 472) by primarily NP with physician, 2.4% (n=14 342) by primarily PA with physician, 10.8% (n=66 042) by NP, and 4% (n=24 250) by PA. No statistically significant difference found in patient characteristics by provider type. No clinically significant differences found in HbA1c, systolic blood pressure, or LDL cholesterol concentrations by provider type	Weak. Non-randomised retrospective design. Confounders: team care not accounted for; patients with diabetes in VHA see their usual provider for around 75% of visits
Kurtzman and Barnow, 2017[36]	USA. Community health centres	Retrospective cohort study. Quality of care and practice patterns. Physicians *v* NPs *v* PAs	Review of 23 704 records of patient visits between 2006 and 2010 from National Ambulatory Medical Care Survey. Involving 1139 practitioners	Patient characteristics. Smoking cessation counselling. Depression treatment. Statin for hyperlipidaemia. Physical examination. Total No of health education/counselling services. Imaging. Total No of medications. Return visit at specified time. Referral to another physician	Physicians comprised 65% (n=742) of providers, NPs 26% (n=291), and PAs 9% (n=106). NPs were more likely to see female patients. NPs and PAs were more likely to see patients in rural areas (P<0.01 for both variables). Of 9 outcomes studied, only 2 had statistically significant differences. NPs were more likely to give recommended smoking cessation counselling (adjusted OR 1.62, 95% CI 1.17 to 2.26; P≤0.01). NPs and PAs were more likely to provide education/counselling services (adjusted incidence rate ratio 1.40, 95% CI 1.19 to 1.64; P≤0.01)	Weak. Non-randomised retrospective design. Confounders: potential differences in caseload (number of patients, throughput, and complexity) not accounted for

Table 1 | Summary of results—primary care *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Drennan et al, 2015[37]	UK. Primary care	Retrospective cohort study. Outcomes and costs of consultations. PAs *v* GPs	Review of 2086 records of patients with same day appointments at 12 GP practices in England over 2 weeks in summer and 2 weeks in winter	Patient characteristics. Re-consultation within 14 days for same problem. Process measures: No of tests, referrals, prescriptions, general advice, medication advice. Length of consultation. Cost of consultation (calculated by salary and related costs of PA/GP plus consultation length). Patient satisfaction. Clinical review of records of re-consulting patients	PAs and GPs saw significantly different patients. PAs saw patients who were younger (mean age 34.45 (SD 23.2) *v* GPs 42.93 (24.87); P<0.001); had fewer chronic diseases (mean per patient 0.55 (SD 0.99) *v* GPs 0.87 (1.26); P<0.001); had fewer repeat prescriptions (mean 1.81 (SD 3.02) *v* GPs 2.60 (3.63); P<0.001); had fewer visits to practice in previous 3 months (mean 2.12 (SD 2.83) *v* GPs 2.70 (2.99); P<0.001); were more likely to live in deprived area (mean index of multiple deprivation 21.99 (SD 16.61) *v* GPs 15.81 (13.04); P<0.001); were more likely to present with minor problems or symptoms (62.9% of consultations *v* 50.2% for GPs; P<0.001), and were less likely to present with chronic problems (32.7% of consultations *v* 43.7% for GPs; P<0.001). PAs attended significantly more patients presenting for "minor problems or symptoms" and less often "chronic" problems than GPs. No significant difference in re-consultation rates between those who initially consulted PAs or GPs (including when adjusted for planned re-consultations)	Weak. Non-randomised retrospective design. Confounders: no data on time spent on supervision (direct or indirect) and signing prescriptions by GPs. Small number of PAs included in this study (n=7)

Table 1 | Summary of results—primary care *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
					After adjustment for clustering at practice level, presenting problem, and patient characteristics described above, no significant difference was found between PAs and GPs in rate of diagnostic tests ordered, referrals to secondary care, or prescriptions issued. PAs were significantly more likely to document giving general advice (adjusted OR 3.30, 95% CI 1.69 to 6.45; P<0.001) and advice on medication management (adjusted OR 1.72, 1.08 to 2.73; P=0.02). Consultation times were significantly different. PA consultation time mean of 16.8 (SD 8.3) min *v* GPs 11.3 (7.6) min; P<0.001. GPs saw 3 patients for every 2 seen by PAs. Costs per consultation were lower for PAs (£28.14 *v* £34.36 for GPs). 93% of records of re-consulting patients were reviewed by GP reviewers for overall appropriateness, subjective information, objective information, documentation of assessment/problem, and plan (investigations, prescription). In all elements, PAs performed better than GPs, with overall appropriateness of 81.6% *v* 50.8% of GPs. GP reviewers incorrectly judged 58.3% of PA consultations to be those of GPs and 23% of GP consultations to be those of PAs	

CI=confidence interval; FDA=Food and Drug Administration; GP=general practitioner; LDL=low density lipoprotein; NP=nurse practitioner; OR=odds ratio; PA=physician assistant; SBP=systolic blood pressure; SD=standard deviation; VHA=Veterans' Health Administration.

One study was conducted in the UK and published in 2015 (table 1).[37] This was a retrospective study based on a review of consultation notes, linked medical records, and patient satisfaction. It analysed the records of 2086 adults attending for same day/urgent appointments being seen by either a physician assistant or a general practitioner in 12 volunteer practices, of which six employed physician assistants and six did not. The primary outcome of this study was re-attendance within 14 days for the same or a linked problem. Secondary outcomes were related to processes of care: use of diagnostics, referrals, prescriptions, advice given, length of consultation, and cost of consultation. All but one of the practices had guidelines for receptionists to assign patients to physician assistants, defined by the supervising general practitioner. In five practices, physician assistants had longer appointment times or empty slots to give time to consult their supervising general practitioner. Physician assistants and general practitioners saw significantly different patients. Physician assistants' patients were younger, were more likely to present with minor problems or symptoms, and had fewer chronic diseases, fewer repeat prescriptions, and fewer visits to the practice in the previous three months. No significant difference was found in the primary outcome. After adjustment for clustering at practice level, presenting problem, and patients' characteristics, no significant differences were found in the secondary outcomes. General practitioners saw three patients for every two seen by physician assistants. Costs per consultation were lower for physician assistants (£28.14 ($38.6; €32.9) versus

£34.36 for general practitioners), but lack of data on time spent supervising and signing prescriptions by general practitioners means that the true costs of physician assistants are underestimated to an unknown extent. In a review of the medical records of re-attendances, physician assistants performed significantly better than general practitioners in documenting the consultation. Patient satisfaction was high for both groups. We judged this study to be of weak quality owing to its non-randomised, retrospective design, with general practitioner supervision not accounted for and only seven physician assistants studied.

Secondary care

Three retrospective cohort studies looking at care in emergency departments were conducted in the US (table 2).[38-40] These all analysed outcomes such as unplanned re-attendance within 72 hours, patient acuity/diagnosis, and patient flow measures. The first study used data over 12 years from the National Hospital Ambulatory Medical Care Survey.[38] This found that physician teams saw older, more severely ill patients and more often saw them overnight. Patients seen by physician assistant or nurse practitioner teams received fewer diagnostics, fewer procedures, and fewer hospital admissions after adjustment for age, severity, and other characteristics of patients. The second study analysed 25 883 patient encounters in a single emergency department.[39] Physicians saw older patients, but physicians and physician assistants saw patients with similar acuity scores. Patients seen by physician assistants waited longer to be seen and had a longer lengths of stay. No differences were found in unplanned re-attendances, patient disposition, and computed tomography scans requested. Patient satisfaction was higher for physician assistant care. The third study looked at 10 369 children aged 6 years or younger seen during a 24 month period in a single emergency department and analysed re-attendance rates.[40] Physicians saw younger, sicker patients, and no statistically significant difference was found in re-attendance rates by provider. We judged all these studies to be of weak quality because of their non-randomised retrospective design, the confounder of team based care in the emergency department, and no data on whether diagnostics or procedures were appropriate. The second and third study did not adjust for differences in patients' characteristics. In addition, accepted metrics of efficiency in the emergency department, such as length of stay, have not shown a causal relation with improved patient care.[41]

Table 2 | Summary of results—secondary care

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Kurtzman et al, 2023[38]	USA. Emergency department	Retrospective cohort study. Practice patterns of teams in EDs. Physician *v* NP *v* PA led teams	Review of 95 718 records—randomly sampled patient visits within 12 year period (2009-20) from National Hospital Ambulatory Medical Care Survey	Patient characteristics. Patient clinical information. Day and time of visit. Patient disposition (eg, transferred, admitted, died in ED). Patient flow indicators (ie, arrival time, time seen, time discharged). Process measures: diagnostic tests, procedures, prescriptions	Physicians saw patients who were statistically significantly older (47.1% aged >45 years *v* 33.2% for NPs *v* 35.2% for PAs; P≤0.01); more severely ill on basis of triage level (8.4% *v* 2.0% for NPs *v* 2.4% for PAs; P≤0.01); more often seen between midnight and 8 am (16.4% *v* 8.4% for NPs *v* 7.2% for PAs; P≤0.01) and transported by ambulance (12.5% *v* 4.5% for NPs *v* 4.0% for PAs; P≤0.01). PAs and NPs were statistically significantly more likely to see patients presenting with injuries and poisoning (30.5% for physicians *v* 38.9% for NPs *v* 41.4% for PAs; P≤0.01) Multivariate regression analysis was used to adjust for patient and clinical characteristics to examine associations between provider type and outcomes of interest. Being seen by PA team significantly lowered adjusted incident rate ratio of diagnostic services (0.8, 95% CI 0.7 to 0.8) and procedures (0.9, 0.8 to 1.0). PA teams were associated with significant decrease in length of a visit by 26.3 (95% CI −36.7 to−15.9) min and reduction in odds of hospital admission (adjusted OR 0.3, 95% CI 0.2 to 0.4)	Weak. Non-randomised (to intervention) retrospective design. Confounders: team care not accounted for

