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## Comparing physician associates and foundation year two doctors in training undertaking emergency medicine consultations in England: a mixed methods study of processes and outcomes

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Comparing physician associates and foundation year two doctors in training undertaking emergency medicine consultations in England: a mixed methods study of processes and outcomes

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Comparing physician associates and foundation year two doctors in training undertaking emergency medicine consultations in England: a mixed methods study of processes and outcomes

## ABSTRACT

#### Objectives

To compare the contribution of physician associates to the processes and outcomes of emergency medicine consultations to that of foundation year two doctors-in-training.

#### Design

Mixed methods study: retrospective chart review using four months' anonymised clinical record data of all patients seen by physician associates or foundation year two doctors-in-training in 2016; review of a sub sample of 40 records for clinical adequacy; semi-structured interviews with staff and patients; observations of physician associates.

#### Setting

Three emergency departments in England

#### **Participants**

The records of 3197 patients attended by six physician associates (n=1129) and 22 foundation year two doctors-in-training (n=2068); 14 clinicians and managers and six patients or relatives for interview; five physician associates for observation.

#### Primary and secondary outcome measures

The primary outcome was unplanned re-attendance at the same emergency department within seven days. Secondary outcomes: consultation processes, clinical adequacy of care, and staff and patient experience.

#### Results

Re-attendances within seven days (n=194 [2.2%]) showed no difference between physician associates and foundation year two doctors-in-training (OR 0.87 [95% CI 0.61, 1.24], p=0.437). If seen by a physician associate, patients were more likely to undergo an x-ray investigation (OR 4.33 95% CI [3.64, 5.15)], p<0.001) and less likely to be admitted to hospital (OR 0.75 95% CI [0.61, 0.92], p=0.006), after adjustment for patient characteristics and triage severity of condition. Clinical reviewers found almost all patients' charts clinically adequate. Physician associates were evaluated as assessing patients in a similar way to foundation year two doctors-in-training and providing

continuity in the team. Patients were positive about the care they had received from a physician associate, but had poor understanding of the role.

#### Conclusions

Physician associates in emergency departments in England treated patients with a range of conditions safely, and at a similar level to foundation year two doctors-in-training, providing clinical operational efficiencies.

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#### Article summary

#### Strengths and limitations of this study

- This study provides a well-powered quantitative comparative analysis of the documented processes and outcomes of patient care by physician associates and foundaion year two doctors-in-training in three emergency departments in different parts of England.
- We believe this to be the first empirical study of the outcomes of care provided by UK-trained physician associates in the emergency department, and the first internationally to include interview and observation data.
- Patients' views have not been previously reported for physician associates in this setting.
- The low sensitivity of the emergency department triage system to identify conditions other than the most serious was a problem and impaired the study's ability to describe case mix fully.

#### The original protocol for the study

The protocol for the study is available at the funding body's website https://www.journalslibrary.nihr.ac.uk/programmes/hsdr/141926/#/

#### Funding

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#### **Competing Interests**

SdeL was head of the Department of Clinical and Experimental Medicine until June 2019 at the University of Surrey, which launched a physician associate course in 2016. JP is the immediate past chair of the UK and Ireland Board for Physician Associate Education and immediate past director of the physician associate programme at the University of Birmingham. PB is honorary faculty at the University of Birmingham and has taught on the physician associate programme since 2008. JE taught part time on the University of Birmingham physician associate programme until 2020. VMD was a HS&DR Board Member in 2015.

#### What this paper adds

#### What is already known on this subject

Growing patient demand on emergency departments and shortages or maldistribution of doctors in many countries have led clinicians and managers to seek other workforce solutions, including the employment of non-physician clinicians such as nurse practititoners and physician assistants/associates. Observational studies from the USA and descriptive accounts from the UK found physician associates in the emergency department to be well accepted and reliable, though the USA evidence presents varying clinical outcomes. There is little research on Physician Associates from outside of the USA; limited evidence of their clinical effectiveness and no qualitative evidence of how PAs deliver care in the emergency department.

#### What this study adds

Our study suggests that physician associates and foundation year two doctors-in-training practice equally safely and appropriately in the emergency department, with no difference in re-attendance rates. Physician associates provide continuity in staff teams, although there are currently some limitations to their practice. Our study supports a role for physician associates in emergency medicine with supervision and more broadly for regulation of the profession.

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## Main text

## Introduction

Health care systems internationally are challenged to ensure good patient outcomes, within financial constraints, as well as to attend to the work life of the workforce.[1] Health workforce shortages, particularly of doctors, are resulting in the development of advanced clinical practitioners or non-physician clinicians (NPCs), such as nurse practitioners (NPs) and physician assistants/associates (PAs) in many countries.[2] Numerous countries are experiencing rising patient demand for emergency services and concommittant shortages of doctors in emergency medicine.[3-7] This situation has led to the development of NPC roles in emergency departments (EDs) in many countries such as the United States (US),[8] Australia,[9] Canada,[10] and the United Kingdom (UK).[11] In the US, 25% (n=14,360) of all emergency medicine clinicians are NPCs, and 68% of these are PAs.[8]

PAs are trained in the medical model to take histories, diagnose illness, develop management plans and prescribe medications as agreed with their supervising physician. PAs have a fifty year history in the US and are a developing part of the workforce in some other countries such as Canada, the Netherlands and Germany.[12] The PA workforce is growing in the UK (where they are known as physician associates). In 2018 there was an estimated 600 qualified PAs with approximately 1000 graduating each year since then.[11] Their employment specialties include EDs,[11] where they are deployed in both the minor and the major illness or injury sections.[8]

Descriptive observations have been published concerning the positive contributions by US-trained PAs employed in EDs in the UK,[13] Australia and New Zealand,[14] and by UK-trained PAs in England.[15] Unlike in the US, PAs in these other countries cannot prescribe medicines or order ionising radiation. PAs in North American EDs are reported to be well accepted by other staff and patients, and reliable in assessing certain medical complaints and performing procedures.[16] No difference is reported between patients attended by a PA and those attended by a doctor for wound infection rates, or rate of revisit within 72 hours to a pediatric ED; but studies find less consistency in practice when analysing prescribing patterns, length of stay and wait times of physicians, PAs and NPs in the ED.[17] There is relatively little research evidence on their clinical effectiveness,[17] little quantitative evidence on outcomes from outside of the US and no qualitative evidence of how PAs deliver care in the ED. In this context our goal was to investigate the contribution of PAs to the processes and outcomes of emergency medicine consultations compared to that of foundation year two (FY2) doctors-in-training in EDs in English hospitals.

### Methods

#### Study design

We conducted a pragmatic, mixed methods convergence study in which we compare and contrast and simultaneously interpret quantitative and qualitative data[18] in three EDs in England, with three components. We undertook a quantitative observational retrospective chart review of patient consultations by PAs compared with FY2 doctors-in-training; and qualitatively we directly observed PAs' practice; and we conducted semi-structured interviews with members of the staff team. Our planned prospective study of patient records with a linked patient satisfaction and outcomes survey had to be revised to a pragmatic retrospective chart review due to practicalities within the participating NHS organisations in the period of the study.

#### Population and sampling

Three consultant-led, 24 hour EDs with full resuscitation facilities ('type one') participated. Two EDs had annual attendances in the range of 100,000 – 120,000 adult and pediatric patients and the third in the range of 170,000 -190,000. One was an university hospital; two were district general hospitals. The hospitals had been recruited as part of a larger study investigating the work and contribution of PAs between 2016 and 2017.[19] We selected foundation year two doctors as the comparator for PAs, as PAs are offered as part of a solution to junior medical workforce shortages.[7]

#### Selection of participants, measurements and outcomes

Our primary outcome was unplanned re-attendance at the same ED within seven days - one of the NHS clinical quality indicators for EDs in England.[20] Our secondary outcomes were: consultation processes (length of time in the ED, use of x-ray, prescriptions and referrals); clinical adequacy of care, referrals and planned follow up; and patient experience.

#### Chart review

For a 16-week period (the standard duration of ED placement for FY2 doctors-in-training in the UK), we obtained pseudo-anonymised, routinely-collected electronic records of all patients attended by a PA or FY2 doctor-in-training, provided in Microsoft Excel by the hospital information teams in each trust, using queries based on staff job role , dates and requested data items. Hospital staff extracted additional data items (supplementary material 1) – age, sex, acuity (as categorised by the Manchester triage score [21]), x-ray orders, diagnosis, prescription issued, admission, area treated, overall time in

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the ED (from check in to discharge, in minutes), and re-consultation within seven days (the primary outcome). No data linkage was required. The researchers did not have access to the original data set and further data cleaning could not be performed.

We calculated a sample size for the primary outcome using the national average of 7.4% (range 2.4% to 21.7%) for unplanned re-attendance at the same ED in England within seven days for all patients; and 18.3% (the highest of two rates for nurse practitioners substituting for physicians).[22,23] Aiming to find a relative difference of 50%, in a non-inferiority hypothesis, we required 284 patients in each group (calculation from Stata v11.1 software) to compare 18.3% to 27.4% unplanned reconsultations within seven days, with conventional 80% power at 5% significance. We included an extra 20 to allow for adjustment for case mix, requiring a minimum of 304 patients in total in each group to achieve the said power.

Two of the participating EDs also agreed to take part in the analysis of clinical adequacy of documented care in every tenth case from the chart review sample (n=40), with equal numbers of cases seen by PA and FY2 doctors-in-training, and using the full anonymised clinical record. We recruited two specialty registrars (doctors in their sixth year of emergency medicine training), one PA lecturer with 20 years ED experience, and one emergency medicine consultant (with 17 years experience at consultant level) from outside the three study hospitals to review these records. All four clinicians independently recorded their judgement as to the clinical adequacy of care for each record using the categories of past medical history, examination, request for radiography, treatment plan and decision, advice given and follow up. Their assessments were blinded to the type of professional attending the patient and to each other's assessment, using a proforma (supplementary material 2) based on published studies.[22,23] As the senior clinician, we accepted the decision of the consultant in cases of disagreement.

#### **Observation**

This element drew on the ethnographic tradition used in many health service research studies.[24] We invited all PAs working in the ED in our three study hospitals to participate (n=6). Five PAs volunteered and gave written informed consent to be observed. One of three researchers (CWh, LN, MH) observed each PA for two or three pre-arranged sessions, of varying lengths, on weekdays in periods between 08.00 and 22.00, following a broad guide (supplementary material 3). Researchers made notes on context, relationships and activities following this guide.We judged data saturation to have been reached with individual PAs when the processes of care observed did not differ significantly from previous observations. During the observation period, PAs asked for patient assent to the researcher's presence. Researchers reflected on the observations, discussing them in pairs.

#### Interview

Semi structured interviews [25] were undertaken with a purposive sample of managerial, medical and nursing ED staff as well as patients and/or their relative who were being seen by a PA in the ED. We used tailored topic guides (supplementary material 4) to explore interviewees' perceptions of the PA role and its impact on service organization, role boundaries, patient experience, patient outcomes, and activities and attitudes of other staff. We digitally recorded interviews or took notes if the participant preferred. Recordings were transcribed verbatim and anonymised.

#### Analysis

*Chart review*: The characteristics of patients treated by PAs and FY2 doctors-in-training were compared using chi-squared tests. We carried out a logistic regression to examine whether the primary and binary secondary outcomes differed between PAs and FY2 doctors-in-training, while adjusting for confounding factors - patient age, sex and triage score. We report odds ratios, their confidence intervals (CI), and two-tailed p values. For length of stay, a linear regression was used for data transformed to logarithm scale to improve normality and reflect the fact that the value of length of stay is positive. Robust standard errors were used in the presence of heteroscedasticity. To account for unobserved heterogeneity, the unobserved component is modelled as a latent variable in a latent class linear model. The assessment of clinical adequacy is reported using descriptive statistics, and sensitivity and specificity of the judgment of whether the record was that of a PA or FY2 doctor-in-training.

*Qualitative*: Our methods for the analysis of observation data drew on methods to identify ethnographic vignettes.[26] We employed thematic analysis[27] of all-specialty interview data for the wider study. Both are described in full elsewhere.[19] For the subsequent specialty-specific analysis we re-read all ED observation data and interview transcripts to identify all data related to the primary and secondary outcomes, and which both confirmed or disconfirmed findings.

*Mixed methods*: Following the separate quantitative and qualitative analyses, we (MH and VMD, in consultation with all authors) merged [18] the quantitative and qualitative datasets by presenting the quantitative results by study outcomes and following these with qualitative data findings (themes and/or excerpts or quotes) that confirmed or disconfirmed the quantitative results.

#### **Ethical approval**

We gained approval from the NHS Health Research Authority London-Central Research Ethics Committee (15/LO/1339).