Table 2 | Summary of results—secondary care *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Moore et al, 2021[39]	USA. Emergency department	Retrospective cohort study. ED. Physicians *v* PAs	Review of 25 883 records of patients who attended between Apr 2016 and Dec 2018	Patient characteristics. Patient acuity. Mean LOS. Door to provider time. Re-attendance within 72 h. No of patients seen per hour. No of CT scans requested. Patient disposition. Patient satisfaction	58.7% (n=15 205) of patient encounters were managed by PAs and 41.3% (n=10 678) by physicians. Statistically significant differences were found in patient characteristics, with patients cared for by physicians being older (36.4 (SD 23.5) *v* PAs 34.4 (22.7) years; P<0.001) and physicians caring for greater proportion of patients aged >65 (14.2% *v* 11.8% for PAs; P<0.05). No clinically significant differences were found in patient acuity by provider type. Patients cared for by PAs had longer mean LOS (126 (SD 96) *v* 120 (96) min for physicians; P<0.001); and longer door-to-clinician times (16.2 (SD 66) *v* 11.4 (108) min for physicians; P<0.001). No statistically significant differences found in re-attendance rates, No of patients seen per hour, and CT scans requested. Patient satisfaction was statistically significantly higher for PAs (mean score 9.3 (SD 0.2) *v* 9 (0.2) for physicians; P<0.001)	Weak. Non-randomised retrospective design. Confounders: team care not accounted for; no adjustments made for differences in patient characteristics

Table 2 | Summary of results—secondary care *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Pavlik et al, 2017[40]	USA. Emergency department (paediatric patients)	Retrospective cohort study. Physicians *v* PAs	Review of 10 369 records of children who attended general community ED in 24 month period	Patient characteristics. Unplanned re-attendances within 72 h	Physicians were statistically significantly more likely to see youngest patients, demonstrated graphically by showing linear correlation between younger age and physician care (85% of 8 week olds falling to 42% of 6 year olds seen by physicians; P<0.001). Physicians saw most patients, but proportion of patients seen by acuity was significantly different, with physicians seeing greater proportion of patients with higher acuity scores and PAs seeing greater proportion of patients with lower acuity scores (P<0.001). No statistically significant difference was found in re-attendance rates by provider. Patients for whom PAs sought input from attending physicians had highest re-attendance rates	Weak. Non-randomised retrospective design; no adjustments made for differences in patient characteristics.

Table 2 | Summary of results—secondary care *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Halter et al, 2020[42]	UK. Emergency department	Mixed methods study: retrospective records review; semi-structured interviews; observation of staff. Processes and outcomes of consultations. PAs *v* FY2 doctors	Review of 8816 records of patients who attended in 16 week period. 3 EDs. 6 PAs and 40 FY2 doctors. 14 clinicians/managers and 6 patients/relatives interviewed. 5 PAs observed	Patient characteristics. Patient acuity. Area seen. Primary outcome: unplanned re-attendance within 7 days. Secondary outcomes: prescriptions given, admission to hospital, radiography requests, discharge summary completed. 40 records selected for detailed review for clinical adequacy of documented care	FY2 doctors were statistically significantly more likely to see older patients (P=0.002, all age groups) and patients triaged as urgent/very urgent (53.1% for PAs *v* 66.8% for FY2s; P<0.001) but less likely to see patients triaged as immediate (0.6% for PAs *v* 0.1% for FY2s; P<0.001). FY2 doctors were also more likely to see patients in majors (68.8% for PAs *v* 88.4% for FY2s; P<0.001) and less likely to see patients in minors (20.1% for PAs *v* 6.8% for FY2s; P<0.001). PAs did not see any patients overnight but FY2 doctors did After adjustment for patient age, sex, and triage score, no statistically significant differences were found in re-attendance rates. No statistically significant difference was found in prescriptions, admission rates, or discharge summary completed. Patients seen by PA were statistically significantly more likely to have radiography (adjusted OR 2.7, 95% CI 1.72 to 4.24; P<0.001) and had mean 35 min shorter LOS (no statistics provided) after adjustment for age, sex, acuity, whether admitted, radiograph taken, and hospital site. Clinical reviewers found 3/40 patient charts clinically inadequate (1 PA and 2 FY2). Patients were positive about care they had received from PA but had poor understanding of role	Weak. Non-randomised retrospective design. Confounders: no adjustments made for differences in area of ED seen, day, and time of day

Table 2 | Summary of results—secondary care *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
King et al, 2024[43]	UK. Emergency department	Retrospective cohort study. Outcomes of consultations. PAs *v* FY1 doctors	Review of 7405 records of adult patients who attended single ED between Aug 2018 and Jan 2020. 11 PAs and 7 FY1 doctors	Patient characteristics. Area seen. Day and time of day. Patient acuity. Primary outcome: wait time to consultation. Secondary outcomes: LOS in department, left without being seen, unplanned re-attendance within 72 h	FY1 doctors were statistically significantly more likely to see younger patients (all age groups P<0.001) and during normal working hours (81.8% patients seen 8 am to 4 pm for FY1s *v* 58.6% for PAs; P<0.001). FY1s were more likely to see patients in urgent treatment centre (55.3% of patients *v* 11.6% for PAs; P<0.001) and less likely to see patients in majors (42.8% of patients *v* 86.2% for PAs; P<0.001) After adjustment for patient age, time of day, area of ED seen, and patient disposal, no statistically significant difference was found in wait time to consultation. No statistically significant differences were found in left without being seen rates and unplanned re-attendances. Patients seen by PAs had statistically significantly longer LOS (adjusted mean 258.25 (95% CI 251.59 to 264.90) min *v* 198 (190.36 to 205.63) min for FY1s; P<0.001). Patients who left without being seen and those who were admitted were excluded from LOS calculations	Weak. Non-randomised retrospective design. Confounders: team care not accounted for

CI=confidence interval; CT=computed tomography; ED=emergency department; FY=foundation year; LOS=length of stay; NP=nurse practitioner; OR=odds ratio; PA=physician assistant; SD=standard deviation.

Two studies were conducted in the UK (table 2).[42 43] The first was published in 2020 and compared physician assistants and foundation year 2 doctors in training undertaking consultations in three type 1 emergency departments (24 hour, consultant led emergency departments that treat serious and life threatening conditions) in England.[42] It used retrospective chart reviews, a small number of semi-structured interviews with staff and patients, and observations of physician assistants over a 16 week period. The study involved 8816 patient attendances seen by six physician assistants and 40 foundation year 2 doctors. The primary outcome was unplanned re-attendance within seven days as a surrogate of quality of care. Secondary outcomes were length of stay, use of radiography, prescriptions, and referrals. Forty patient records were reviewed for clinical adequacy. The two groups saw significantly different patients. Physician assistants saw younger patients, a higher proportion of patients in minors (less unwell, ambulatory patients), and a lower proportion of patients triaged as urgent/very urgent, and they did not see any patients overnight. Calculation of the primary outcome was limited by a large amount of missing data. This was due to one site where data were not captured on an electronic dataset and were retrieved manually from a random sample of 205 records and then extrapolated for the purposes of the study. No statistically significant difference was found in re-attendance rates after adjustment for patients' age, sex, and triage score. Additionally, no statistically significant difference was found in prescriptions, admission rates, or discharge summaries completed, but patients seen by a physician assistant were more likely to have radiography and to have a shorter length of stay in the department after adjustment for age, sex, acuity, whether admitted, radiograph taken, and hospital site. The authors note that they did not take account of differences in staffing levels (for example, day versus night; therapy teams are not available overnight to help to discharge older patients) and no adjustments were made for differences in area of emergency department seen. Of the records that were reviewed for clinical adequacy, three (one physician assistant and two foundation year 2 doctors) were judged to contain errors or omissions that would have altered the patient's treatment. Of the six patients interviewed who had seen a physician

assistant, two thought that they had seen a doctor. We judged this study to be of weak quality owing to its non-randomised retrospective design, the confounder of team based care (including supervision), and no adjustments made for differences in area seen and time of day.

The second UK study was published in 2024.[43] This was a retrospective cohort study looking at the outcomes of consultations of physician assistants and foundation year 1 doctors in training in one type 1 emergency department in England. It analysed 7405 records of adult patients who attended between August 2018 and January 2020. The primary outcome was wait time to consultation. Secondary outcomes were length of stay, rates of being left without being seen, and unplanned re-attendances within 72 hours. Physician assistants and foundation year 1 doctors saw significantly different patients. Foundation year 1 doctors mainly worked during normal working hours (weekdays 0800-1600) and mainly saw patients in the urgent treatment centre with a different case mix. Physician assistants mainly worked in majors and the resuscitation room and also worked out of hours. After adjustment for patient's age, time of day, area of emergency departments seen, and patient's disposal, no statistically significant difference was found in wait time to consultation, left without being seen rates, or unplanned re-attendances, but patients were in the department for a significantly longer time if seen by a physician assistant. Patients seen by physician assistants were also more likely to be admitted, likely reflecting the different areas they were working in. We judged this study to be of weak quality owing to its non-randomised retrospective design and the confounder of team based care (including supervision) in the emergency department.

Physician assistants versus residents in hospitals

Fourteen studies compared physician assistants versus residents in hospitals (table 3).[44-57] All but two studies were conducted in the US.

Table 3 | Summary of results—residents versus physician assistants (PAs) in hospitals

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Divi et al, 2021[44]	USA. Orthopaedic institute	Retrospective cohort study. Surgical outcomes. PAs *v* PGY2-5 (residents) and PGY6-7 (fellows) as assistants	Review of 171 records of patients undergoing lumbar decompression surgery	Patient characteristics. Total operative time. Readmission rates at 30 and 90 days. Need for revision surgery at 1 year. Postoperative PROMs	No statistically significant differences in patient characteristics between groups. Mean operative time was similar in fellow/resident group and PA group (179 *v* 188.5 min; P=0.58). No statistically significant difference in readmission rates. No statistically significant difference in revision surgery at 1 year. No statistical difference in postoperative PROMS	Weak. Non-randomised retrospective design. Confounders: different assistants assisted according to their level of ability
Hazzard et al, 2022[45]	USA. Department of orthopaedic surgery	Retrospective cohort study. Surgical outcomes. One experienced PA *v* rotating fellows as first assistants	Review of 264 records of patients undergoing anterior cruciate ligament reconstruction	Patient characteristics. Skin-to-skin time. Tourniquet time. Month of surgery. PROMs before and after surgery (up to 2 years)	No statistically significant differences in patient demographics between groups. Longer surgical times were seen in all 4 quarters of year for fellows, but improved each quarter until no statistically significant difference was found between rotating fellows and PA. Skin-to-skin surgical time during quarter 1 (15.9 min difference; P=0.02), quarter 2 (15.8 min difference; P=0.001), quarter 3 (12.1 min difference; P=0.001), and quarter 4 (4.4 min difference; P=0.20). Same pattern was seen for tourniquet time. No statistically significant differences in preoperative and postoperative PROMS between groups	Weak. Non-randomised retrospective design. Confounders: fellow instruction during surgery was not measured.
Malloy et al, 2021[46]	USA. Department of plastic surgery	Retrospective cohort study. Surgical outcomes. One PA with ≥2 years' training *v* 15 PGY3+ residents rotating every 2 months as first assistants	Review of 49 records of paediatric patients undergoing reduction mammaplasty	Patient characteristics. Financial data. Duration of surgery ("indirect cost")	No statistically significant differences in patient characteristics were found between groups. Hospital costs were lower in PA group: median $28 997 (range $24 767-$39 775) for PA *v* $32 747 ($25 121-$43 753) for residents (P<0.01. Mean duration of surgery was shorter in PA group: mean 158 (SD 20) min for PA *v* mean 192 (28) min for residents (P<0.001)	Weak. Non-randomised retrospective design. Confounders: patients elected whether to stay overnight or not, affecting costs. Resident instruction during surgery was not measured

Table 3 | Summary of results—residents versus physician assistants (PAs) in hospitals *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Divi et al, 2021[47]	USA. Department of orthopaedic surgery	Retrospective cohort study. Surgical outcomes. PA *v* PGY5-6 resident/fellow as first assistants	Review of 350 records of patients undergoing lumbar fusion surgery	Patient characteristics. Type of surgery. Total surgery time. Length of stay. Wound infection. Need for revision surgery at 1 year. PROMs	No statistically significant differences in patient characteristics, apart from the Charlson Comorbidity Index which was higher in the resident/fellow group: mean 3.40 (95% CI 3.07 to 3.74) *v* 2.69 (2.39 to 3.00) for PAs (P=0.002). No statistically significant difference in type of surgery, surgery time, length of stay, wound infection rates, need for revision surgery, and preoperative and postoperative PROMs	Weak. Non-randomised retrospective design. Confounders: patient groups differed in comorbidity score
Costa et al, 2013[48]	USA. Department of thoracic surgery	Retrospective cohort study. Surgical outcomes. PA as senior surgeon *v* fellow as senior surgeon, both working with residents	Review of 287 lung procurements for transplant performed between 2008 and 2012	Surgical injuries to donor lung	Significant difference was seen in number of injuries during procurements, with PA having 1/197 (0.5%) and fellows having 22/90 (24%) (P<0.01). No statistically significant difference seen in 30 day and 1 year graft survival rates. Rates for pulmonary graft dysfunction grade 2-3 were significantly lower in PA cohort: 19/197 (9.6%) *v* 29/90 (32.2%) for fellows (P<0.01). Rates for pulmonary graft dysfunction grade 0-1 were significantly lower in fellow cohort: 61/90 (67.8%) *v* 178/197 (90.4%) for PAs (P<0.01)	Weak. Non-randomised retrospective design. Confounders: unknown whether any differences in technical difficulty of procurement between two groups, as not measured
Quanbeck et al, 2025[49]	USA. Department of orthopaedic surgery	Retrospective cohort study. Surgical outcomes. Surgeon alone *v* PA, resident, or fellow as first assistant	Review of 888 cases of closed reduction and percutaneous pinning of paediatric supracondylar humerus fractures	Patient characteristics. Operating time. Complication rate	Other than fewer type II fractures for fellows, no significant difference were found in four groups relative to patient age or percentage of fracture type. Operating time was longer for more complex fractures for all groups. For all fracture types, surgeon operating alone took mean of 36 (SD 15.1) min, with PA 34.7 (13.5) min, with fellow 37.1 (11.6) min, and with resident 44.3 (23.6) min. Only operating with resident was statistically significant (P<0.001) with an 8.3 min increase compared with surgeon alone. No statistically significant difference was found in number of K wires placed or the length of follow-up on basis of assistant category	Weak. Retrospective design. Confounders: 134 patients lost to follow-up. Resident direct involvement and instruction during surgery not measured.

Table 3 | Summary of results—residents versus physician assistants (PAs) in hospitals *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Lui et al, 2023[50]	USA. Department of orthopaedic surgery	Retrospective cohort study. Surgical outcomes. PA *v* resident *v* fellow *v* resident + fellow as first assistants	Review of 274 records of patients with cubital tunnel syndrome who had primary cubital tunnel surgery	Patient characteristics. Operating time. Complication rates. Length of stay	No statistically significant differences in patient characteristics between groups. Statistically significant difference was found in type of cubital tunnel surgery performed: no difference in "in situ" release; PAs more likely to perform subcutaneous transposition (39.5% *v* residents 13.2% *v* fellows 19.7% *v* resident/fellow 15.4%; P=0.008); fellows more likely to perform submuscular transposition (21.2% *v* PAs 5.3% *v* residents 15.4% *v* resident/fellow 0%; P=0.04). No association between surgical assistant and complications, reoperations, or length of stay	Weak. Retrospective design. Confounders: different types of surgery performed; subcutaneous transposition is technically easier but no technique is considered superior
Singh et al, 2011[51]	USA. General medicine inpatient service	Retrospective cohort study. Hospital outcomes. PA-hospitalist teams *v* residents-attending teams	Review of 9681 general medical hospital records of patients admitted on weekdays between Jan 2005 and Dec 2006	Patient characteristics. LOS. Costs. Unplanned readmission within 7, 14, and 30 days. Inpatient mortality	No statistically significant differences in patient characteristics or admission diagnosis between groups. Overall LOS was higher for PA-hospitalist teams by 6.73% (95% CI 1.99% to 11.70%; P<0.005). This persisted when winsorised data were used, and admissions that involved ICU stay and deaths were excluded. Analysis of subset of admissions during times when both types of teams could receive patients (11 am to 4 pm) showed no significant difference in LOS: 2.97% (95% CI −4.47% to 10.98%) higher (P=0.44). On restricting multivariable analyses to subset of hospitalists who staffed both types of teams, the increase in LOS associated with PA-hospitalist care was no longer significant: 5.44% (95% CI −0.65% to 11.91%) higher (P=0.08). No statistically significant differences in hospital charges, readmission at 7 and 30 days, and inpatient mortality after adjustment for patient characteristics, admission source, ward, time, day of week, and comorbidity measures	Weak. Non-randomised retrospective design. Confounders: severity of illness not accounted for

Table 3 | Summary of results—residents versus physician assistants (PAs) in hospitals *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Glotzbecker et al, 2013[52]	USA. Chemotherapy service in academic medical centre	Retrospective cohort study. Patient outcomes. PAs *v* house officers, both working with attending physicians	Review of 95 records of patients admitted for chemotherapy for acute myeloid leukaemia between 2008 and 2012	Patient characteristics. Primary outcomes: LOS, inpatient mortality. Secondary outcomes: readmission within 14 days, No of consults requested, ICU transfer	No statistically significant differences in patient characteristics between groups. Mean LOS was statistically significantly shorter in PA group: 30.9 days *v* 36.8 days for house officers (P=0.03). No statistically significant difference in inpatient mortality between groups. Readmission rates were statistically significantly lower in PA group: 0% *v* 10.6% for house officers (P=0.03). No of consults requested was also lower: mean per patient 1.47 *v* 2.11 for house officers (P=0.03). No statistically significant differences in ICU transfers	Weak. Non-randomised retrospective design. Confounders: practice patterns of attending physicians not accounted for
Roy et al, 2008[53]	USA. General medicine inpatient service	Retrospective cohort study. Hospital outcomes. PAs working with hospitalists *v* residents working with attending physicians	Review of 5194 records of patients admitted between July 2005 and June 2006	Patient characteristics. LOS. Hospital costs. Unplanned re-admission at 72 hours. 14 days, and 30 days. ICU admission. Inpatient mortality. Patient satisfaction	Patients in PA-hospitalist group were statistically significantly younger with lower Charlson Comorbidity Index scores (P=0.04 for all age groups; P=0.02 for all CCI scores). Patients in PA-hospitalist group were more likely to be admitted at night (43.8% *v* 30.3% for residents + attendings; P<0.001). After adjustment for age, race, CCI, time of admission, insurer, and case mix index, no statistically significant difference was found in LOS, hospital costs, readmission rates, or in-patient mortality. No statistically significant difference in patient satisfaction scores was found between groups	Weak. Non-randomised retrospective design. Confounders: PA-hospitalist group were geographically localised; practice patterns of hospitalists/attending physicians not accounted for