#### Results

#### Characteristics of chart review subjects

In the 16 week period studied, 8,816 patients seen by PAs or FY2 doctors-in-training were identified, of which 3197 records including the primary outcome were provided to the research team; 1129 had been seen by six PAs and 2068 by 22 FY2 doctors-in-training. Characteristics of the patients are shown in Table 1. PAs saw a lower proportion of patients categorised on triage into the urgent category than FY2 doctors-in-training.

In interview, the type of patient seen, patient throughput and role of PAs and FY2 doctors-in-training were described as similar:

They're pretty much equal to .....a senior FY2 doctor in training level. As a consultant we feel comfort because we know [PA name 1] can work in majors, she can clear [majors] pretty much...... And [PA name 2],... can clear paeds minors... Participant 150 Emergency Medicine consultant

However more than one participant tentatively suggested that PAs saw the less acutely unwell patients.:

So my understanding is like they're equivalent to, I would put it like a certain level of like a junior physician.....I wouldn't say they would be at registrar level.....I'd put them somewhere in between. You know a...lot better than like a newly qualified physician because they've got the skills and stuff, so in that gap of what I would say equivalent to maybe like a second to four years post qualified doctor.. Participant 144, Registrar

#### Characteristics of interview and observation participants

Staff interviewed included four PAs, two managers, five nurses and three senior doctors; six patients and/or their relatives were also interviewed, spread across the three sites. We observed four PAs, at three sites; we do not report further demographic details due to concerns about anonymity in a small population.

Characteristic	<b>PA</b> (N = 2890)	<b>FY2 doctor</b> (N = 5926)	<b>Total</b> (N = 8816)	n_value	
	N (%)	N (%)	N (%)	p-value	
Age band					
0-20	375 (13.0%)	581 (9.8%)	956 (10.8%)		
21-40	611 (21.1%)	1425 (24.0%)	2036 (23.1%)		
41-60	637 (22.0%)	1299 (21.9%)	1936 (22.0%)	<0.001	
61-80	699 (24.2%)	1448 (24.4%)	2147 (24.4%)	<0.001	
81 and over	501 (17.3%)	1101 (18.6%)	1602 (18.2%)		
Unknown	67 (2.3%)	72 (1.2%)	139 (1.6%)		
Sex				·	
Male	1342 (46.4%)	2723 (46.0%)	4065 (46.1%)		
Female	1548 (53.6%)	3202 (54.0%)	4750 (53.9%)	0.672	
Unknown	0 (0.0%)	1 (0.0%)	1 (0.0%)		
Manchester triage score					
1 Immediate	10 (0.3%)	3 (0.1%)	13 (0.1%)		
2 Very urgent	163 (5.6%)	565 (9.5%)	728 (8.3%)		
3 Urgent	769 (26.6%)	2842 (48.0%)	3611 (41.0%)	<0.001	
4 Standard	811 (28.1%)	1681 (28.4%)	2492 (28.3%)	<0.001	
5 Non Urgent	5 (0.2%)	12 (0.2%)	17 (0.2%)		
Unknown	1132 (39.2%)	823 (13.9%)	1955 (22.2%)		
ED area treated in					
Minor	386 (13.4%)	258 (4.4%)	644 (7.3%)		
Major	1757 (60.8%)	3110 (52.5%)	4867 (55.2%)		
Resuscitation	2 (0.1%)	4 (0.1%)	6 (0.1%)	<0.001	
Paediatrics	181 (6.3%)	174 (2.9%)	355 (4.0%)	<0.001	
Clinical decision unit or primary care	21 (0.7%)	20 (0.3%)	41 (0.5%)		
Unknown	543 (18.8%)	2360 (39.8%)	2903 (32.9%)	]	

## Table 1 Characteristics of chart review sample

## The primary outcome: rate of return to the ED within seven days

Re-attendance within seven days was found following 2.2% (N = 194) of the 3197 index visits for which these data were available. The high rate of unknown data is accounted by one site where these data were not captured in the electronic dataset and were only retrieved manually for a random sample for the purposes of this study. After adjustment for confounding, no statistically significant difference was found for cases seen by PAs or FY2 doctors-in-training; see Table 2.

<b>Re-attendance</b>	PA	FY2 doctor	Total	Unadjusted odds ratio	Adjusted odds ratio
at the same ED within seven	(N = 2890)	(N = 5926)	(N = 8816)	(95% CI) and p-value	(95% CI) and p-value
days				(PA relative to FY2	(PA relative to FY2
				doctor-in-training) in	doctor-in-training) in
				rate of re-attendance	rate of re-attendancee†
No	1066 (26.0%)	1027 (22 79/)	3003		
INO	1000 (30.9%)	1937 (32.770)	(34.1%)		
Vac	(2, (2, 20/))	121 (2 29/)	194	0.87 (0.64, 1.19)	0.87 (0.61, 1.24)
1 05	03 (2.2%)	131 (2.2%)	(2.2%)	p=0.393	p=0.437
I Index areas	1761 (60.00/)	2959 (65 10/)	5619		
UIIKIIOWII		3838 (03.1%)	(63.7%)		

Table 2: Re-attendance at the same ED within seven days

†Adjustment made for triage score (as a measure of acuity), age band, sex, admission, x-ray and site

## Secondary outcome: consultation processes

No differences were found between patients attended by PAs or by FY2 doctors-in-training in: whether prescriptions were given, or a discharge summary was completed. However, patients seen by a PA were more likely to have an x-ray performed in the ED (Table 3), less likely to be admitted to hospital, and to have a shorter length of stay in the ED (by 35 minutes), after adjustment for age, sex, acuity, whether admitted, x-ray taken, and site, although no account was able to be taken of the staffing level.

We observed PAs being the first member of the medical team to carry out assessment of patients following triage to either the major, minor or paediatric areas of the ED. We noted that PAs saw patients independently, following a medical history taking and examination model, before reporting in person to the senior ED physician in the same way as nurse practitioners and FY2 doctors-in-training do.

Clinical process measure	PA (N = 2890)	FY2 doctor (N = 5926)	Total (N = 8816)	Unadjusted odds ratio (95% CI) and p-value (PA relative to FY2 doctor-in- training) in rate of re-	Adjusted odds ratio (95% CI) and p-value (PA relati to FY2 doctor-in-training in rate of re-attendancee		
				attendance			
X-ray investigatio	ons performed						
No	558 (19.3%)	1702 (28.7%)	2260 (25.6%)				
Yes	572 (19.8%)	366 (6.2%)	938 (10.6%)	4.77 (4.05, 5.61) p<0.001	4.33 (3.64, 5.15) p<0.00		
Unknown	1760 (60.9%)	3858 (65.1%)	5618 (63.7%)	-			
Prescriptions give	en in the ED	6	I				
No	173 (6.0%)	158 (2.7%)	331 (3.8%)				
Yes	126 (4.4%)	146 (2.5%)	272 (3.1%)	0.79 (0.57, 1.09) p=0.147	0.75 (0.5, 1.13) p=0.		
Unknown	2591 (89.7%)	5622 (94.9%)	8213 (93.2%)				
Admitted as an ir	patient from t	he ED	6				
No	883 (30.6%)	1436 (24.2%)	2319 (26.3%)				
Yes	245 (8.5%)	614 (10.4%)	859 (9.7%)	0.65 (0.55, 0.77) p<0.001	0.75 (0.61, 0.92) p=0.00		
Unknown	1762 (61.0%)	3876 (65.4%)	5638 (64.0%)				
Discharge summa	ary completed			4			
	86 (3.0%)	71 (1.2%)	157 (1.8%)	0.72 (0.10, 1.00) 0.100			
No			1	-0.72(0.48, 1.08) p=0.109	1.57 (0.93, 2.66) p=0.09		
No Yes	117 (4.0%)	134 (2.3%)	251 (2.8%)				

PAs were differentiated from FY2 doctors-in-training by many of our interviewees for not being able to prescribe medications or order tests utilising ionising radiation. Some participants considered this to have a detrimental impact on PAs and patients:

[prescribing] would make a massive difference for them as well and [for] patients because at the end of the day they're having to wait for the PAs to go talk through [with] the physicians what's going on and then probably see somebody else. Participant 118 Nurse practitioner However, PAs were observed taking on several roles in relation to prescriptions and x-ray orders, for example suggesting medications to or charting the medication for a senior doctor to sign off:

So when one of my PAs comes to me and says "This patient has a temperature of 38, they're coughing up horrible green sputum and they're tachycardic and I listened to their chest and they've got crackles at the left base, can we order a chest x-ray and prescribe sepsis drugs for, you know, pneumonia?" I say "Yes" and I sign it. With probably more confidence at this stage having had [number] PAs here for a year than I would with a junior physician in training on day two. And the irony of that is of course, the junior physician in training doesn't need to come and ask me, technically, they can prescribe themselves. Participant 21 Emergency Medicine consultant

PAs were also observed making referrals to medical and surgical teams outside of the ED, completing discharge summary information, and carrying out procedures, most commonly cannulation, phlebotomy and suturing.

#### Secondary outcome: clinical adequacy

Our reviewers found the chart documentation to have been appropriate in 37/40 cases for each of the key consultation components (Table 4), with no errors or omissions that resulted in significant probability that the patient might be harmed. In the three records (two of FY2 doctors-in-training and one of a PA) judged as having errors or omissions at the level of a breach in normal guidelines and procedures that would have altered the patient's treatment, all reviewers agreed that a senior doctor review had occurred in one case; this was unclear in the other cases. Our observation data suggest that such a senior review was undertaken for all assessment and clinical decision making in the 'majors' sections of the ED, but that 'minors' care was often completed independently.

Our reviewers were 40% sensitive, 46% specific on judging the clinician type: 68% (13/19) of the PA records were thought to be of a FY2 doctor-in-training and 60% (9/15) vice versa (kappa score for inter-rater agreement 0.15).

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## Table 4: Chart reviewers' assessments of clinical adequacy

 

		Judgment of appropriateness																							
PA or FY2		Past	Past medical history				minati	on		Requ	iest fo	r		Trea	tment	plan a	and	Adv	ice giv	en		Follow up			
consultatio	on									radi	ograpl	ıy*		decis	sion										
record		Approp	Approvide From or omission		A Error or omission			Approp	Appro Error or omission		Appro		Error or omission			Error or omission				Approj	A Error or omission				
		priate	Harm unlikely	Altered treatment	Harm	priate	Harm unlikely	Altered treatment	Harm	priate	Harm unlikely	Altered treatment	Harm	priate	Harm unlikely	Altered treatment	Harm	priate	Harm unlikely	Altered treatment	Harm	priate	Harm unlikely	Altered treatment	Harm
FY2	n	14	6	0	0	15	5	0	0	9	0	1	0	14	5	1	0	4	1	1	0	16	3	0	0
	%	70	37	0	0	75	25	0	0	45	0	5	0	70	25	5	0	20	5	5	0	80	15	0	0
PA	n	13	5	1	0	11	7	1	0	9	3	0	0	13	5	1	0	3	1	1	0	13	4	1	0
	%	65	25	5	0	55	35	5	0	45	15	0	0	65	25	5	0	15	5	5	0	65	20	5	0
Not	n			1		1					1	8				1			2	9				3	
rated*	%		2	.5			2	.5			45				2	.5			7	3			7	.5	
Total	n	27	11	1	0	26	12	1	0	18	3	1	0	27	10	2	0	0	7	2	2	29	7	1	0
	%	68	28	3	0	65	30	3	0	45	8	3	0	66	25	5	0	0	18	5	5	73	18	3	0
Agreement	t	0.01				0.15				0.26		1	0.15				-0.03				0.30				
(Kappa)																									

\*Missing rating or rated as 'not applicable' if no request for radiography was made or no advice given

Interviewees also presented other aspects related to clinical adequacy, particularly the PAs' stability in the team. The clinicians' familiarity with the longer standing team member PA/s - in contrast to FY2 doctors-in-training on rotation - was raised repeatedly:

If there was a junior physician over here, and he said oh, what do you think of this wound, which they do ask us. And I say yeah, it needs suturing. I then have to say, but can you suture or do you want me to suture it?.....Because I don't know, and some will say oh no, I can't.....I've never sutured before, and some will say oh yeah, that's fine, I'll suture it.....Whereas I know with PAs they'll suture their own. Because I know that they've got that skill set. Participant 177 Advanced nurse practitioner

#### Secondary outcome: patient experience

Patients were positive about the care they had received from the PA, but had not understood what the PA role meant, with two participants believing they had been seen by a doctor and another unsure in the context of multiple ED staff:

I presumed he was a fully-qualified physician, yes his approach and everything was absolutely 100%. Participant 120 Patient

Most of our patient participants were receptive to the role on the grounds that it might speed up care, although they were not without concern for the difference in training from a doctor and the diminishment of a senior medical workforce:

It's good to have another person, another opinion...but would it not perhaps be better to have another doctor? Participant 083 Patient's relative

#### Discussion

#### **Summary of findings**

The study presents evidence from three English EDs and has demonstrated no difference in safety or appropriateness between PAs and FY2 doctors-in-training. We report no difference in re-attendance rates. Those patients seen by a PA (within PA working hours 08-22.00) had a shorter average length of stay in the ED than those seen by doctors-in-training (24 hour working period). Our review of clinical adequacy found few errors and no difference between PAs and FY2 doctors-in-training. Patients appeared relatively unconcerned with the title of the clinician treating them and thought they

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had been treated by a doctor; however they were keen to know that the employment of PAs would not represent a widespread substitution for doctors in the ED.