Table 3 | Summary of results—residents versus physician assistants (PAs) in hospitals *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Kawar and DiGiovine, 2011[54]	USA. Medical intensive care unit	Retrospective cohort study. Hospital outcomes. PAs in one ICU *v* residents in another ICU, both groups working with critical care fellow/attending physician	Review of 5346 records of patients admitted to one of two medical ICUs in single hospital between Jan 2004 and Jan 2007	Patient characteristics. ICU LOS. Hospital LOS. ICU mortality. Hospital mortality. Readmission rates	Resident group had higher rate of renal insufficiency (25% *v* 22%; P=0.05) and PA group had higher rate of stroke (5.6% *v* 4%; P=0.02); other patient characteristics (eg, age) were similar. After exclusion of patients who died in ICU, ICU LOS was longer for patients admitted to PA group (median 2.58 (95% CI 1.55 to 4.86) days) than for patients admitted to resident group (2.33 (1.39 to 4.16) days). This difference persisted after adjustment for severity of illness. No statistically significant difference was found in hospital LOS, ICU mortality, hospital mortality, or readmission rates. A matched analysis was done (identifying 1249 pairs of patients to create two matched groups). Using this well matched subgroup of patients, no significant differences were found in any outcomes	Weak. Non-randomised retrospective design. Confounders: PA ICU was covered by critical care fellows overnight
Dhuper and Choksi, 2009[55]	USA. General medicine inpatient service	Before and after study. Hospital outcomes. PAs *v* residents, both working with attending physicians	Review of 5508 records of patients admitted to PA-hospitalist service (1998-2000) compared with 5458 records of patients admitted during residency-attending service (1996-98)	Mortality. Adverse events. Readmissions within 30 days. Patient satisfaction. Medical record review of all deaths and readmissions to identify any deficiencies in care	No data on patient characteristics between groups. Statistically significant reduction in all cause mortality found: 148/5508 (2.7%) deaths in PA-hospitalist model *v* 235/5458 (4.3%) deaths in resident-attending model (P<0.001). Statistically significant reduction in case mix index adjusted mortality: 0.019 for PA-hospitalist model *v* 0.029 for resident-attending model (P<0.001). No statistically significant differences found in adverse events, readmissions, and patient satisfaction. Medical record reviews of readmissions found no statistically significant difference in incidences of inadequate care between groups	Weak. Non-randomised retrospective design. Confounders: changes in hospital or attending practices/new drugs/technology between 1996 and 1998 not accounted for (in 1988 institution went through major restructuring). PA-hospitalist group had 24/7 onsite supervision from hospitalist and intensivist

Table 3 | Summary of results—residents versus physician assistants (PAs) in hospitals *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Bos et al, 2018[56]	Netherlands. Inpatient medical and surgical wards	Multicentre non-randomised, matched controlled study. Prescribing quality. Wards run by PAs >51% of time during 8 am to 6 pm weekdays *v* wards run by residents, both groups supervised by physicians	Review of 2307 records of adult inpatients on participating wards.	Patient characteristics. Hospital type. Ward type. Admission type. Primary diagnosis. Charlson Comorbidity Index score. 17 quality indicators to measure adherence to prescribing guidelines	No statistical analysis done on patient characteristics, hospital/ward/admission type, admission diagnosis, and comorbidity score to look for differences. 2/17 quality indicators showed statistically significantly less non-adherence for PA model. These were gastric protection in NSAID use in combination with corticosteroids (OR 0.42, 95% CI 0.19 to 0.90) and in use of NSAIDs in patients >70 years. No statistically significant differences were found in any other quality indicators for non-adherence to guidelines on medication prescribing. Adherence to recommendations varied across indicators but tended to be low overall	Weak. Non-randomised retrospective design. Confounders: wards not run by PAs 100% of time, team based care, practice patterns of supervisor not accounted for. PAs were ward based whereas residents had other duties
Timmermans et al, 2017[57]	Netherlands. Inpatient medical and surgical wards	Multicentre non-randomised, matched controlled study. Hospital outcomes. Wards run by PAs >51% of time during 8 am to 6 pm weekdays *v* wards run by residents, both groups supervised by physicians	Review of 2307 records of adult inpatients on participating wards.	Patient characteristics. Primary outcome: LOS. Secondary outcomes: quality and safety of care indicators: (eg, in-hospital mortality, unplanned admission to ICU, CPR, pressure ulcer development, hospital acquired infections, unplanned readmission). Patient experience	Uses same dataset as above study. Baseline characteristics of patients differed in specialty, hospital type, major diagnostic group, type of admission (elective *v* urgent), discharge destination, and ward workload (P<0.001). After adjustment for confounders (eg, patient characteristics), no statistically significant differences were found in LOS or any quality and safety of care indicators. Patient experiences of care (communication, continuity, cooperation, and medical care) were all rated as significantly higher in PA model (overall evaluation score 8.4 (SD 1.3) for PA group *v* 8.0 (1.5) for MD group; P<0.05)	Weak. Non-randomised retrospective design. Confounders: wards not run by PAs 100% of time, team based care and practice patterns of supervisor not accounted for. PAs were ward based whereas residents had other duties

CI=confidence interval; CPR=cardiopulmonary resuscitation; FY=foundation year; ICU=intensive care unit; LOS=length of stay; NSAID=non-steroidal anti-inflammatory drug; OR=odds ratio; PA=physician assistant; PGY=postgraduate year; PROM=patient reported outcome measure; SD=standard deviation.

Surgery

Seven US studies looked at the impact of using physician assistants compared with residents/fellows as first assistants in different types of low risk surgery (table 3).[44-50] The first found no difference in outcomes, but different types of assistants (physician assistants, residents, and fellows) assisted to varying degrees according to their level of ability.[44] The second compared the same experienced physician assistant with rotating orthopaedic fellows and found no difference in patients' outcomes but longer surgical times for fellows, which reduced over time until no significant difference was seen by the fourth quarter.[45] The third study additionally investigated the impact on hospital costs of using physician assistants versus residents as assistants.[46] No difference in patients' outcomes was found, but longer length of surgery involving residents incurred a "hidden" additional cost, although this was neutralised by the fact that physician assistants were more expensive to employ than residents. The fourth study found no difference in outcomes, although significantly more comorbidities were present in patients

in the resident/fellow group that were not adjusted for.[47] The fifth compared one highly trained physician assistant versus fellows as lead surgeon working with residents in harvesting lungs for transplant and measured surgical injuries to the donor lung.[48] Significantly fewer injuries occurred in lungs harvested by the physician assistant compared with fellows, as well as significantly lower rates of pulmonary graft dysfunction grades 2 and 3, and no statistically significant difference was seen in 30 day and one year graft survival rates. The sixth study found no difference in complication rates, but operative times were 10 minutes longer on average when a resident participated compared with a physician assistant, surgical fellow, or no assistant.[49] The final study found that the presence of a physician assistant, resident, or fellow had no association with length of surgery, complications, and reoperation rates.[50] We judged all these studies to be of weak quality owing to their non-randomised retrospective design that did not account for learning curves and other various different confounders, listed in table 3.

Medicine

Five US studies looked at the impact of using physician assistants compared with residents/fellows in general medicine inpatient services (table 3).[51-55] The first was a retrospective cohort study analysing 9681 hospital records of patients admitted on weekdays between January 2005 and December 2006.[51] It compared hospitalist (a board certified physician specialising in acute inpatient care)-physician assistant teams and attending-resident teams. Inpatient care provided by hospitalist-physician assistant teams was associated with a statistically significantly longer length of stay; however, when adjusted for times when both types of teams could receive admissions, this difference was no longer significant. After adjustment for confounding variables, no statistically significant difference was seen in hospital charges, readmission rates at seven, 14, and 30 days, and inpatient mortality. The second was a retrospective cohort study looking at the care of 95 patients admitted for re-induction chemotherapy for acute myeloid leukaemia between 2008 and 2012.[52] Patients were cared for by either physician assistants or house officers, both groups supervised by attending physicians. No statistically significant difference was seen in characteristics of patients admitted to either service. A statistically significantly shorter length of stay, fewer readmissions, and fewer consults per patient were seen for those in the physician assistant service, with no difference in mortality or transfers to intensive care. The third was a retrospective cohort study investigating the care of 5194 consecutive patients admitted to a general medicine service between July 2005 and June 2006.[53] It compared hospitalist-physician assistant teams and attending-resident teams. Patients admitted to the hospitalist-physician assistant service were significantly younger, had lower comorbidity scores, and were more likely to be admitted at night. After adjustment for confounders such as age, race, comorbidities, and time of admission, no statistically significant difference was seen in length of stay, inpatient mortality, transfers to intensive care, readmissions, or patient satisfaction. The fourth was a retrospective cohort study investigating the care of 5346 patients admitted to two different medical intensive care units between January 2004 and January 2007, one run by physician assistants during the day with a fellow and attending physician and the other run by residents with a fellow and an attending physician.[54] After adjustment for severity of illness, the physician assistant group had a longer length of stay in intensive care. No statistically significant difference was seen in hospital length of stay, intensive care unit mortality, hospital mortality, or readmission rates. A subsequent matched analysis using a subset of 1249 pairs of patients found no difference in any of the outcomes. The fifth was a before-and-after study between 1996 and 2000 of residents versus physician assistants working with supervising physicians in a general medicine inpatient service.[55] Whereas the resident service had access to direct supervision during normal working hours and indirect supervision out of hours, the physician assistant service had access to direct supervision from a hospitalist 24 hours a day, seven days a week. A statistically significant reduction in mortality was seen in the physician assistant service compared with the resident service. No difference was seen in adverse events, readmission rates, and patient satisfaction.

All these studies were judged to be of weak quality owing to their non-randomised retrospective design that did not account for various different confounders, listed in table 3. For example, in the first general medicine study,[51] when the multivariable analyses were restricted to the subset of hospitalists who served as attending physicians on both teams, the increase in length of stay associated with hospitalist-physician assistant teams was no longer significant, suggesting that it is the supervisor rather than the physician assistant or resident who most influences patient management. In the fourth study,[54] residents covered the physician assistant intensive care unit overnight; and in the fifth study,[55] the authors conjectured that onsite availability 24/7 of a hospitalist could have contributed to the reduction in mortality, which is in keeping with other studies showing that hospitalists improve quality of patient care.