### How this study is similar or different from prior studies

We believe this to be the first empirical study of the outcomes of care provided by UK-trained PAs in the ED, and the first internationally to include interview and observation data. Additonally, patients' views do not appear to have been previously gathered at the time of the visit (and qualitatively), although there have been previous questionnaire studies in the USA of patient satisfaction, administered after the visit. [28,29,30]

We reported few differences in the the practice and processes of care – other than prescribing (which PAs currently cannot do independently in the UK) – between PAs and doctors in their second foundation year of training. Our finding of no difference in the primary outcome (ED reattendance rate within 28 days) for patients of PAs and FY2 doctors-in-training is consistent with the comparisons of nurse-qualified NPCs and FY2 doctors-in-training on which we based our study design [22,23] and other PA literature from the USA.[16] It should be noted that for patients in the majors section of ED, all assessment and treatment plans by FY2 doctors-in-training and NPCs were reviewed and agreed by a senior clinician. Our participants commented frequently on the transient nature of FY2 doctors-in-training, whose rotation in the ED only last four months. In contrast, PAs remained long-term and provided continuity in the team. Their accumulated knowledge of the policies and practices (clinical and otherwise) of the department, the consultants and the hospital was reported to enable operational efficiencies. Simlar observations about PAs providing continuity within the medical/surgical team have been made in North America and the Netherlands[31-33] and also for other NPCs.[34]

This study's strengths lie in its mixed-methods approach to the study of PAs in the ED, allowing a number of angles on their contribution, compared to that of FY2 doctors-in-training to be considered. We were able to carry out a well-powered quantitative comparative analysis of the documented processes and outcomes of patient care by PAs and FY2 doctors-in-training in three EDs in different parts of the country, and to gather qualitative data on PAs 'in practice'. The qualitative component of our mixed methods approach enabled contextual explanations of the quantitative analysis.

Our study however has several limitations. Our comparison of PAs and doctors working in all areas of the ED introduced the potential for PAs and FY2 doctors-in-training to be attending to patients of different acuity and complexity. We sought to mitigate this by using three different EDs, taking a sample across a 16 week period at all times of day and night (although the FY2 doctors-in-training

worked over the 24 hour period when staff:patient ratios may have fluctuated). We also made statistical adjustments that included triage category. The low sensitivity of most ED triage systems to identification of conditions other than the most serious, however, is a drawback.[35] The higher number of x-rays undertaken by PAs than by FY2 doctors-in-training may reflect a greater tendency for PAs to be allocated to minor injury cases

The level of missing data for some variables in the routinely collected data, and not having data from which to take into account whether PA reduced the staff: patient ratio (or fully replaced FY2 doctorsin-training) is a further limitation and needs to be borne in mind in the comparisons we present. Likewise, . our observation data illustrated care is predominently delivered by teams which creates difficulties in attributing outcomes or processes to individual staff, and compromised our ability to undertake an economic evaluation.

#### Implications for policy and practice

PAs in the ED are acceptable to patients and can help to relieve staffing pressures and improve efficiency in the delivery of care. They are able to treat patients safely with a range of conditions and FY2 doctors-in-training deliver similar care to that provided by doctors in their second year of training. Deployment of PAs within ED teams is a potential solution to the situation of growing patient demand and predicted shortage of junior doctors in the British NHS.[7] An alternative, which is to hire locum doctors, comes at a higher costs and loss of team continuity, and has potential implications for patient safety. Moves to regulate the PA profession were started in 2019 by the General Medical Council.[36]

The findings of this study support employment of appropriately trained, supervised PAs with professional registration in ED teams. Further research is needed to investigate fully the impacts we have observed, particularly the cost effectiveness.

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## Supplementary material

Supplementary material 1: Extract of the chart review dataset Supplementary material 2: Proforma for the assessment of clinical adequacy Supplementary material 3: Observation guide Supplementary material 4: Tailored topic guides for the interview

## **Author Statement**

VMD (PhD, health policy and service delivery research), MH (PhD, health services research), JP (MD, general practice and clinical education), HG (PhD, health economics), SdeL (MD[Res], general practice and information science), JG (PhD, medical sociology), and PB (PhD, audiology and strategic management) conceived and designed the study and obtained research funding. VMD, MH, JP supervised the conduct of the study and data collection. VMD, MH, JP undertook recruitment of participating centers and managed the data, including quality. CWa (PhD, statistics) undertook the statistical analysis; CW (PhD, health services research), LN (PhD, health services research), MH, JE (MSc, physician associate and education) and VMD undertook qualitative data collection and thematic analysis and HG considered the economic aspects. MH drafted the manuscript, and all authors contributed substantially to its revision. VMD takes responsibility for the paper as a whole. All authors attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

## The Patient and Public Involvement statement

The patient and public voice was important to this study and informed the design, conduct, analysis, interpretation and final reporting. We brought the views of our public and patient representative forum for a previous study on physician associates into the research questions and design of the study. These were views such as how do patients understand this new role. Sally Brearley, as a public voice representative, was a co-applicant and member of the research team. The study advisory group had two public voice members who were reimbursed for their time, following NIHR INVOLVE guidance. Two patient and public voice groups were formed: one in London and the other in the West Midlands and members reimbursed as per NIHR Involve guidelines. The patient and public voice groups informed the design of the research tools such as topic guides and participant information sheets,

developed coding frameworks and analysed interview transcripts, and participated in the overall synthesis of findings. Sally Brearley continues to be involved in the dissemination of the study.

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### Data statement

No additional data are available.

## Supplementary file 1: Extract of the chart review dataset (first 50 cases, according to date of attendance)

study id sa	mple case site	numlage f	ormatted sex formatted	arrival date	arrival time	seen time presenting complaint mts	ews	ed strean	profession xrays for	rpxn forn	n diagnosis	discharge timed	estination g	rc discharge discharge disch	narge reattend reatt
C\$30115	0	3	5 0	05-Aug-16	9:10:00 PM	10:56:00 PM Flank Pain(renal colic 3yrs ago) #NULL	! #NULL!	1	1 #NULL!	#NULL!	Renal colic	2:07:00 AM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS30197	0	3	6 1	05-Aug-16	7:54:00 PM	10:01:00 PM Abdo/Back Pain 5/7	3 #NULL!	#NULL!	1 #NULL!	#NULL!	Generally unwell	1:40:00 AM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS30415	0	3	4 1	05-Aug-16	4:51:00 PM	7:05:00 PM 21/40 ?DVT on clexane	3 #NULL	#NULL!	1 #NULL!	#NULL!	Acute coronary syndrome	8:50:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS30514	0	3	5 1	05-Aug-16	1:08:00 PM	2:15:00 PM swelling to arm/hand ?clot	3 #NULL	#NULL!	1 #NULL!	#NULL!	Deep venous thrombosis	5:07:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS30726	0	3	3 0	05-Aug-16	11:45:00 PM	1:12:00 AM HEADACHE	2 #NULL	1	1 #NULL!	#NULL!	Unknown problem	1:58:00 AM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS30962	0	3	4 0	05-Aug-16	4:26:00 PM	6:59:00 PM Back Pain(mr maurice bulging disc)	3 #NULL	#NULL!	0 #NULL!	#NULL!	Chronic back pain	8:20:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
C\$30993	0	3	4 1	05-Aug-16	6:57:00 AM	8:04:00 AM Enigastric Pain 13months on/off	4 #NUILI	#NULLI	1 #NUUU	#NUUU	Acute gastritis	10:54:00 AM	#NULLI	#NUILI #NUILI	#NUILI #NU
C\$31043	0	3	9 1	05-Aug-16	10:49:00 PM	12:00:00 AM AP 21ITI	/ #NUUL	#NULLI	1 #NUUU	#NULLI	IIII - Urinary tract infection	2:13:00 AM	#NULLI	#NULL #NULL	#NULLI #NUL
CS31165	0	3	3 1	05-Aug-16	9:56:00 PM	11:31:00 PM PV Bleed+cramps(bloods with go pad)	4 #NUUL	#NULLI	1 #NULLI	#NULLI	Menorrhagia	1:56:00 AM	#NULLI	#NULLI #NULLI	#NULLI #NUL
CS31275	0	3	8 1	05-Aug-16	8:55:00 PM	10:50:00 PM enigestric pain	3 #NUUL	1	0 #NULLI	#NULLI	Wenomagia	12:38:00 AM	#NULLI	#NULLI #NULLI	#NULLI #NU
CS31564	0	3	1 0	05-Aug-16	4:26:00 PM	5/18:00 PM not passing urine /feeding unsettled	3 #NUUL	#NUULI	0 #NULLI	#NULLI	Well child	6:52:00 PM	#NULLI	#NULLI #NULLI	#NULLI #NUL
CS 315 73	0	2	2 0	05 Aug 10	4.20.00 PM	12:42:00 AM Sickle coll attack	2 #NULLL	#NULLI	1 #NUULI	#NULLI	Sickle cell anomia crisis	2:19:00 4 14	#NULLI	#NULL #NULL	#NULLI #NUL
CS31572	0	2	S U	05-Aug-16	9:52:00 AM	0.28:00 AM bit upwitnessed stumbling on street	3 #NULL!	#NULL!	1 #NULL!	#NULL!	Head injung	12:50:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS31640	0	2	0 1	05-Aug-16	0.33.00 AIVI	10.22.00 AM FALL	3 #NULL!	#NULL!	1 #NULL!	#NULL!	rall	12.30.00 PIVI	#NULL!	#NULL! #NULL!	#NULL! #NU
CS31040	0	3	8 1	05-Aug-16	10:24:00 AIVI		3 #NULL!	#NULL!	1 #NULL!	#NULL!	Fall	2:23:00 PIVI	#NULL!	#NULL! #NULL!	#NULL! #NU
0004040	0	3	3 1	05-Aug-16	10:46:00 AIVI		4 #NULL!	#INULL!	1 #NULL!	#NULL!	Fainting	2:03:00 PIVI	#NULL!	#NULL! #NULL!	#NULL! #NU
CS31642	0	3	1 0	05-Aug-16	3:04:00 PIM	3:55:00 PM unwell vomiting yellow	3 #NULL!	#NULL!	1 #NULL!	#NULL!	vomiting - bile stained	6:01:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS31644	0	3	8 1	05-Aug-16	8:17:00 PM	10:06:00 PM abdo pain #NULL	! #NULL!	1	1 #NULL!	#NULL!	Gastroenteritis	12:17:00 AM	#NULL!	#NULL! #NULL!	#NULL! #NU
2532315	0	3	4 1	05-Aug-16	9:35:00 PM	11:24:00 PM headaches	3 #NULL!	#NULL!	1 #NULL!	#NULL!	Headache	2:49:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS32354	0	3	2 1	05-Aug-16	8:43:00 PM	10:24:00 PM early pregnant, abdominal pain	3 #NULL!	#NULL!	1 #NULL!	#NULL!	Abdominal pain	12:18:00 AM	#NULL!	#NULL! #NULL!	#NULL! #NU
\$32524	0	3	9 1	05-Aug-16	2:48:00 PM	3:46:00 PM FALL unwitnessed, unsteady (dementia)	3 #NULL	#NULL!	1 #NULL!	#NULL!	Fall - accidental	6:44:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
\$32671	0	3	6 0	05-Aug-16	3:10:00 PM	4:02:00 PM ?SEIZURE, hand was twitching (ca brain)	3 #NULL!	#NULL!	0 #NULL!	#NULL!	Partial seizure	7:10:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
\$32693	0	3	8 1	05-Aug-16	10:20:00 PM	11:23:00 PM RUQ Pain 3/7	4 #NULL!	1	1 #NULL!	#NULL!	Abdominal pain	2:19:00 AM	#NULL!	#NULL! #NULL!	#NULL! #NU
\$32713	0	3	9 0	05-Aug-16	4:09:00 PM	4:37:00 PM UNWELL(bradycardia atropine given)	3 #NULL!	#NULL!	0 #NULL!	#NULL!	Acute confusion	8:09:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
S32840	0	3	7 0	05-Aug-16	11:06:00 AM	12:02:00 PM SOB/Right sided CP (PE, pneumonia)	3 #NULL!	#NULL!	1 #NULL!	#NULL!	Pulmonary embolism	3:07:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
\$32973	0	3	6 0	05-Aug-16	6:32:00 PM	9:01:00 PM Paraphimosis	4 #NULL!	#NULL!	1 #NULL!	#NULL!	Paraphimosis	10:02:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
											Alcohol intoxication				
\$33011	0	3	8 1	05-Aug-16	6:52:00 PM	8:55:00 PM Suicidal/Intoxicated (etoh) #NULL	! #NULL!	1	1 #NULL!	#NULL!	(disorder)	10:51:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
\$33793	0	3	7 1	05-Aug-16	2:25:00 PM	3:14:00 PM COLLAPSED/AP ?seizure	3 #NULL	#NULL!	1 #NULL!	#NULL!	Small bowel obstruction	6:25:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS33926	0	3	7 1	05-Aug-16	11:44:00 AM	12:45:00 PM painfull red eye]	2 #NULL	#NULL!	1 #NULL!	#NULL!	Red eye	3:05:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS34018	0	3	8 0	05-Aug-16	11:05:00 PM	12:34:00 AM ?UTI	3 #NULL!	#NULL!	1 #NULL!	#NULL!	Urinary tract infection	2:57:00 AM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS34076	0	3	3 1	05-Aug-16	6:35:00 PM	8:54:00 PM ? chronns flare up/black stools	4 #NULL!	#NULL!	1 #NULL!	#NULL!	Crohn's disease (disorder)	10:34:00 PM	#NULL!	#NULL! #NULL!	#NULL! #NU
CS31018	1	3	9 1	05-Aug-16	6:26:00 PM	8:19:00 PM SOB(inpatient langley green)	4 #NULL!	#NULL!	0 1	#NULL!	Pneumonia	4:57:00 AM		1 1.00 ######### SPR	0 #NU
CS31643	1	3	5 0	05-Aug-16	8:03:00 PM	10:05:00 PM Flank Pain(renal colic)	3	0 1	0 0	#NULL!	Left flank pain	11:13:00 PM		0 1.00 ######## Cons	utlan 0 #NU
CS32456	1	3	7 0	05-Aug-16	7:27:00 PM	9:39:00 PM sudden onset pain L testis	4	0 #NULL!	0 0	#NULL!	O/E - testicular swelling	11:23:00 PM		0 1.00 ######## Cons	utlan 0 #NU
											Community acquired				
850052	0	3	7 0	06-Aug-16	7:45:00 PM	9:01:00 PM 2/7 hx CCP	3 #NUU	#NUU	1 #NUUL	#NULL	ppeumonia	9:46:00 PM	#NUU	#NULLI #NULLI	#NUILI #NU
2550050		3	, .	007105 10	71151001111		5	mitole.	1	IIIIOLL.	pricultoriu	5.10.001111	into EE.		
C20156	0	2	2 1	06 Aug 16	1.10.00 AM	2:08:00 AM Headache took 24xParacetamol 500mg+4 kalms	2 #NUUL	1	1 #NUULI	#NULLI	Paracetamel overdese	7-20-00 4 14	#NU 11 1	#NUULI #NUULI	#NUULI #NUU
530130	0	3	5 1	06 Aug 16	1.15.00 AM	4:00:00 AM Accoult HI/Ift chouldor pain	2 #NULL	1	1 #NULL!	#NULL!	Accoult	7.33.00 AM	#NULL!	#NULL: #NULL!	#NULL: #NU
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S30695	0	3	6 0	06-Aug-16	9:49:00 PM	12:02:00 AM RTC 14hrs ago lower back pain, headache	4 #NULL!	#NULL!	1 #NULL!	#NULL!	Back pain	12:44:00 AM	#NULL!	#NULL! #NULL!	#NULL! #NU
\$30834	0	3	8 0	06-Aug-16	11:19:00 PM	12:55:00 AM non epileptic seizure	3 #NULL!	#NULL!	1 #NULL!	#NULL!	Chronic confusion	10:13:00 AM	#NULL!	#NULL! #NULL!	#NULL! #NU
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Supplementary material 2, assessment of clinical adequacy questions

Excel spread sheet sent to each reviewer to complete for all records. One column for each record -

reviewer to fill in id number

	Questions *	Insert study ID number from top of record
		Drop down response options followed by a cell for free text if
		appropriate
1	Record of the patient's medical	Appropriate
	history	Or
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
		the patient might be harmed
	Free text on rationale or	
	comment on response to item 1	
2	Examination of the patient	Appropriate
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		OI An error or omission seen that caused a breach in normal guidelines
		and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
		the patient might be harmed
-	Free text on rationale or	
	comment on response to item 2	
3	Request for radiography	Appropriate Or
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines
		and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
		the patient might be harmed
	Free text on rationale or	
1	Treatment nlen and desision	Appropriato
4		Appropriate
		VI Fror or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines
		and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
		the patient might be harmed
		Or An error or omission seen that resulted in significant probability that
		ine patient might be narmed

	Questions *	Insert study ID number from top of record
		appropriate
	Free text on rationale or comment on response to item 4	
5	Treatment plan and decision reviewed by senior doctor	YES Or NO
6	Advice given	Appropriate Or Error or omission – but unlikely to have resulted in harm or different treatment Or
		An error or omission seen that caused a breach in normal guidelines and procedures that would have altered the patient's treatment Or An error or omission seen that resulted in significant probability that the patient might be harmed
	Free text on rationale or comment on response to item 6	
7	Follow-up	Appropriate Or Error or omission – but unlikely to have resulted in harm or different treatment Or An error or omission seen that caused a breach in normal guidelines
		An error or omission seen that resulted in significant probability that the patient might be harmed
	Free text on rationale or comment on response to item 7	
8	In your view what type of clinician attended this patient?	Doctor Or Physician associate Or Unable to decide
	Free text on rationale or comment on response to item 8	

\* Review questions taken from Sakr et al study <sup>17</sup> comparing patients attended by advanced nurse practitioners

with doctors in the ED.



# **OBSERVATION: AIDE MEMOIRE for researchers**

Our observation aims to support answering the four study research questions but specifically to provide data on impact on organisation of services, other team members working practices and team

relationships.

We wish to be able to consider this in terms of:

- Acceptability -how do they appear to be viewed or treated by others?
- Appropriateness how are they observed in terms of safety e.g. how do they check, how are they checked upon, how are they supervised?
- Equity who receives the PA service; do any patient groups appear to be over represented?
- Efficiency how do they appear to contribute to this? How are issues, such as prescribing, worked around?
- Effectiveness are the outcomes of PA care or contribution to the team observed?

We are observing context, relationships and activities.

## Conduct of the observation

- Put up approved notices of our observation activity in the study setting places advised by the clinical team
- Provide the PA with the approved script to inform patients/ patients' representatives to gain permission for the researcher's presence. Each patient is to be asked for permission.
- Researcher to maintain an unobtrusive presence
- Record observations in the ethnographic tradition take detailed unstructured notes, bearing in mind the importance of capturing context, relationships and activities
- Record as much as possible at the time and add as soon as possible afterwards
- Length of observation to be pre-planned but also to allow for flexibility according to the PA's wishes, the demands of the clinical setting and researcher's length of focus
- Allow the PA to see the notes at any point

# After the observation

- Add to the notes as soon as possible where detail was not able to be captured at the time
- Maintain a reflective diary associated with the observation conduct and analytical processes.
- Discuss the observation with local research team members to promote group understanding and consistency across researchers
- Transfer data into NVivo software.

Supplementary data file 4: Tailored topic guides for the interview

## Topic guide for senior managers and clinicians

Topic areas

- Confirm the person's job role
- Ask them to describe their involvement with physician associate employment in the hospital to date
- Ask questions on the factors supporting the adoption of the employment of physician associates
- Ask questions on the factors inhibiting the employment of physician associates
- Questions on their views of physician associates' impact on (ask for examples):
  - Organisation of services
  - Patient experience and outcomes
  - Other staff
  - o Costs
- Anything else they would like to say?

**Interviewer to probe** on all answers to ensure the meaning is clear (e.g. that is an interesting point, can you explain a bit more about it) and check for understanding (e.g. so can I check I have understood you correctly)......

**Interviewer to check** for any routine management reports or data or evaluations that the hospital team would be willing to share with the researchers.

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data.

## Topic guide for physician associate interviews

## Topic areas

- Ask them to describe how long they have been a physician associate, how many posts, type and length as a physician associate
- Ask them to describe the work they undertake, with what type of medical/surgical team
- Ask about their supervising doctor and arrangements when they are not there
- Ask questions on their views of the factors supporting the adoption of the employment of physician associate in their experience

- - Ask questions on their views of the factors inhibiting the employment of physician associate in their experience
  - Ask how they have been received in the hospital as a new type of health professional?
  - Ask how they explain to patients, family and staff who they are and what a physician associate is
  - Questions on their views of their, or other physician associates, impact on (ask for examples):
    - Organisation of services
    - Patient experience and outcomes
    - Other staff
    - Costs
  - Anything else they would like to say?

**Interviewer to probe** on all answers to ensure the meaning is clear (e.g that is an interesting point, can you explain a bit more about it) and check for understanding (e.g. so can I check I have understood you correctly)......

**Interviewer to check** for any routine management reports or data or evaluations that the hospital team would be willing to share with the researchers .

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data.

## Topic guide for all other types of professionals/managers interviews

- Confirm the person's job role
- Ask them to describe their involvement with physician associate employment in the hospital to date
- Ask questions on their views of any factors supporting the adoption of the employment of physician associates in their experience
- Ask questions on their views of any factors inhibiting the employment of physician associates in their experience
- Ask their views as to how the PAs have been received in that service/team, and probe for any explanations

- Questions on their views of physician associates' impact on (ask for examples): •
  - Organisation of services
  - o Boundaries between the job roles of different types of professionals e.g. with nurses
  - Patient experience and outcomes
  - Other staff
  - o Costs
- Anything else they would like to say?

Interviewer to probe on all answers to ensure the meaning is clear (e.g that is an interesting point, can you explain a bit more about it ) and check for understanding (e.g. so can I check I have understood you correctly ).....

Interviewer to check for any routine management reports or data or evaluations that the hospital team would be willing to share with the researchers.

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data. 4. Zonj

## **Topic guide for patient interviews**

Topic areas

- Confirm the person is/has been a patient
- Ask them to outline the type of care they have been in receipt of without giving personal medical details e.g. in patient for x days
- Confirm the patient has met the physician associate
- Explore what sort of involvement the physician associate has had with them
- Ask them how they understand the role of the physician associate in the medical/surgical team
- Ask them how they found receiving care from a physician associate
- If they were to need similar medical or surgical care, would they be content to receive • similar care from a physician associate in the future as they had this time (and can

they explain why) or would they prefer someone different? And if yes, can they explain why?

• Anything else they would like to say?

**Interviewer to probe** on all answers to ensure the meaning is clear (e.g. that is an interesting point, can you explain a bit more about it) and check for understanding (e.g. so can I check I have understood you correctly).

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data.

O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health services research. J Health Serv Res Policy. 2008;13(2):92-98.