Two multicentre studies were conducted in the Netherlands (table 3). The first analysed 2307 records of adult inpatients on participating medical and surgical wards to look for non-adherence to prescribing guidelines.[56] Wards staffed by physician assistants at least 51% of the time during normal working hours were compared with wards staffed by residents, both groups being supervised by physicians. No statistically significant differences in outcomes were found between the two groups. The second study used the same dataset to investigate quality of care.[57] The primary outcome was length of stay, and secondary outcomes consisted of 11 quality indicators (for example, in-hospital mortality, unplanned transfers to intensive care, cardiopulmonary resuscitation, pressure ulcer development after admission) and patient experience. No statistically significant differences were found in length of stay or any of the quality indicators between the two groups. Patients' experiences of care were all rated statistically significantly higher on the wards that involved physician assistants. We judged these studies to be of weak quality owing to their non-randomised retrospective design and various confounders not accounted for (see table 3).

Diagnosis/performance

Eight studies compared the diagnosis or management of physician assistants versus physicians (table 4).[58-61 63-66] Seven of these were published in the US.

Table 4 | Summary of results—diagnosis/performance

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Jiao et al, 2018[58]	USA. Ambulatory care	Retrospective cohort study. Prescribing practices. Physicians *v* NPs *v* PAs	Review of 701 499 records from two large databases of patient visits between 2006 and 2012 (96.8% of visits to physicians, 1.6% PAs, 1.6% NPs)	Patient characteristics. Patient payment source. 13 validated outpatient quality indicators for prescribing	Patient characteristics statistically significantly differed in all variables by clinician group (P<0.001). For example, physicians were more likely to see older, privately paying patients and PAs provided more care in outpatients and in emergency department. Overall mean performance across all indicators was 58.7%. After adjustment for potentially confounding patient, provider, and visit characteristics, no statistically significant differences were found in quality of prescribing practices between physicians and non-physicians (NPs and PAs) for 10/13 quality standards evaluated. Both NPs and PAs met quality standard of antithrombotic therapy for atrial fibrillation more often than physicians (OR 1.76, 95% CI 1.16 to 2.67) but were less likely to meet quality standards for treating depression (OR 0.75, 0.61 to 0.93) and antibiotic use in otitis media (0.41, 0.24 to 0.70)	Weak. Non-randomised retrospective design. Confounders: patient characteristics significantly differed by clinician type, diagnosis assumed to be correct

Table 4 | Summary of results—diagnosis/performance *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Ellenbogen and Segal, 2020[59]	USA. Primary care, urgent care, hospital discharges	Retrospective cohort study. Opioid prescribing. Physicians *v* NPs *v* PAs	All generalist physicians, NPs, and PAs who provided more than 10 Medicare Part D prescription claims between 2013 and 2016 (n=36 999)	Practice setting. Provider gender, years in practice. Practice setting and median income of ZIP code. Total prescription claims. Opioid claims as proportion of all prescription claims	Distributions of total opioid claims for all groups were extremely right skewed but clustered around zero (ie, relatively small No of practitioners were responsible for large proportion of prescriptions). Adjusted total number of opioid claims across study period was 660 (95% CI 660 to 661) for physicians, 755 (753 to 757) for NPs, and 812 (811 to 814) for PAs. NPs and PAs made up disproportionately high number of prescribers with highest 5% of opioid prescription proportions. PAs made up 43% of this group and 12% of entire study sample. NPs made up 32% of this group and 22% of study sample. Physicians made up 24% of this group and 66% of study sample. Significantly more data were withheld from public release for low prescription counts for NPs and PAs than for physicians. Percentage of physicians in year with withheld data ranged from 13.1% in 2015 to 14.1% in 2013. For NPs, it ranged from 20.0% in 2016 to 23.7% in 2014. For PAs, it ranged from 23.4% in 2015 to 25.2% in 2014	Weak. Non-randomised retrospective design. Confounders: differences in percentages of withheld data between groups, differences in practice patterns, some states place restrictions on opioid prescribing by non-physicians

Table 4 | Summary of results—diagnosis/performance *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Lozada et al, 2020[60]	USA. Primary care	Retrospective, cohort study. Opioid prescribing. Physicians *v* NPs *v* PAs	Review of 222 689 Medicare Part D prescriptions (20% sample of all 2015 prescriptions in primary care)	Patient characteristics. State. Among providers who issued ≥50 prescriptions, identification of potential opioid overprescribing, as defined by one of: opioid prescribed to >50% of patients (high frequency); prescribed ≥100 morphine milligram equivalents (MME)/day to >10% of patients (high dose); prescribed opioid for >90 days to >20% of patients (long term)	3.8% of physicians, 8.0% of NPs, and 9.8% of PAs overprescribed opioids. Most NPs and PAs prescribed opioids in pattern similar to physicians, but NPs and PAs had more outliers who prescribed high frequency, high dose opioids, after adjustment for patient comorbidity in multivariable analyses. Odds ratios were as follows: 2.96 (95% CI 2.78 to 3.15) for NPs, 5.73 (5.35 to 6.13) for PAs for high frequency opioids compared with physicians; 1.66 (1.52 to 1.80) for NPs, 2.16 (1.97 to 2.38) for PAs for high dose opioids compared with physicians. NPs and PAs were less likely than physicians to prescribe long term opioids: OR 0.57 (95% CI 0.53 to 0.61) for NPs, 0.71 (0.65 to 0.77) for PAs. NPs and PAs who practised in states with independent prescription authority were around 28 times more likely to overprescribe opioids than those in states that restricted authority	Weak. Non-randomised retrospective design. Confounders: palliative care patients not analysed separately, only 20% of claims analysed
Satyaprakash et al, 2007[61]	USA. Ambulatory care	Retrospective cohort study. Prescribing practices. Dermatologists *v* dermatology PA *v* primary care physician *v* primary care PAs *v* other physician	Review of 301 million records of outpatient visits from National Ambulatory Medical Care Survey between 1995 and 2004	Patient age, sex, and race/ethnicity. Prescribing rates of clotrimazole-betamethasone in different clinician groups, PAs with and without direct supervision by physician.	In multivariate logistic regression analyses, rates of prescribing clotrimazole-betamethasone, by clinician: PAs in primary care 16.9%; PAs in primary care with direct supervision 8.3%; primary care physician 4.9%; dermatology PAs 3.8%; dermatology PAs with direct supervision 1.1%; dermatologists 0.2%; other physicians 1.7%. Clotrimazole-betamethasone was more likely to be prescribed at visits to PAs (regardless of specialty) when PA was sole provider of dermatological care *v* when the physician assistant was under direct supervision by physician (OR 4.3 (95% CI 0.7 to 25.6) *v* 1.8 (0.4 to 8.0)	Moderate. Non-randomised retrospective design. Unclear whether patient characteristics were statistically significantly different between groups (but vast database)

Table 4 | Summary of results—diagnosis/performance *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Fejleh et al 2020[63]	USA. Veterans' Affairs medical centre	Retrospective cohort study. Screening colonoscopy outcomes. PAs *v* fellows *v* gastroenterologists	Retrospective review of 597 records of patients undergoing average risk screening colonoscopies between July 2015 and June 2016	Patient characteristics. Endoscopist experience level. Colonoscopy data (eg, caecal intubation, time to intubation). Adenoma detection rates	Study involved 5 PAs and 7 gastroenterologists (No of fellows unknown). No statistically significant differences in patient age, sex, and race/ethnicity between groups. PAs performed better than gastroenterology fellows with regard to mean intubation time (7.8 *v* 13.2 min; P<0.001) and had shorter mean withdrawal time (9.6 *v* 11.5 min; no P value given). No significant difference was found between mean intubation time of PAs and all attending gastroenterologists (7.8 *v* 8.8 min; P=0.25). PAs with ≥15 years' experience had shorter mean intubation times than 2 attending gastroenterologists with similar experience (15.6 *v* 7.5 min; P=0.002). PAs had higher caecal intubation rates than attending gastroenterologists (98.8% *v* 94.8%; P=0.04), but no difference was found when PAs were compared with fellows. PAs achieved average adenoma detection rate of 46.7%, which was comparable to both gastroenterologists (adenoma detection rate of 43.5%; P=0.59) and fellows (44.2%; P=0.89)	Weak. Non-randomised retrospective design. Confounders: no information on how patients were prospectively allocated to different clinician groups, poor bowel preparation excluded from analysis, gastroenterology fellows could be assisted by gastroenterologist, only 200 cases with no biopsy taken were analysed for withdrawal time

Table 4 | Summary of results—diagnosis/performance *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Anderson et al, 2018[64]	USA. Dermatology	Retrospective cohort study. Dermatology PAs *v* dermatologists	Review of 20 270 records of patients attending for skin screening over 5 years between 2011 and 2015	Patient characteristics. Number needed to biopsy to diagnose skin cancer	No difference in patient characteristics, except patients with history of melanoma were more likely to see dermatologist, whereas those with history of any type of skin cancer were more likely to see PA (P<0.001 for both). PAs did more biopsies overall (22.9% of visits *v* 20.8% for dermatologists; P<0.001) and of pigmented lesions (12.9% of visits *v* 11.1% for dermatologists; P<0.001). To diagnose 1 case of skin cancer, NNB was 3.9 for PAs and 3.3 for dermatologists (P<0.001). Per diagnosed melanoma, NNB was 39.4 for PAs and 25.4 for dermatologists (P=0.007). Patients screened by PA were significantly less likely than those screened by dermatologist to receive diagnosis of melanoma in situ (0.2% *v* 0.4% of visits; P=0.04), but differences were not significant for invasive melanoma (0.2% *v* 0.2% of visits; P>0.99) or non-melanoma skin cancer (6.1% *v* 6.1% of visit; P=0.98)	Weak. Non-randomised retrospective design. No strategy used to deal with statistically significant differences in patient characteristics