Box 1 Good Reporting of A Mixed Methods Study (GRAMMS)

GRAMMS criterion	Page in manuscript
(1) Describe the justification for using a mixed methods approach to the research question	8
(2) Describe the design in terms of the purpose, priority and sequence of methods	8
(3) Describe each method in terms of sampling, data collection and analysis	8-10
(4) Describe where integration has occurred, how it has occurred and who has participated in it	10
(5) Describe any limitation of one method associated with the present of the other method	18-19
(6) Describe any insights gained from mixing or integrating methods	18-19
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No.	Торіс	Item
	Title and abstract	
\$1	Title	Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnograph grounded theory) or data collection methods (e.g., interview, focus group) is recommended
52	Abstract	Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions
	Introduction	
\$3	Problem formulation	Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement
S4	Purpose or research question	Purpose of the study and specific objectives or questions
	Methods	
\$5	Qualitative approach and research paradigm	Qualitative approach (e.g., ethnography, grounded theory, case study phenomenology, narrative research) and guiding theory if appropriat identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale <sup>b</sup>
56	Researcher characteristics and reflexivity	Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actua interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability
\$7	Context	Setting/site and salient contextual factors; rationale <sup>b</sup>
S8	Sampling strategy	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessa (e.g., sampling saturation); rationale <sup>b</sup>
\$9	Ethical issues pertaining to human subjects	Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues
\$10	Data collection methods	Types of data collected; details of data collection procedures includin (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale <sup>b</sup>
\$11	Data collection instruments and technologies	Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how th instrument(s) changed over the course of the study
\$12	Units of study	Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)
\$13	Data processing	Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/deidentification of excerpts
\$14	Data analysis	Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale <sup>b</sup>
\$15	Techniques to enhance trustworthiness	Techniques to enhance trustworthiness and credibility of data analysi (e.g., member checking, audit trail, triangulation); rationale <sup>b</sup>
	Results/findings	
\$16	Synthesis and interpretation	Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory
S17	Links to empirical data	Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings
	Discussion	substantiate anarytic mungs
\$18	Integration with prior work, implications, transferability, and contribution(s) to the field	Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/ generalizability; identification of unique contribution(s) to scholarship in a discipline or field.
\$19	Limitations	Trustworthiness and limitations of findings
1996	Other	
S20	Conflicts of interest	Potential sources of influence or perceived influence on study condu- and conclusions; how these were managed
\$21	Funding	Sources of funding and other support; role of funders in data collection, interpretation, and reporting
The authors critical appra contacting e research by The rationale	created the SRQR by searching the literature to identify guidelines, re aisal criteria for qualitative research; reviewing the reference lists of re xperts to gain feedback. The SRQR aims to improve the transparency providing clear standards for reporting qualitative research. e should briefly discuss the justification for choosing that theory, appr	porting standards, and trieved sources; and of all aspects of qualitative roach, method, or technique

choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together. For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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S1 p3 (MMR cannot fit in more detail in title)
S2 P3
S3 P7
S4 P7
S5 P8, 9
S6 P10
S7 P8
S8 P9-10
S9 P10
S10 P9-10
S11 P10 (refers to detail elsewhere)
S12 P11
S13 P10 (refers to detail elsewhere)
S14 P10 (refers to detail elsewhere) S14 As above
S16 P11-17, embedded alongside quant S17 As above
S18 P17-19
S19 P18-19
S20&21 P5



For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

# The RECORD statement: Checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	ltem Number	STROBE Items	RECORD Items	Page number
Title and Abstract				
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract. (b) Provide in the abstract an informative and balanced summary of what was done and what was found.	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	3
Introduction				
Background rationale	2	Explain the scientific background and rationale for the investigation being reported.		7
Objectives	3	State specific objectives, including any prespecified hypotheses.		7
Methods				
Study Design	4	Present key elements of study design early in the paper.		8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection.		8
Participants	6	(a) Cohort study: Give the eligibility criteria and the sources and methods of selection of participants. Describe methods of follow-up. <i>Case-control study</i> : Give the eligibility criteria and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls. <i>Cross-sectional study</i> : Give the eligibility criteria and the sources and methods of	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published	8

	ltem Number	STROBE Items	RECORD Items	Page number
		selection of participants. (b) Cohort study: For matched studies, give matching criteria and number of exposed and unexposed. Case- control study: For matched studies, give matching criteria and the number of controls per case.	elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	10, 12
Data sources/measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group.		8,10
Bias	9	Describe any efforts to address potential sources of bias.		10
Study size	10	Explain how the study size was arrived at.		9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.	0,	8,10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding. (b) Describe any methods used to examine subgroups and interactions. (c) Explain how missing data were addressed. (d) <i>Cohort</i> <i>study</i> : If applicable, explain how loss to follow-up was addressed. <i>Case-control study</i> : If applicable, explain how matching of cases and controls was addressed. <i>Cross-sectional</i> <i>study</i> : If applicable, describe analytical methods taking account of sampling strategy. (e) Describe any sensitivity analyses.		10
Data access and cleaning methods		N/A	RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors	8-9

	ltem Number	STROBE Items	RECORD Items	Page numbe
			should provide information on the data cleaning methods used in the study.	
Linkage		N/A	RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	8-9
Results	Ċ			
Participants	13	(a) Report the numbers of individuals at each stage of the study (e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed). (b) Give reasons for nonparticipation at each stage. (c) Consider use of a flow diagram.	RECORD 13.1: Describe in detail the selection of the persons included in the study (i.e., study population selection), including filtering based on data quality, data availability, and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	11, 12, 13
Descriptive data	14	(a) Give characteristics of study participants (e.g., demographic, clinical, and social) and information on exposures and potential confounders. (b) Indicate the number of participants with missing data for each variable of interest. (c) <i>Cohort study</i> : summarise follow-up time (e.g., average and total amount).		12
Outcome data	15	<i>Cohort study</i> : Report numbers of outcome events or summary measures over time. <i>Case-control study</i> : Report numbers in each exposure category or summary measures of exposure. <i>Cross-sectional study</i> : Report numbers of outcome events or summary measures.		13
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included. (b) Report category boundaries when continuous variables were categorized. (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period.		13,14

	ltem Number	STROBE Items	RECORD Items	Page number
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions and sensitivity analyses		15
Discussion				
Key results	18	Summarise key results with reference to study objectives.		17-18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.		19
Generalisability	21	Discuss the generalisability (external validity) of the study results.		18-19
Other Information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based.		5
Accessibility of protocol, raw data, and programming code		N/A	RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	24

N/A, not applicable

**BMJ** Open

# **BMJ Open**

## Comparing physician associates and foundation year two doctors in training undertaking emergency medicine consultations in England: a mixed methods study of processes and outcomes

Journal:	BMJ Open
Manuscript ID	bmjopen-2020-037557.R1
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5	1	Comparing physician associates and foundation year two doctors in training
7	2	undertaking emergency medicine consultations in England: a mixed methods study of
8 9	3	processes and outcomes
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- 1 Comparing physician associates and foundation year two doctors in training
- 2 undertaking emergency medicine consultations in England: a mixed methods study of
- 3 processes and outcomes

## 4 ABSTRACT

# 56 Objectives

- 7 To compare the contribution of physician associates to the processes and outcomes of emergency
- 8 medicine consultations to that of foundation year two doctors-in-training.

## 9 Design

10 Mixed methods study: retrospective chart review using four months' anonymised clinical record data 11 of all patients seen by physician associates or foundation year two doctors-in-training in 2016; review

- 12 of a sub sample of 40 records for clinical adequacy; semi-structured interviews with staff and patients;
- 13 observations of physician associates.

## 14 Setting

15 Three emergency departments in England

## 16 Participants

- 17 The records of 8816 patients attended by six physician associates and 40 foundation year two doctors-
- 18 in-training; of these n=3197 had the primary outcome recorded (n=1129 PA, n=2068 doctor); 14
- 19 clinicians and managers and six patients or relatives for interview; five phyisican associates for
- 20 observation.
- 21 Primary and secondary outcome measures
- The primary outcome was unplanned re-attendance at the same emergency department within seven
   days. Secondary outcomes: consultation processes, clinical adequacy of care, and staff and patient
   experience.

## 25 Results

Re-attendances within seven days (n=194 [6.1%]) showed no difference between physician associates and foundation year two doctors-in-training (OR 0.87 [95% CI 0.61, 1.24], p=0.437). If seen by a physician associate, patients were more likely receive an x-ray investigation (OR 2.10 [95% CI 1.72, (4.24)], p<0.001), after adjustment for patient characteristics, triage severity of condition and statistically significant clinician intra-class correlation. Clinical reviewers found almost all patients' charts clinically adequate. Physician associates were evaluated as assessing patients in a similar way to foundation year two doctors-in-training and providing continuity in the team. Patients were 

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positive about the care they had received from a physician associate, but had poor understanding of the role.

#### Conclusions

Physician associates in emergency departments in England treated patients with a range of conditions

- safely, and at a similar level to foundation year two doctors-in-training, providing clinical operational
- efficiencies.

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3 4	1	Article summary							
5	2								
o 7	3	Strengths and limitations of this study							
8	4								
9 10	5	• This study provides a well-powered quantitative comparative analysis of the documented							
11 12	6	processes and outcomes of patient care by physician associates and foundaion year two doctors-							
13	7	in-training in three emergency departments in different parts of England.							
14 15	8	• We believe this to be the first empirical study of the outcomes of care provided by UK-trained							
16	9	physician associates in the emergency department, and the first internationally to include							
17 18	10	interview and observation data.							
19 20	11	• Patients' views have not been previously reported for physician associates in this setting.							
20	12	• The low sensitivity of the emergency department triage system to identify conditions other than							
22 23	13	the most serious was a problem and impaired the study's ability to describe case mix fully.							
24	14								
25 26	15	The original protocol for the study							
27	16	The protocol for the study is available at the funding body's website							
28 29	17	https://www.journalslibrary.nihr.ac.uk/programmes/hsdr/141926/#/							
30 31	18								
32	19	Funding							
33 34	20	This project was funded by the National Institute for Health Research Health Services and Delivery							
35	20	Research Programme (project number 14/19/26). This paper presents independent research							
36 37	21	commissioned by the National Institute for Health Research (NIHR). The views and opinions							
38	22	expressed by authors in this publication are those of the authors and do not necessarily reflect those of							
40	23	the NHS the NIHP the Health Service and Delivery Research Programme or the Department of							
41 42	24	Health							
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44 45	20								
46	27	Competing Interests							
47 48	28	SdeL was head of the Department of Clinical and Experimental Medicine until June 2019 at the							
49 50	29	University of Surrey, which launched a physician associate course in 2016. JP is the immediate past							
50 51	30	chair of the UK and Ireland Board for Physician Associate Education and immediate past director of							
52 53	31	the physician associate programme at the University of Birmingham. PB is honorary faculty at the							
53 54	32	University of Birmingham and has taught on the physician associate programme since 2008. JE taught							
55 56	33	part time on the University of Birmingham physician associate programme until 2020. VMD was a							
57	34	HS&DR Board Member in 2015.							
58 59	35								
60	36								

#### Main text

#### Introduction

8 0	3	Health care systems internationally are challenged to ensure good patient outcomes, within financial
10	4	constraints, as well as to attend to the work life of the workforce.[1] Health workforce shortages,
11 12	5	particularly of doctors, are resulting in the development of advanced clinical practitioners or non-
13	6	physician clinicians (NPCs), such as nurse practitioners (NPs) and physician assistants/associates
14 15	7	(PAs) in many countries.[2] Numerous countries are experiencing rising patient demand for
16	8	emergency services and concommittant shortages of doctors in emergency medicine.[3-7] This
17 18	9	situation has led to the development of NPC roles in emergency departments (EDs) in many countries
19 20	10	such as the United States (US),[8] Australia,[9] Canada,[10] and the United Kingdom (UK).[11] In the
20	11	US, 25% (n=14,360) of all emergency medicine clinicians are NPCs, and 68% of these are PAs.[8]
22 23	12	
24	13	PAs are trained in the medical model to take histories, diagnose illness, develop management plans
25 26	14	and prescribe medications as agreed with their supervising physician. PAs have a fifty year history in
27	15	the US and are a developing part of the workforce in some other countries such as Canada, the
28 29	16	Netherlands and Germany.[12] The PA workforce is growing in the UK (where they are known as
30 31	17	physician associates). In 2018 there was an estimated 600 qualified PAs with approximately 1000
32	18	graduating each year since then.[11] Their employment specialties include EDs,[11] where they are
33 34	19	deployed in both the minor and the major illness or injury sections.[8]
35	20	
36 37	21	Descriptive observations have been published concerning the positive contributions by US-trained
38	22	PAs employed in EDs in the UK,[13] Australia and New Zealand,[14] and by UK-trained PAs in
39 40	23	England.[15] Unlike in the US, PAs in these other countries cannot prescribe medicines or order
41 42	24	ionising radiation. PAs in North American EDs are reported to be well accepted by other staff and
43	25	patients, and reliable in assessing certain medical complaints and performing procedures.[16] No
44 45	26	difference is reported between patients attended by a PA and those attended by a doctor for wound
46	27	infection rates, or rate of revisit within 72 hours to a pediatric ED; but studies find less consistency in
47 48	28	practice when analysing prescribing patterns, length of stay and wait times of physicians, PAs and
49 50	29	NPs in the ED.[17] There is relatively little research evidence on their clinical effectiveness,[17] little
50	30	quantitative evidence on outcomes from outside of the US and no qualitative evidence of how PAs

deliver care in the ED. In this context our goal was to investigate the contribution of PAs to the processes and outcomes of emergency medicine consultations compared to that of foundation year two (FY2) doctors-in-training in EDs in English hospitals.