Table 4 | Summary of results—diagnosis/performance *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Brock et al, 2016[65]	USA. All settings	Retrospective cohort study. Physicians *v* NPs *v* PAs	Review of 178 035 malpractice claims in 10 year period from National Practitioner Data Bank	No of claims by clinician group. Type of claim by clinician group	Data included 104 482 unique providers: 94.8% (n=99 070) physicians, 2.9% (n=3064) PAs, and 2.2% (n=2256) NPs. Physicians had significantly more malpractice reports than adverse event reports (63.0% *v* 37.0%; P<0.001), but this relation was reversed for PAs, who had significantly fewer total malpractice reports than adverse event reports (28.1% *v* 71.9%; P<0.001). Across 10 year period, highest rate of malpractice reports for physicians was in 2005 (19.0 per 1000) and lowest in 2014 (11.2 per 1000). For PAs, highest rate of malpractice was 2.4 per 1000 in 2011 and lowest was 1.4 per 1000 in 2007. Most common groupings when aggregating provider groups were diagnosis related (32.2%), surgery related (26.0%), and treatment related (19.8%). PAs and NPs were significantly more likely to have diagnosis related and treatment related malpractice allegations than were physicians (each P<0.001)	Weak. Retrospective study. Confounders: not all malpractice/ adverse events are reported or claimed for; plaintiff may hold physician, as supervisor, accountable for actions of his or her employees

Table 4 | Summary of results—diagnosis/performance *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
de Lusignan et al, 2016[66]	UK. General practice	Comparative observational study. PAs *v* GPs	Review of video recordings of 62 consultations (41 GP consultations and 21 PA consultations)	Patient characteristics. Number of presenting complaints. Nature of presenting complaint(s). No of relevant chronic conditions. Quality of consultation across 6 domains using Leicester Assessment Package. Inter-rater reliability	12 GP practices were recruited, 6 with PAs and 6 without. Five GPs and 4 PAs participated. Adult patients attending for same day appointments were informed of study as they arrived and consent obtained. Assessors were experienced GPs blinded to role of clinician performing consultation. 54% of consultations were for minor symptoms/conditions. Statistically significant differences were found in presenting complaints, with GP patients having more presenting complaints per consultation (P=0.01) and more likely to have presenting complaint related to chronic condition (P=0.01) compared with PA patients. No of chronic conditions was not related to seeing GP or PA Of rating of A-E (A being best and E being worst), average global score was C (range A-D) with no PA being given overall A for any consultation. GPs were rated more highly than PAs for all elements of consultation. In terms of median scores, this was statistically significantly higher for patient management and problem solving domains (P<0.001). Assessors were able to correctly identify GP consultations but failed to correctly identify 2/4 of PAs'. Leicester Assessment Package had limited inter-rater reliability (κ=0.602, 95% CI 0.428 to 0.777) and did not contain "complexity of consultation" rating	Weak. Prospective design but small numbers. Confounders: volunteer participants, differences in patient characteristics between groups, limited inter-rater reliability of Leicester Assessment Package, unknown whether patients were triaged to PA care *v* GP care

CI=confidence interval; GP=general practitioner; NNB=number needed to biopsy; NP=nurse practitioner; OR=odds ratio; PA=physician assistant.

Prescribing

Four studies investigated prescribing practices (table 4).[58-61] The first used national databases to analyse the prescribing quality of physician assistants, nurse practitioners, and physicians in outpatients/ambulatory care between 2006 and 2012.[58] Overall mean performance across all indicators was 58.7%. Statistically significant differences were found in three of 13 quality indicators (see table 4). The second study used a large national database to investigate differences in opioid prescribing between physician assistants, nurse practitioners, and generalist physicians between 2013 and 2016.[59] It found that physician assistants and nurse practitioners made up a disproportionately high number of the prescribers after adjustment for potential confounders, such as practice setting. The third study investigated opioid overprescribing in primary care and found that most nurse practitioners and physician assistants prescribed opioids in a pattern similar to that of physicians, but the

nurse practitioner and physician assistant groups had more outliers who prescribed high frequency, high dose opioids than did physicians.[60] The fourth study used clotrimazole-betamethasone prescribing as a surrogate of quality of dermatology care, using a database of 301 million outpatient visits for common inflammatory or fungal skin conditions.[61] Most visits were to primary care physicians (44.7%) and dermatologists (38.8%). A physician assistant was the sole provider for 0.9% of visits. Each visit was analysed according to whether a physician, physician assistant, or both were involved in the visit. Direct supervision was defined as a visit in which patients were seen by both a physician assistant and a physician. In multivariate logistic regression analyses, prescription rates were as follows: physician assistants in primary care without direct supervision 16.9%, physician assistants in primary care with direct supervision 8.3%, primary care physicians 4.9%, dermatology physician assistants without direct supervision 3.8%, dermatology physician assistants with direct supervision 1.1%, dermatologists 0.2%, and other physicians 1.7%.

We judged the first three studies to be of weak quality owing to their non-randomised retrospective design and various confounders not accounted for (see table 4).[58-60] The fourth study assumed that dermatologists provided gold standard care,[61] as clotrimazole-betamethasone overuse by primary care physicians has been observed and may represent clinical uncertainty or unfamiliarity with studies examining the therapeutic efficacy of combination versus monotherapy agents.[62] The study included multivariate logistic regression analyses to deal with potential confounders; although whether statistically significant differences in patients' characteristics existed between groups is unknown, the database was vast, and it is unique in measuring the effect of direct supervision.

Procedures

One study analysed 597 consecutive patients undergoing routine, average risk screening colonoscopy at a single centre between July 2015 and June 2016 (table 4).[63] It compared performance of physician assistants, gastroenterology fellows, and gastroenterologists. Physician assistants performed better than fellows in mean intubation time and had higher caecal intubation rates than did gastroenterologists (98.8% *v* 94.8%; P=0.04). Adenoma detection rates were similar in all groups. Physician assistants with at least 15 years' experience had shorter mean intubation times than did the two attending gastroenterologists with similar experience (15.6 *v* 7.5 min; P=0.002). The authors speculated that this could be because the physician assistants kept more up to date with latest endoscopic techniques. We judged this study to be of weak quality owing to its non-randomised retrospective design and no information on how patients were prospectively triaged to different clinicians. Patients found to have poor bowel preparation were excluded from the retrospective analysis.

Patient management

Three studies investigated patient management by physician assistants versus physicians.[64-66] The first was a US study published in 2018 that investigated the accuracy of skin cancer diagnosis by physician assistants versus dermatologists.[64] It analysed 33 647 cancer screening records and found that the number needed to biopsy to diagnose one skin cancer was statistically significantly higher for physician assistants compared with dermatologists. Screenings performed by dermatologists were also more likely to result in a diagnosis of melanoma in situ, but no difference was seen between physician assistants and dermatologists in diagnosing invasive melanomas and other skin cancers, which tend to be more obvious. We judged this study to be of weak quality for its non-randomised retrospective design and not accounting for differences in patient's characteristics (see table 4). The second was a US study published in 2016 that analysed 178 035 malpractice claims during a 10 year period.[65] It found that physicians had higher rates of malpractice claims (range 11.2-19 per 1000 clinicians) than did physician assistants (range 1.4-2.4 per 1000 clinicians). The three most common claims for all groups were diagnosis related (32.2%), surgery related (26.0%), and treatment related (19.8%). Physician assistants were significantly more likely to have diagnosis related and treatment related malpractice allegations than were physicians (P<0.001). We judged this study to be of weak quality because of potential confounders—not all malpractice and adverse events are reported or claims made; and in the US, a plaintiff may hold the physician, as a supervisor, accountable for the actions of his or her employees.

One UK study, published in 2016, compared the performance of physician assistants and general practitioners by using video recordings of 62 primary care consultations in volunteer practices in England.[66] Five general practitioners and four physician assistants participated. The consultations involved adults presenting for same day/urgent appointments. Quality of consultations was assessed by experienced general practitioners masked to the role of the clinician, using the Leicester Assessment Package. Statistically significant differences were found in the number and nature of presenting complaints in each group (see table 4). General practitioners performed better in all domains of the consultation than did physician assistants and were statistically significantly better at problem solving and patient management. No consultation was deemed unacceptable. We judged this study to be of weak quality because of several limitations, including a small number of volunteer participants, differences in patients' characteristics between the groups, and the low the inter-rater reliability of the Leicester Assessment Package (κ=0.602, 95% confidence interval 0.428 to 0.777).

Patient satisfaction

Three studies focused on patient satisfaction, comparing physician assistants and physicians (table 5).[67-69] Of these, two were from the US and one was from the Netherlands. The first,[67] published in 2005, analysed 146 880 randomly sampled completed surveys by Medicare beneficiaries in the US between 2000 and 2001. It found that patients were generally satisfied with their care and no difference were apparent between physician assistants, nurse practitioners, and physicians. This study was limited by the low percentage of respondents (2.8%) who identified a physician assistant or nurse practitioner as their primary provider, which was lower than expected and could be explained by the fact that many physician assistants and nurse practitioners work in physicians' offices as part of a healthcare team. The second study analysed 12 386 surveys completed after dermatology outpatient visits at one US institution between April 2019 and December 2021.[68] It found that patient satisfaction was consistently high for physician assistants, residents, and dermatologists throughout the study period. No statistically significant differences were observed between dermatologists and physician assistants. Scores were statistically significantly lower for residents, but the effect size was small (Cohen's d=0.29). The third study surveyed patients who had received care from either a general practitioner or a physician assistant out of hours in primary care in the Netherlands between July and August 2014.[69] A total of 214 patients completed the survey (27% response rate). Patients were highly satisfied with their care and seemed to be just as satisfied with care they received from

physician assistants as from general practitioners. We judged all these studies to be of weak quality owing to their unknown or low response rates and potential confounders such as non-responder bias or patients being unable to identify their provider as a physician assistant.

Table 5 | Summary of results—patient satisfaction

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Hooker et al, 2005[67]	USA. Primary care	Questionnaire survey. Older patients' satisfaction. Physicians *v* NPs *v* PAs	Review of 146 880 completed surveys that met inclusion criteria from 321 407 randomly selected records	Patient characteristics. Patient payment source. Self-reported health. Patient satisfaction measures: attention, communication/responsiveness, respect of values/thoughts, overall rating	2.8% (n=3770) of respondents identified PA or NP as their personal provider. Patient age groups were evenly distributed across providers. Statistically significant differences were seen in patient payment source between groups, with NPs and PAs more likely to see Medicaid enrolees (16.5% NPs *v* 14.1% PAs *v* 9% physicians; P<0.001) and physicians more likely to see patients with supplemental health insurance (72.3% NPs *v* 76.8% PAs *v* 85.6% physicians; P<0.001). After applying multivariate analyses of covariance, no statistically significant difference was found for 4 satisfaction measure questions between providers	Weak. Response rate unknown. Confounders: non-responder bias; people who were unsatisfied with one provider may have moved to another leaving satisfied patients behind
Griffith et al, 2023[68]	USA. Academic dermatology centre	Questionnaire survey. PAs *v* residents *v* dermatologists	Review of routinely collected patient satisfaction surveys following 12 386 outpatient visits. Dermatologists *v* residents *v* PAs	Patient satisfaction measures: timeliness, patient centredness, time spent with patient, likelihood of recommending care provider	No data on patient characteristics. No of questionnaires: dermatologists 8988, residents 892, PAs 2479. Mean scores for each item for all 3 groups was high (all answers scoring >4.5/5.0). Scores were slightly lower for residents and reached statistically significant difference (P<0.01), but effect size was very small—eg, mean scores for satisfaction with time spent with patient were 4.76 for residents *v* 4.90 for PAs (95% CI for difference −0.17 to −0.1; Cohen's d=0.29)	Weak. Response rate unknown. Confounders: non-responder bias.

Table 5 | Summary of results—patient satisfaction *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Meijer and Kuilman, 2017[69]	Netherlands. Primary care (out of hours)	Questionnaire survey. PAs *v* GPs	202 patients who had home visit out of hours and completed validated Consumer Quality Index questionnaire	Patient characteristics. Patient satisfaction measures: questions made up 3 composite subscales: approach, professional practice, and customised care plus overall satisfaction	800 questionnaires were posted, evenly distributed to patients who had seen GP or PA. 24.8% (n=99) of patients seen by GPs and 28.8% (n=115) of those seen by PAs responded. No statistically significant difference in patient characteristics by provider type. No statistically significant difference in patient satisfaction with care provided by GP *v* PA for items and composite scores in professional practice and approach scales. However, two items in customised care scale, as well as related scale score, showed statistically significant difference between provider types, favouring PAs	Weak. Low response rate. Confounders: non-responder bias; owing to urgency of call, patients may not be aware which type of provider they saw

CI=confidence interval; GP=general practitioner; NP=nurse practitioner; PA=physician assistant.

Cost effectiveness

Four studies looked at cost effectiveness (table 6).[70 -73] Of these, three studies were conducted in the US and one in the Netherlands. The first used US Veterans' Affairs data between 2012 and 2013 to analyse the records of 47 236 patients with medically complex diabetes.[70] Case mix adjusted total care costs were 7% lower for patients of physician assistants, driven by less use of pharmacy and outpatient services by physician assistants than by physicians. Although the study adjusted for differences in the case mix of patients assigned to different provider types, unmeasured confounders not adjusted for included team based care and the smaller average caseload of physician assistants compared with physicians, which could allow them more time for patient care activities. The second study,[71] published in 2020, analysed the potential economic impact of using physician assistants to provide routine postoperative care instead of surgeons, on the basis of data provided by 16 physician assistants and six surgeons. Owing to their lower salaries, physician assistants were less expensive than surgeons in providing routine postoperative care and could potentially save surgeons time that they could use for other activities. The third study,[72] published in 2020, compared healthcare utilisation and costs among patients with diabetes cared for by physician assistants, nurse practitioners, and physicians as their primary providers. It used the same Veterans' Affairs database as the second study in this category,[70] but it analysed 368 481 records of patients with diabetes. Its findings and limitations were similar—case mix adjusted total care costs were 6% lower for patients seen be physician assistants, driven by lower inpatient, outpatient, and pharmacy costs. We judged all these studies to be of weak quality owing to their retrospective design, various confounders not accounted for (see table 6), and focus on costs rather than cost effectiveness.

Table 6 | Summary of results—cost effectiveness

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Morgan et al, 2019[70]	USA. Primary care (Veterans' Healthcare Administration)	Retrospective cohort study. Utilisation and costs of care. Physicians *v* NPs *v* PAs as primary provider	Review of 47 236 records of medically complex patients with diabetes	Patient characteristics. Patient payment source. Diagnoses. Healthcare utilisation. Costs of care	Primary provider was physician for 78.1% (n=36 894) of patients, NP for 16% (n=7536), and PA for 6% (n=2806). Patients saw their identified provider in 70.6% of visits. Differences seen in patient characteristics between groups (eg, physicians saw more black, Asian, and Hispanic patients). 65% of physician patients were in facilities with endocrinology referral capacities, compared with 58% for PAs and 52% for NPs. Similar patient payment source between groups. In terms of diagnostic score group and comorbidities, patients were similar between groups	Weak. Non-randomised retrospective design. Confounders: team based care and average practice (panel) size being higher for physicians compared with PAs not accounted for. Quality of care not assessed
					After adjustment for differences in case mix, patients of PAs were less likely to incur hospital admissions than those of physicians (OR 0.92, 95% CI 0.846 to 0.997). Most inpatient admissions were related to ambulatory care sensitive conditions. Patients of PAs also visited ED less frequently in year than patients of PAs (PAs *v* physicians rate ratio: 0.94, 95% CI 0.88 to 0.99). However, when adjusted for patient characteristics, inpatient costs were not statistically significantly different between physicians and PAs. Pharmacy and outpatient costs were statistically significantly lower for PAs *v* physicians: 9% (95% CI 4% to 13%) lower (P<0.001) for pharmacy and 5% (1% to 9%) lower for outpatients (P<0.05). Total costs were therefore lower for PAs *v* physicians by 7% per year ($2300)	

Table 6 | Summary of results—cost effectiveness *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Horak et al, 2020[71]	USA. Orthopaedic clinics (Veterans' Healthcare Administration)	Questionnaire survey then economic modelling. Postoperative care, PA *v* surgeon	Questionnaire of 22 clinicians followed by economic modelling	Top 5 procedures performed annually. Mean No of postoperative encounters. Mean length of postoperative visit. Annual cost of postoperative care based on PA *v* surgeon salaries	Questionnaires sent to 44 surgeons and 44 PAs. 25% response rate (6 surgeons and 16 PAs). Using information from survey on procedures, mean No of postoperative encounters, and mean length of postoperative visits, clinical team was found to spend 443.3 h/year on postoperative care. Using salaries of surgeons *v* PAs, surgeon:PA expense ratio was 5.1:1 or $122 797 per year for surgeon *v* $23 871 per year for PA, leading to more revenue generated per procedure owing to lower costs	Weak. Non-randomised retrospective design. Confounders: quality of care not assessed.
Smith et al, 2020[72]	USA. Adult diabetes care (Veterans' Healthcare Administration)	Retrospective cohort study. Utilisation and costs. NPs *v* PAs *v* physicians	Review of 368 481 records of patients with diabetes for year 2013 attending 568 Veterans' Administration facilities	Patient characteristics. Social complexity measures. Body mass index. Global health status. Utilisation outcomes: hospital admission, ED visits, primary care visits, endocrinology outpatient visits, non-endocrinology outpatient visits. Total healthcare costs	Primary provider was physician for 74.9% (n=276 009) of patients, NP for 18.2% (n=67 120), and PA for 6.9% (n=25 352). Differences seen in patient characteristics between groups (eg, physicians saw more black, Asian, and Hispanic patients). 55.2% of physician patients were in facilities with endocrinology referral capacities, compared with 43.8% for PAs and 41.4% for NPs. Similar patient payment source between groups. In terms of diagnostic score group and comorbidities, patients were similar between groups After adjustment for differences in case mix, patients of PAs were less likely to incur hospital admissions (OR 0.92, 95% CI 0.87 to 0.97) and visit ED (mean of 0.59 *v* 0.67 visits per year for physicians). No clinically meaningful differences were observed for No of primary care visits or endocrinology or non-endocrinology specialty visits per year. PA patients incurred lower inpatient, outpatient, pharmacy, and total costs compared with physicians, overall incurring 6% (95% CI 3% to 9%) lower cost per year, equating to $696 per year	Weak. Non-randomised retrospective design. Confounders: team based care and average practice (panel) size being higher for physicians than PAs not accounted for. Quality of care not assessed

Table 6 | Summary of results—cost effectiveness *(Continued)*

Author, year	Country and setting	Study design and comparators	Data analysed	Measures	Results	Quality assessment
Timmermans et al, 2017[73]	Netherlands. Inpatient medical and surgical wards	Multicentre non-randomised, matched controlled study. Cost effectiveness. Wards run by PAs >51% of time during 8 am to 6 pm weekdays *v* wards run by residents, both groups supervised by physicians	Review of 2292 records of adult inpatients on participating wards	Patient characteristics. Patient QALY (generic measure of disease burden). Costs of admission and within 1 month of discharge. Personnel costs	Baseline characteristics of patients differed in specialty, hospital type, major diagnostic group, type of admission (elective *v* urgent), and discharge destination (P<0.001). No statistically significant difference in QALY between groups (0.02, 95% CI −0.01 to 0.05). When adjusted for medical specialty, hospital type, diagnosis, comorbidities, type of admission, and discharge destination, mean total costs per patient did not differ significantly between groups: mean difference €568 (95% CI −€254 to €1391; P=0.17) In sub-analyses: costs for length of stay were on average €465 (95% CI $10 to $920) per patient lower in physician model than in PA model (P=0.04). Personnel costs were lower for PA group (mean difference −€11 (95% CI −€16 to −€6) per patient (P<0.01), but this was offset by increased supervision costs for physicians (€43 (95% CI €39 to €47) per patient; P<0.01). When 4 wards staffed only by medical specialists were removed from analysis, supervision costs were significantly lower for PA wards (mean difference −€11 (95% CI −€16 to −€6; P<0.01). Significant differences in costs for blood products and required home care were higher in PA model (P<0.01)	Weak. Retrospective design. Confounders: 76% response rate to questionnaire sent to patients after discharge, wards not run by PAs 100% of time, team based care and practice patterns of supervisors not accounted for

CI=confidence interval; ED=emergency department; GP=general practitioner; NP=nurse practitioner; OR=odds ratio; PA=physician assistant; QALY=quality adjusted life years.