## Methods

# 3 Study design

We conducted a pragmatic, mixed methods convergence study in which we compare and contrast and simultaneously interpret quantitative and qualitative data[18] in three EDs in England, with three components. We undertook a quantitative observational retrospective chart review of patient consultations by PAs compared with FY2 doctors-in-training; and qualitatively we directly observed PAs' practice; and we conducted semi-structured interviews with members of the staff team. Our planned prospective study of patient records with a linked patient satisfaction and outcomes survey had to be revised to a pragmatic retrospective chart review due to practicalities within the participating NHS organisations in the period of the study.

## 13 Population and sampling

14 Three consultant-led, 24 hour EDs with full resuscitation facilities ('type one') participated. Two EDs 15 had annual attendances in the range of 100,000 – 120,000 adult and pediatric patients and the third in 16 the range of 170,000 -190,000. One was an university hospital; two were district general hospitals. 17 The hospitals had been recruited as part of a larger study investigating the work and contribution of 18 PAs between 2016 and 2017.[19] We selected FY2 doctors-in-training as the comparator for PAs, as 19 PAs are offered as part of a solution to junior medical workforce shortages[7] and the most junior 20 doctors working in the UK ED at the time were FY2s.

## 22 Selection of participants, measurements and outcomes

Our primary outcome was unplanned re-attendance at the same ED within seven days - one of the
 NHS clinical quality indicators for EDs in England.[20] Our secondary outcomes were: consultation
 processes (length of time in the ED, use of x-ray, prescriptions and referrals); clinical adequacy of
 care, referrals and planned follow up; and patient experience.

## 28 Chart review

For a 16-week period (the standard duration of ED placement for FY2 doctors-in-training in the UK), we obtained anonymised, routinely-collected electronic records of all patients attended by a PA or FY2 doctor-in-training, provided in Microsoft Excel by the hospital information teams in each trust, using queries based on staff job role, dates and requested data items. Hospital staff extracted additional data items (supplementary material 1) – age, sex, acuity (as categorised by the Manchester 

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triage score [21]), x-ray orders, diagnosis, prescription issued, admission, area treated, overall time in the ED (from check in to discharge, in minutes), and re-consultation within seven days (the primary outcome). No data linkage was required. The researchers did not have access to the original data set and so could not identify if any patients appeared more than once in the dataset, and further data cleaning could not be performed.

We calculated a sample size for the primary outcome based on rate of 18.3% (the highest of two rates for nurse practitioners substituting for physicians, [at 28 days]).[22,23] Aiming to find a relative difference of 50%, in a non-inferiority hypothesis, we required 284 patients in each group (calculation from Stata v11.1 software) to compare 18.3% to 27.4% unplanned re-consultations, with conventional 80% power at 5% significance. We included an extra 20 to allow for adjustment for case mix, requiring a minimum of 304 patients in total in each group to achieve the said power. As 28 day data could not be collected we went on to use the seven day reattendance rate, with its national average of 7.4% (range 2.4% to 21.7%) for unplanned re-attendance at the same ED in England within for all patients.

Two of the participating EDs also agreed to take part in the analysis of clinical adequacy of documented care in every tenth case from the chart review sample (n=40), with equal numbers of cases seen by PA and FY2 doctors-in-training, and using the full anonymised clinical record. We recruited two specialty registrars (doctors in their sixth year of emergency medicine training), one PA lecturer with 20 years ED experience, and one emergency medicine consultant (with 17 years experience at consultant level) from outside the three study hospitals to review these records. All four clinicians independently recorded their judgement as to the clinical adequacy of care for each record using the categories of past medical history, examination, request for radiography, treatment plan and decision, advice given and follow up. Their assessments were blinded to the type of professional attending the patient and to each other's assessment, using a proforma (supplementary material 2) based on published studies.[22,23] As the senior clinician, we accepted the decision of the consultant in cases of disagreement.

#### 30 Observation

This element drew on the ethnographic tradition used in many health service research studies.[24] We invited all PAs working in the ED in our three study hospitals to participate (n=6). Five PAs volunteered and gave written informed consent to be observed. One of three researchers (CWh, LN, MH) observed each PA for two or three pre-arranged sessions, of varying lengths, on weekdays in periods between 08.00 and 22.00, following a broad guide (supplementary material 3). Researchers made notes on context, relationships and activities following this guide.We judged data saturation to **BMJ** Open

1 have been reached with individual PAs when the processes of care observed did not differ

- 2 significantly from previous observations. During the observation period, PAs asked for patient assent
- 3 to the researcher's presence. Researchers reflected on the observations, discussing them in pairs.

#### 5 Interview

Semi structured interviews [25] were undertaken with a purposive sample of managerial, medical and nursing ED staff who volunteered after receiving information about the study from the researcher during observation periods and/or via their site manager. We also opportunistically interviewed patients and/or their relative who were being seen by a PA in the ED, identified and invited to participate during observation periods, once they had been assessed and treated by the PA but before discharge from the ED. We used tailored topic guides (supplementary material 4) to explore interviewees' perceptions of the PA role and its impact on service organization, role boundaries, patient experience, patient outcomes, and activities and attitudes of other staff. We digitally recorded interviews or took notes if the participant preferred. Recordings were transcribed verbatim and anonymised.

#### 17 Analysis

Chart review: The characteristics of patients treated by PAs and FY2 doctors-in-training were compared using chi-squared tests. We carried out a logistic regression to examine whether the primary and binary secondary outcomes differed between PAs and FY2 doctors-in-training, while adjusting for confounding factors - patient age, sex and triage score. Since patients seen by the same clinician are likely to be correlated, we calculated intraclass correlation coefficients (ICC) for each outcome and report results using a random-effects model if the ICC is statistically significant. We report odds ratios, their confidence intervals (CI), and two-tailed p values. For length of stay, a linear regression was used for data transformed to logarithm scale to reduce heteroscedasticity and reflect the fact that the value of length of stay is positive. To account for unobserved heterogeneity, the unobserved component is modelled as a latent variable in a latent class linear model. The assessment of clinical adequacy is reported using descriptive statistics, sensitivity and specificity of the judgment of whether the record was that of a PA or FY2 doctor-in-training, and Fleiss kappa for inter-rater agreement, calculated for each of the four components of the assessment . 

*Qualitative*: Our methods for the analysis of observation data drew on methods to identify ethnographic vignettes. [26] We employed thematic analysis [27] of all-specialty interview data for the wider study. Both are described in full elsewhere.[19] For the subsequent specialty-specific analysis we re-read all ED observation data and interview transcripts to identify all data related to the primary and secondary outcomes, and which both confirmed or disconfirmed findings. 

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4	1 2	Mixed methods: Following the senarete quantitative and qualitative analyses, we (MH and VMD, in
5 6	2	consultation with all authors) merged [18] the quantitative and qualitative datasets by presenting the
7 8	1	quantitative results by study outcomes and following these with qualitative data findings (themes
9	4	qualitative results by study outcomes and following these with qualitative data mutigs (themes
10 11	5	and/or excerpts of quotes) that confirmed of discontinued the quantitative results.
12	6	
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15	8	Ethical approval
16 17	9	We gained approval from the NHS Health Research Authority London-Central Research Ethics
18	10	Committee (15/LO/1339).
19 20 21 22	11	Results
23	12	Characteristics of chart review subjects
24 25	13	
26 27	14	In the 16 week period studied, 8,816 patients seen by six PAs (n=2890) or forty FY2 doctors-in-
28	15	training (n=5926) were identified; some secondary outcomes were available for all cases. For 3197 of
29 30	16	these patient episodes (n=1129 by the six PAs and n= 2068 by 22 FY2 doctors-in-training) the
31	17	primary outcome was collected at site for the research team. Characteristics of the patients are shown
32 33	18	in Table 1. PAs saw a lower proportion of patients categorised on triage into the urgent category than
34	19	FY2 doctors-in-training.
35 36	20	
37	21	In interview, the type of patient seen, patient throughput and role of PAs and FY2 doctors-in-training
38 39	22	were described as similar:
40 41		
42	23	They're [the PAs] pretty much equal toa senior FY2 doctor in training level. As a consultant we
43 44	24	feel comfort because we know [PA name 1] can work in majors, she can clear [majors] pretty
45	25	much And [PA name 2], can clear paeds minors Participant 150 Emergency Medicine
46 47	26	consultant
48	27	However more than one participant tentatively suggested that PAs saw the less acutaly unwell
49 50	27	nowever more than one participant tentarivery suggested that I As saw the less activity unwen
51	28	patients
52 53	29	So my understanding is like they're [the PAs] equivalent to, I would put it like a certain level of like a
54	30	junior physicianI wouldn't say they would be at registrar levelI'd put them somewhere in
56	31	between. You know alot better than like a newly qualified physician because they've got the skills
57 58	32	and stuff, so in that gap of what I would say equivalent to maybe like a second to four years post
59	33	qualified doctor. Participant 144, Registrar
60		- · · · ·

#### 3 Characteristics of interview and observation participants

The staff interviewed included four PAs, two managers, five nurses and three senior doctors; six

6 patients and/or their relatives were also interviewed, spread across the three sites. We observed four

7 PAs, at three sites; we do not report further demographic details due to concerns about anonymity in a

8 small population.

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Chausstanistic	$\begin{array}{c} \mathbf{PA} \\ (N = 2381) \end{array}$	<b>FY2 doctor</b> (N = 6435)	<b>Total</b> (N = 8816)	n volu
Characteristic	N (%)	N (%)	N (%)	p-value
Age band				
0-20	300 (13.0%)	656 (10.3%)	956 (11.0%)	
21-40	543 (23.5%)	1493 (23.5%)	2036 (23.5%)	
41-60	530 (22.9%)	1406 (22.1%)	1936 (22.3%)	
61-80	551 (23.8%)	1596 (25.1%)	2147 (24.7%)	0.002
81 and over	390 (16.9%)	1212 (19.0%)	1602 (18.5%)	
Unknown				
Sex				I
Male	1132	2933 (45.6%)	4065 (46.1%)	
Female	1249	3501 (54.4%)	4750 (53.9%)	0.102
Unknown				
Manchester triage score				1
1 Immediate	10 (0.6%)	3 (0.1%)	13 (0.2%)	
2 Very urgent	163 (9.3%)	565 (11.1%)	728 (10.6%)	
3 Urgent	770 (43.8%)	2841 (55.7%)	3611 (52.6%)	
4 Standard	811 (46.1%)	1681 (32.9%)	2492 (36.3%)	< 0.001
5 Non Urgent	5 (0.3%)	12 (0.2%)	17 (0.2%)	
Unknown			4	
ED area treated in				I
Minor	369 (20.1%)	275 (6.8%)	644 (10.9%)	
Major	1266 (68.8%)	3601 (88.4%)	4867 (82.3%)	
Resuscitation	2 (0.1%)	4 (0.1%)	6 (0.1%)	
Paediatrics	181 (9.8%)	174 (4.3%)	355 (6.0%)	<0.001
Clinical decision unit or primary care	21 (1.1%)	20 (0.5%)	41 (0.7%)	
Unknown				

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#### The primary outcome: rate of return to the ED within seven days

Re-attendance within seven days was found following 2.2% (N = 194) of the 3197 index visits for which these data were available. The high rate of unknown data is accounted by one site where these data were not captured in the electronic dataset and were only retrieved manually for a random sample (n=205) for the purposes of this study. After adjustment for confounding, no statistically significant difference was found for cases seen by PAs or FY2 doctors-in-training; see Table 2.

Table 2: Re-attendance at the same ED within seven days

<b>Re-attendance</b>	PA	FY2 doctor	Total	Unadjusted odds ratio	Adjusted odds ratio
at the same ED within seven	(N = 1129)	(N = 2068)	(N = 3197)	(95% CI) and p-value	(95% CI) and p-value
days				(PA relative to FY2	(PA relative to FY2
				doctor-in-training) in	doctor-in-training) in
				rate of re-attendance	rate of re-attendancee†
No	1066 (04 49/)	1027 (02 79/)	3003		
INO	1000 (94.4%)	1937 (95.7%)	(93.9%)	0.87 (0.64, 1.19)	0.87 (0.61, 1.24)
Vac	62(5.69/)	121 (6 20/)	194	p=0.388	p=0.437
1 05	03 (3.0%)	131 (0.3%)	(6.1%)		
Unknown	1251	4368	5619	-	-

†Adjustment made for triage score (as a measure of acuity), age band, sex, admission, x-ray and site; no
adjustment was made for clustering as the ICC by individual staff member on outcome was small (0.008) and
statistically insignificant (p= 0.236).

#### 14 Secondary outcome: consultation processes

No differences were found between patients attended by PAs or by FY2 doctors-in-training in: whether prescriptions were given, admission to hospital from the ED, or if a discharge summary was completed. However, patients seen by a PA were more likely to have an x-ray performed in the ED (Table 3), less likely to be admitted to hospital, and to have a shorter length of stay in the ED (by 35 minutes), after adjustment for age, sex, acuity, whether admitted, x-ray taken, and site, as well as for clustering by individual clinician, although no account was able to be taken of the staffing level.
We observed PAs being the first member of the medical team to carry out assessment of patients

following triage to either the major, minor or paediatric areas of the ED. We noted that PAs saw

25 patients independently, following a medical history taking and examination model, before reporting in

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3 4	1	person to the senior ED physician in the same way as nurse practitioners and FY2 doctors-in-training
5	2	did.
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### 1 Table 3 Clinical process measures

Clinical process measure	PA (N = 2381)	FY2 doctor (N = 6435)	Total (N = 8816)	Unadjusted odds ratio (95% CI) and p-value (PA relative to FY2 doctor-in- training) in rate of re- attendance	Adjusted odds ratio (95% CI) and p-value (PA relative to FY2 doctor-in-training) in rate of re-attendancee†		
X-ray investigatio	ons performed						
	559 (49.4%)	1701	2260				
No		(82.3%)	(70.7%)	4 76 (4 04 5 59) p<0 001	2 70 (1 72 4 24) p<0 001		
Yes	572 (50.6%)	366 (17.7%)	938 (29.3%)		, (,)p		
Unknown	1250	4368	5618	-	-		
Prescriptions give	en in the ED	6					
No	174 (58.0%)	157 (51.8%)	331 (54.9%)		/		
Yes	126 (42.0%)	146 (48.2%)	272 (45.1%)	0.79 (0.56, 1.07) p=0.127	1.35 (0.08, 23.5) p=0.8		
Unknown	2081	6132	8213				
Admitted as an in	patient from th	ne ED	R.				
No	883 (78.2%)	1436	2319				
110		(70.1%)	(73.0%)	0.65(0.55, 0.77) p<0.001	0.78 (0.55, 1.1) p=0.158		
Yes	246 (21.8%)	613 (29.9%)	859 (27.0%)	0.05 (0.55, 0.77) p<0.001			
Unknown	1762	3876	5638	2			
Discharge summa	ary completed			0.			
No	86 (42.4%)	71 (34.6%)	157 (38.5%)				
Yes	117 (57.6%)	134 (65.4%)	251 (61.5%)	0.72 (0.48, 1.08) p=0.109	1.57 (0.93, 2.66) p=0.09		
Unknown	2178	6230	8408				
†Adjustment made	for MTS (as a 1	neasure of acuit	ty), age band, se	ex, and site, and for clustering	where the ICC		
(and p-value) is sig discharge summary	gnificant: x-ray ( y <0.001 (p=0.4)	0.04 (p<0.001), 98)	prescriptions 0.	73 (p<0.001), admitted 0.02 (j	p=0.001),		

PAs were differentiated from FY2 doctors-in-training by many of our interviewees for not being able to prescribe medications or order tests utilising ionising radiation. Some participants considered this to have a detrimental impact on PAs and patients:

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1 [prescribing] would make a massive difference for them as well and [for] patients because at the end 2 of the day they're having to wait for the PAs to go talk through [with] the physicians what's going on 3 and then probably see somebody else. Participant 118 Nurse practitioner

However, PAs were observed taking on several roles in relation to prescriptions and x-ray orders, for example suggesting medications to or charting the medication for a senior doctor to sign off:

8 So when one of my PAs comes to me and says "This patient has a temperature of 38, they're coughing 9 up horrible green sputum and they're tachycardic and I listened to their chest and they've got

10 crackles at the left base, can we order a chest x-ray and prescribe sepsis drugs for, you know,

pneumonia?" I say "Yes" and I sign it. With probably more confidence at this stage having had 11

12 [number] PAs here for a year than I would with a junior physician in training on day two. And the

13 irony of that is of course, the junior physician in training doesn't need to come and ask me,

technically, they can prescribe themselves. Participant 21 Emergency Medicine consultant 14

16 PAs were also observed making referrals to medical and surgical teams outside of the ED, completing 17 discharge summary information, and carrying out procedures, most commonly cannulation, 18 phlebotomy and suturing.

20 Secondary outcome: clinical adequacy

21 Our reviewers found the chart documentation to have been 'appropriate' or 'with no errors or 22 omissions that resulted in significant probability that the patient might be harmed' in 36/40 cases for 23 all of the key consultation components (Table 4). In the three records (two of FY2 doctors-in-training 24 and one of a PA) judged as having errors or omissions at the level of a breach in normal guidelines 25 and procedures that would have altered the patient's treatment, all reviewers agreed that a senior 26 doctor review had occurred in one case; this was unclear in the other cases. Our observation data 27 suggest that such a senior review was undertaken for all assessment and clinical decision making in 28 the 'majors' sections of the ED, but that 'minors' care was often completed independently. 29

30 Our reviewers were 40% sensitive, 46% specific on judging the clinician type: 68% (13/19) of the PA 31 records were thought to be of a FY2 doctor-in-training and 60% (9/15) vice versa (kappa score for 32 inter-rater agreement 0.15).

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## 35 Table 4: Chart reviewers' assessments of clinical adequacy

		Judgment of appropriateness																							
PA or FY2		Past medical history				Exa	ninati	on		Requ	uest fo	r		Trea	tment	plan a	and	Advice given				Follow up			
consultati	on										radiography*			decision											
record		Ap	Error or			Ap	Erro	Error or		Ap	Erro	r or	Ap		Error or			Ap	Error or			Ap	Error or		
		prop	omis	sion		prop	omis	sion		prop	omis	sion		prop	omis	sion		prop	omis	sion		prop	omis	sion	
		riate	Harm unlikely	Altered treatment	Harm	riate	Harm unlikely	Altered treatment	Harm	riate	Harm unlikely	Altered treatment	Harm	riate	Harm unlikely	Altered treatment	Harm	riate	Harm unlikely	Altered treatment	Harm	riate	Harm unlikely	Altered treatment	Harm
FY2	n	14	6	0	0	15	5	0	0	9	0	1	0	14	5	1	0	4	1	1	0	16	3	0	0
	%	70	37	0	0	75	25	0	0	45	0	5	0	70	25	5	0	20	5	5	0	80	15	0	0
PA	n	13	5	1	0	11	7	1	0	9	3	0	0	13	5	1	0	3	1	1	0	13	4	1	0
	%	65	25	5	0	55	35	5	0	45	15	0	0	65	25	5	0	15	5	5	0	65	20	5	0
Not	n			1			1	1		18			1				29				3			·	
rated*	%		2	.5			2	.5		45				2.5				6	7	3		7.5			
Total	n	27	11	1	0	26	12	1	0	18	3	1	0	27	10	2	0	7	2	2	0	29	7	1	0
	%	68	28	3	0	65	30	3	0	45	8	3	0	66	25	5	0	18	5	5	0	73	18	3	0
Agreemen	t	0.01				0.15				0.26				0.15				-0.03	5			0.30			
(Fleiss kap	pa,																								
combined)																									
Agreemen	t	0.04	-0.02	-0.04	n/a	0.17	0.12	0.15	n/a	0.29	0.11	0.33	n/a	0.24	0.01	0.14	n/a	-0.00	0.11	0.08	n/a	0.36	0.20	0.28	n/a
(Fliess kap	opa,																								
by respons	e)																								

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 37 \*Missing rating or rated as 'not applicable' if no request for radiography was made or no advice given

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3 ⊿	1	Interviewees also presented other aspects related to clinical adequacy, particularly the PAs' stability
5	2	in the team. The clinicians' familiarity with the longer standing team member PA/s - in contrast to
6 7	3	FY2 doctors-in-training on rotation - was raised repeatedly:
8	4	
9 10	5	If there was a junior physician over here, and he said oh, what do you think of this wound,
11	6	which they do ask us. And I say yeah, it needs suturing. I then have to say, but can you suture
12 13	7	or do you want me to suture it?Because I don't know, and some will say oh no, I
14	8	can'tI've never sutured before, and some will say oh yeah, that's fine, I'll suture
15 16	9	itWhereas I know with PAs they'll suture their own. Because I know that they've got that
17 18	10	skill set. Participant 177 Advanced nurse practitioner
19	11	
20 21	12	Secondary outcome: patient experience
22	13	
23 24	14	Patients were positive about the care they had received from the PA, but had not understood what the
25 26	15	PA role meant, with two participants believing they had been seen by a doctor and another unsure in
20 27 28	16	the context of multiple ED staff:
29 30	17	I presumed he was a fully-qualified physician, yes his approach and everything was
31 32	18	absolutely 100%. Participant 120 Patient
33 34	19	Most of our patient participants were receptive to the role on the grounds that it might speed up care,
35	20	although they were not without concern for the difference in training from a doctor and the
36 37 38	21	diminishment of a senior medical workforce:
39	22	It's good to have another person, another opinionbut would it not perhaps be better to have
40 41 42	23	another doctor? Participant 083 Patient's relative
43 44 45	24	
46 47	25	Discussion
48 49	26	
50 51	27	Summary of findings
52	28	The study presents evidence from three English EDs and has demonstrated no difference in safety or
53 54	29	appropriateness between PAs and FY2 doctors-in-training. We report no difference in re-attendance
55	30	rates. Those patients seen by a PA (within PA working hours 08-22.00) had a shorter average length
50 57	31	of stay in the ED than those seen by doctors-in-training (24 hour working period). Our review of
58 50	32	clinical adequacy found few errors and no difference between PAs and FY2 doctors-in-training.
60	33	Patients appeared relatively unconcerned with the title of the clinician treating them and thought they
		Page 18 of 25

had been treated by a doctor; however they were keen to know that the employment of PAs would not
 represent a widespread substitution for doctors in the ED.

#### How this study is similar or different from prior studies

We believe this to be the first empirical study of the outcomes of care provided by UK-trained PAs in the ED, and the first internationally to include interview and observation data. Additonally, patients' views do not appear to have been previously gathered at the time of the visit (and qualitaitvely), although there have been previous questionnaire studies in the USA of patient satisfaction,

administered after the visit.[28,29,30]

We reported few differences in the the practice and processes of care – other than prescribing (which PAs currently cannot do independently in the UK) – between PAs and doctors in their second foundation year of training. Our finding of no difference in the primary outcome (ED reattendance rate within seven days) for patients of PAs and FY2 doctors-in-training is consistent with the comparisons of nurse-qualified NPCs and FY2 doctors-in-training on which we based our study design [22,23] and other PA literature from the USA.[16] It should be noted that for patients in the majors section of ED, all assessment and treatment plans by FY2 doctors-in-training and NPCs were reviewed and agreed by a senior clinician. Our participants commented frequently on the transient nature of FY2 doctors-in-training, whose rotation in the ED only last four months. In contrast, PAs remained long-term and provided continuity in the team. Their accumulated knowledge of the policies and practices (clinical and otherwise) of the department, the consultants and the hospital was reported to enable operational efficiencies. Simlar observations about PAs providing continuity within the medical/surgical team have been made in North America and the Netherlands[31-33] and also for other NPCs.[34]

This study's strengths lie in its mixed-methods approach to the study of PAs in the ED, allowing consideration of different types of data on their contribution, compared to that of FY2 doctors-intraining, to be considered. We were able to carry out a well-powered quantitative comparative analysis of the documented processes and outcomes of patient care by PAs and FY2 doctors-in-training in three EDs in different parts of the country, and to gather qualitative data on PAs 'in practice'. The qualitative component of our mixed methods approach enabled contextual explanations of the quantitative analysis.

Our study however has several limitations. Our comparison of PAs and doctors working in all areas of
 the ED introduced the potential for PAs and FY2 doctors-in-training to be attending to patients of
 different acuity and complexity. We sought to mitigate this by using three different EDs, taking a

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1 sample across a 16 week period at all times of day and night (although the FY2 doctors-in-training 2 worked over the 24 hour period when staff:patient ratios may have fluctuated). We also made statistical 3 adjustments that included triage category. The low sensitivity of most ED triage systems to 4 identification of conditions other than the most serious, however, is a drawback.[35] The prevention of 5 collection of 28 day outcomes by NHS organisations was also a barrier, particularly as we had based 6 our sample size calculation on that, as opposed to the lower 7-day return rate.

7 The level of missing data for some variables in the routinely collected data, and not having data from 8 which to take into account whether PA reduced the staff: patient ratio (or fully replaced FY2 doctors-9 in-training) is a further limitation and needs to be borne in mind in the comparisons we present. 10 Likewise, our observation data illustrated care is predominently delivered by teams which creates 11 difficulties in attributing outcomes or processes to individual staff, and compromised our ability to 12 undertake an economic evaluation.