One study,[73] using the same dataset as two previous studies from the Netherlands,[56 57] measured costs and patients' quality of life scores. After adjustment for differences in medical specialty, hospital type, diagnosis, comorbidities, type of admission, and discharge destination, it found that the mean total costs per patient and quality of life measures did not differ significantly between the two groups. We judged this study to be of weak quality owing to its retrospective design and various confounders; for example, the comparison was wards staffed by physician assistants at least 51% of the time during normal working hours working with residents versus wards staffed by residents, with both groups being supervised by physicians.

Discussion

The review question was: "What is the impact of physician assistants on quality of care compared with physicians?" We compared care delivered by physician assistants with care delivered by physicians, including residents, in economically developed countries, using the Institute of Medicine's definition of quality in healthcare.[29] The review found mainly retrospective observational studies of weak quality that varied as to whether statistical adjustments were made for confounders, as well as the statistics used to present findings. The results of studies were also spread across a range of different outcomes and settings, which makes synthesis difficult. The weak

nature of the evidence is an important finding in itself. The findings are discussed below in light of this limited evidence.

Safe

"Safe" is defined as avoiding harm to patients from the care that is intended to help them.[29] The greatest number of studies with the most consistent results in this review were those which found that physician assistants practised safely when working under direct supervision and in post-diagnostic care.[33-35 44-57 63] This is consistent with past studies which have found that physician assistants perform competently within the framework of their delegated responsibilities.[74]

None of the studies in the review was designed to measure harm. This is difficult to do, especially in primary care where a significant proportion of consultations are for minor ailments and the number of physician assistants in the UK is relatively small.[75] Evidence of harm is more likely to be found in organisational safety reporting systems or by hand searching coroners' reports and litigation records. The most common approaches for measuring harm include reporting by staff, analysis of existing databases, reviewing patient records manually or using automation, and asking professionals or patients to recall errors.[76] These methods are potentially biased and time consuming, and numbers need to be large to look for relatively rare events such as death.

Most studies in this review involved retrospective review of patient records, which has limitations. For example, of the four studies comparing physician assistant versus physician performance in the UK, three consisted of retrospective record reviews and used outcomes such as unplanned re-attendance to the same provider as surrogates for safety.[37 42 43] This is unreliable, as UK patients may return to another provider if they had a problem with the first one, especially in urban areas with multiple providers. Retrospective record reviews may be limited in detecting diagnostic error, the most common and most dangerous of medical mistakes.[77] If the documented diagnosis is wrong but the treatment is appropriate to the wrong diagnosis, then potential patient harm due to a wrong diagnosis will not be detected. This is also a limitation of indirect supervision.

UK general practitioners performed better in all domains of the consultation compared with physician assistants but were significantly better at problem solving and patient management.[66] Physician assistants were significantly more likely to have diagnosis related and treatment related malpractice allegations than physicians.[65] One systematic review of the impact of physician assistants in the emergency department found that physician assistants were rated highly by their colleagues in patient education, history taking, and physical examination but lower in diagnosis and management. The willingness of physicians to be treated by a physician assistant decreased as the severity of the clinical scenario increased (44.3% falling to 0.8%),[78] implying that physicians did not feel safe being treated by a physician assistant when the scenario was deemed to be outside the scope of their training.[78]

Effective

"Effective" is defined as providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit.[29] Physician assistants have been found to compare favourably with physicians in post-diagnostic care outcomes—for example, in studies of diabetes[33-35]—and in general medical inpatient care when compared with residents.[51-57] Physician assistants were also more likely to provide smoking cessation advice and health education.[36 37]

Evidence from studies measuring processes of care in undifferentiated (not yet diagnosed) settings is limited. These studies had mixed results and did not assess the appropriateness of investigations and treatments.[38 39 42 58-60] The clotrimoxazole-betamethasone prescribing study showed that physician assistants were more likely than physicians to prescribe this drug ineffectively, although safely.[61]

Patient centred

"Patient centred" is defined as providing care that is respectful of and responsive to individual patients' preferences, needs, and values and ensuring that patients' values guide all clinical decisions.[29] This review found that patients' satisfaction, pertaining to communication (attention, information sharing, customised care, and respect) and time spent with the patient was consistently high, and no difference was apparent between physician assistants and physicians, although patients may not always know they are seeing a physician assistant rather than a physician.[42 69]

Timely

"Timely" is defined as reducing waits and sometimes harmful delays for both people who receive care and those who give care.[29] Studies in emergency departments that focused on commonly used patient flow indicators had mixed results.[38-40 42 43] However, several studies have shown that adding physician assistants to medical teams increases access to care. This has been found in settings as varied as emergency medicine,[79] surgery,[80] outpatient clinics,[81] and nursing homes.[82] For example, a study investigating the impact of regular visits by a physician assistant specialising in geriatric medicine reduced the number of annual hospital visits by 38%.[83] Although adding physician assistants to medical teams seems to increase access to care, this may reflect the benefits of increased staffing rather than the unique contribution of the physician assistant role.

Efficient

"Efficient" is defined as avoiding waste (for example, unnecessary tests and referrals) and also includes cost effectiveness.[29] A previous study found that both physician assistants and nurse practitioners were statistically significantly more likely to refer unnecessarily than were physicians[84]; however, none of the studies in this review was designed to assess waste, apart from one study which found that physician assistants did statistically significantly more biopsies than dermatologists to diagnose skin cancer.[64] In this review, three of the four studies assessing cost effectiveness were from the US.[70-72] They analysed costs, not necessarily cost effectiveness. Caution is needed in applying evidence from a very different healthcare system with higher costs, lower efficiency, and worse outcomes compared with the UK.[85] In the single study from the Netherlands,[73] total hospital costs and measures of patients' quality of life did not differ between physician assistant-physician care and resident-physician care. Physician assistants, however, are cheaper to train than residents.

Equitable

"Equitable" is defined as providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographical location, and socioeconomic status.[29] Physician assistants in UK are more likely to be found working in under-resourced areas.[21 86] This review also found that patients are more likely to see a physician assistant if they live in a socioeconomically deprived area in the UK.[37] Although the physician assistant role increases patients' access to care, the distribution of

physician assistants risks maintaining or establishing new inequities in healthcare.

Strengths and limitations of review

The strengths of this review are that it explores the available evidence across all domains of quality in healthcare, and its findings are directly relevant to the debate on regulation and deployment of physician assistants in the UK. The review was conducted according to Cochrane rapid review guidance, with systematic search strategies, dual screening, and risk of bias assessments. The limitations are that we found only four UK studies that were relevant to the review question. The vast majority of included studies were of weak quality and retrospectively analysed routinely collected data, not always using strategies to deal with confounding factors. Nearly all studies were from the US, and we found no data from a post-covid-19 context. However, the weak nature of the evidence is an important finding and establishes the need for further research.

Implications for clinicians and policy makers

Many arguments for introducing physician assistants into the NHS hinged on the assumption that physician assistants could be indirectly supervised by a named clinician (for example, in primary care), thereby increasing the efficiency of a service. However, the evidence does not support the safety or effectiveness of indirect supervision of physician assistants in undifferentiated (not yet diagnosed) settings. Rather, studies show that physician assistants perform safely and effectively under direct supervision, working in post-diagnostic care, or doing procedures for which they are highly trained, working as part of a medical team. The inability of UK physician assistants to prescribe or request ionising radiation limits the transferability of these findings. Reports in the UK that physician assistants are seeing undifferentiated patients without adequate supervision, acting as senior decision makers, and supervising residents have caused concern.[87 -91] National guidance on the supervision and scope of practice for physician assistants can ensure that they practice safely and effectively.

Unanswered questions and future research

Very few well designed studies on the impact of physician assistants on the domains of quality of healthcare have been conducted in the UK. Future research could attempt to answer the questions in box 2 in the UK context.

Box 2: Future research question

- In what scopes of practice do physician assistants perform most safely and effectively?
- What is the impact of direct supervision versus indirect supervision of physician assistants on patient diagnosis and management outcomes?
- What is the impact of physician assistants on resident training?
- How best could physician assistants be deployed in a way that positively affects resident training and patient care?
- What is the impact (in terms of cognitive load, clinical efficiency, and wellbeing) on physicians of supervising physician assistants?
- What are public perceptions of the physician assistant role?
- What is the impact of physician assistant patterns of employment on equity of access to physician care?
- In what defined settings or scope are physician assistants cost effective?

Conclusions

The evidence to inform how physician assistants should be deployed effectively and safely in the UK is limited. However, the findings from this review are consistent with previous studies and can inform UK practice. A legitimate role exists for physician assistants working alongside physicians in well defined roles under supervision. However, indirect or unsupervised management by physician assistants of undifferentiated symptoms and disease may risk patients' safety.

What is already known on this topic

- Physician assistants (PAs) were introduced in the US in response to medical shortages in certain specialities and regions
- The first PAs graduated from UK pilot programmes in 2007
- Concerns have been raised about the implementation of the PA role in the UK, particularly as "doctor substitutes"

What this study adds

- The greatest number of studies with the most consistent results were those that found PAs to practise safely and effectively when working under direct supervision and in post-diagnostic care
- The evidence is limited and does not support the safety or effectiveness of indirect supervision of PAs in undifferentiated (not yet diagnosed) settings

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Web appendix: Supplementary materials