Our interview invitations yielded relatively small numbers of participants, particularly amongst patients/relatives. While we attribute this in part to the fast patient throughput of the ED and limited availability of the researcher, this limits our analysis

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### 17 Implications for policy and practice

have observed, particularly the cost effectiveness.

PAs in the ED are acceptable to patients and can help to relieve staffing pressures and improve efficiency in the delivery of care. They are able to treat patients safely with a range of conditions and FY2 doctors-in-training deliver similar care to that provided by doctors in their second year of training. Deployment of PAs within ED teams is a potential solution to the situation of growing patient demand and predicted shortage of junior doctors in the British NHS[7], of which FY2 doctors on rotation in specialties such as the ED are one part; it is not our intention to raise or limit PAs to one particular junior doctor comparator level, but we have used this here as the closest pragmatic comparator. An alternative, which is to hire locum doctors, comes at a higher costs and loss of team continuity, and has potential implications for patient safety. Moves to regulate the PA profession under the General Medical Council were started in 2019.[36] The findings of this study support employment of appropriately trained, supervised PAs with professional registration in ED teams. Further research is needed to investigate fully the impacts we

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## 1 Supplementary material

- 2 Supplementary material 1: Extract of the chart review dataset
- 3 Supplementary material 2: Proforma for the assessment of clinical adequacy
- 4 Supplementary material 3: Observation guide
- 5 Supplementary material 4: Tailored topic guides for the interview
  - 7 Author Statement
- 8 VMD (PhD, health policy and service delivery research), MH (PhD, health services research), JP
- 9 (MD, general practice and clinical education), HG (PhD, health economics), SdeL (MD[Res], general
- 10 practice and information science), JG (PhD, medical sociology), SB (BSc, patient and public
- 11 engagement), and PB (PhD, audiology and strategic management) conceived and designed the study
- 12 and obtained research funding. VMD, MH, JP supervised the conduct of the study and data collection.
- 13 VMD, MH, JP undertook recruitment of participating centers and managed the data, including quality.
- 14 CWa (PhD, statistics) undertook the statistical analysis; CW (PhD, health services research), LN
- 15 (PhD,health services research), MH, JE (MSc, physician associate and education) and VMD
- 16 undertook qualitative data collection and thematic analysis and HG considered the economic aspects.
- 17 MH drafted the manuscript, and all authors contributed substantially to its revision. VMD takes
- 18 responsibility for the paper as a whole.
- All authors attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
- 26 The Patient and Public Involvement statement

27 The patient and public voice was important to this study and informed the design, conduct, analysis, interpretation and final reporting. We brought the views of our public and patient representative forum 28 29 for a previous study on physician associates into the research questions and design of the study. These 30 were views such as how do patients understand this new role. Sally Brearley, as a public voice 31 representative, was a co-applicant and member of the research team. The study advisory group had 32 two public voice members who were reimbursed for their time, following NIHR INVOLVE guidance. 33 Two patient and public voice groups were formed: one in London and the other in the West Midlands 34 and members reimbursed as per NIHR Involve guidelines. The patient and public voice groups 60

informed the design of the research tools such as topic guides and participant information sheets, developed coding frameworks and analysed interview transcripts, and participated in the overall synthesis of findings. Sally Brearley continues to be involved in the dissemination of the study.

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#### Data statement

No additional data are available.

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## Supplementary file 1: Extract of the chart review dataset (first 50 cases, according to date of attendance)

study id same	nle case site	numbage for	rmatted sex for	ormatted a	arrival date arrival tim	e seen time presenting complaint	mts	ews	ed stream pro	fession grays fo	rr nxn forr	n diagnosis	discharge timed	estination a	redischarge discharge discha	rge reattend	t reattend dat
C\$30115	0	3	5	0	05-Aug-16 9:10:00 F	10:56:00 PM Flank Pain(renal colic 3vrs ago)	#NULL!	#NULL!	1	1 #NULL	#NULL!	Renal colic	2:07:00 AM	#NUII!	#NULLI #NULLI	#NULL	#NULL!
C\$30197	0	3	6	1	05-Aug-16 7:54:00 F	10:01:00 PM Abdo/Back Pain 5/7	3	#NULLI	#NUU1	1 #NULL!	#NULL!	Generally unwell	1:40:00 AM	#NULLI	#NULLI #NULLI	#NUU1	#NULLI
C\$30415	0	3	4	1	05-Aug-16 4:51:00 F	7:05:00 PM 21/40 2DVT on clexane	3	#NULLI	#NULLI	1 #NULL!	#NULL!	Acute coronary syndrome	8:50:00 PM	#NULLI	#NULLI #NULLI	#NULL!	#NULLI
C\$30514	0	3	5	1	05-Aug-16 1:08:00 I	2:15:00 PM swelling to arm/hand 2clot	3	#NUULI	#NUULI	1 #NULLI	#NULLI	Deep venous thrombosis	5:07:00 PM	#NULLI	#NULLI #NULLI	#NUILL	#NULLI
C\$30726	0	3	3	-	05-Aug-16 11:45:00 F	1:12:00 AM HEADACHE	2	#NULLI	1	1 #NULL!	#NULL!	Unknown problem	1:58:00 AM	#NULLI	#NULLI #NULLI	#NUILI	#NULLI
C\$30962	0	3	4	0	05-Aug-16 4:26:00 F	6:59:00 PM Back Pain(mr maurice hulging disc)	3	#NULLI	#NUU1	0 #NULL	#NULL!	Chronic back pain	8:20:00 PM	#NULLI	#NULLI #NULLI	#NUU1	#NULLI
C\$30993	0	3	4	1	05-Aug-16 6:57:00/	M 8:04:00 AM Enigastric Pain 13months on/off	1	#NULLI	#NULLI	1 #NULLI	#NULLI	Acute gastritis	10:54:00 AM	#NULLI	#NULLI #NULLI	#NUULI	#NULLI
CS21042	0	2	-	1	05 Aug 16 10:40:00			#NULLI	#NULLI	1 #NUULI	#NULLI	IIII - Urinary tract infection	2:12:00 AM	#NULLI	#NULLI #NULLI	#NUULI	#NULLI
CS31043	0	2	2	1	05-Aug-16 0-56-001	M 11:21:00 PM PV Pload+gramps(bloads with gp pad)	4	#NULLI	#NULL!	1 #NULL!	#NULLI	Monorrhagia	1.56.00 AM	#NULLI	#NULLI #NULLI	#NULL!	#NULLI
CS21275	0	2	0	1	05-Aug-16 9:55:001	M 10:50:00 PM opigastric pain		#NULLI	1	0 #NUULI	#NULLI	Wertormagia	12:29:00 AM	#NULLI	#NULLI #NULLI	#NULL!	#NULL!
CS31275	0	2	1	1	05-Aug-16 4-26-001	M 5:48:00 PM not passing uring /fooding upsettled	2	#NULLI	#NUULI	0 #NULL!	#NULLI	Woll child	6:52:00 PM	#NULLI	#NULLI #NULLI	#NULL!	#NULLI
CS21572	0	2	2	0	05 Aug 16 11:20:00 I	M 12:42:00 AM Sickle cell attack	2	#NULLI	#NULLI	1 #NUULI	#NULLI	Sickle cell anomia crisis	2:19:00 AM	#NULLI	#NULLI #NULLI	#NUULI	#NULLI
CS31572	0	3	0	1	OF Aug 16 9:52:00 /	M 0/28/00 AM HI upwitnessed stumbling on street	2	#NULLI	#NULL!	1 #NULL!	#NULLLI	Head injung	12:50:00 DM	#NULLI	#NULL #NULL	#NULL!	#NULL!
C531640	0	3	0	1	05-Aug-10 8.55.00 A	10:32:00 AM FALL	3	#NULL!	#NULL!	1 #NULL!	#NULL!	Fall	12.30.00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS31040	0	3	2	1	05-Aug-16 10:24:00 /	NU 10.35.00 ANI FELING FAINT	5	#NULL!	#NULL!	1 #NULL!	#NULL!	Fainting	2.23.00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
C551041	0	3	3	1	05-Aug-16 10.46.007		4	#NULL!	#NULL!	1 #NULL!	#NULL!	Veniting bile stained	2.05.00 PIVI	#INULL!	#NULL! #NULL!	#NULL!	#INULL!
CS31642	0	3	1	0	05-Aug-16 3:04:001	10:00:00 PM unwell vomiting yellow	450001	#NULL!	#INULL!	1 #NULL!	#NULL!	Contrary attached	6:01:00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#INULL!
CS31644	0	3	8	1	05-Aug-16 8:17:001	10:06:00 PM abdo pain	#INULL!	#NULL!	4511111	1 #NULL!	#NULL!	Gastroenteritis	12:17:00 AIVI	#NULL!	#NULL! #NULL!	#NULL!	#INULL!
CS32315	0	3	4	1	05-Aug-16 9:35:001	11:24:00 PM neadaches	3	#NULL!	#INULL!	1 #NULL!	#NULL!	Abdaminal asia	2:49:00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#INULL!
CS32354	0	3	2	1	05-Aug-16 8:43:001	10:24:00 PM early pregnant, abdominal pain	3	#NULL!	#INULL!	1 #NULL!	#INULL!	Abdominal pain	12:18:00 AIVI	#INULL!	#NULL! #NULL!	#NULL!	#NULL!
CS32524	0	3	9	1	05-Aug-16 2:48:00 F	3:46:00 PM FALL unwitnessed, unsteady (dementia)	3	#NULL!	#NULL!	1 #NULL!	#NULL!	Fall - accidental	6:44:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS326/1	0	3	6	0	05-Aug-16 3:10:00 P	4:02:00 PM /SEIZURE, hand was twitching (ca brain)	3	#NULL!	#NULL!	0 #NULL!	#NULL!	Partial seizure	7:10:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS32693	0	3	8	1	05-Aug-16 10:20:00 F	M 11:23:00 PM RUQ Pain 3/7	4	#NULL!	1	1 #NULL!	#NULL!	Abdominal pain	2:19:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS32/13	0	3	9	0	05-Aug-16 4:09:00 l	4:37:00 PM_UNWELL(bradycardia atropine given)	3	#NULL!	#NULL!	0 #NULL!	#NULL!	Acute confusion	8:09:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS32840	0	3	7	0	05-Aug-16 11:06:00 /	M 12:02:00 PM SOB/Right sided CP (PE, pneumonia)	3	#NULL!	#NULL!	1 #NULL!	#NULL!	Pulmonary embolism	3:07:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS32973	0	3	6	0	05-Aug-16 6:32:001	M 9:01:00 PM Paraphimosis	4	#NULL!	#NULL!	1 #NULL!	#NULL!	Paraphimosis	10:02:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
6622011					05 4 10 0.50.001		450.0.1			4 450 0 1 1	4611111	(discolor)	10.51.00 014	4511011			450.011
CS33011	0	3	8	1	05-Aug-16 6:52:001	NI 8:55:00 PM SUICIDAI/Intoxicated (etch)	#INULL!	#NULL!		1 #NULL!	#NULL!	(disorder)	10:51:00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#INULL!
CS33793	0	3	7	1	05-Aug-16 2:25:00 P	M 3:14:00 PM COLLAPSED/AP /Seizure	3	#INULL!	#INULL!	1 #NULL!	#INULL!	Small bower obstruction	6:25:00 PIVI	#INULL!	#NULL! #NULL!	#NULL!	#INULL!
CS33926	0	3	/	1	05-Aug-16 11:44:00 /	IN 12:45:00 PM painfull red eyej	2	#NULL!	#NULL!	1 #NULL!	#NULL!	Red eye	3:05:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS34018	0	3	8	0	05-Aug-16 11:05:00 P	M 12:34:00 AM 2011	3	#NULL!	#NULL!	1 #NULL!	#NULL!	Urinary tract infection	2:57:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS34076	0	3	3	1	05-Aug-16 6:35:00 F	101 8:54:00 PM ? chronns flare up/black stools	4	#NULL!	#NULL!	1 #NULL!	#NULL!	Cronn's disease (disorder)	10:34:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS31018	1	3	9	1	05-Aug-16 6:26:00 F	1VI 8:19:00 PM SOB(Inpatient langley green)	4	#NULL!	#NULL!	0	1 #NULL!	Pheumonia	4:57:00 AM		1 1.00 ######### SPR		0 #NULL!
CS31643	1	3	5	0	05-Aug-16 8:03:00 P	M 10:05:00 PM Flank Pain(renal colic)	3	(	J 1	0	0 #NULL!	Left flank pain	11:13:00 PM		0 1.00 ######### Consu	.lan (	0 #NULL!
CS32456	1	3	/	0	05-Aug-16 /:2/:001	M 9:39:00 PM sudden onset pain L testis	4	(	) #NULL!	0	0 #NULL!	O/E - testicular swelling	11:23:00 PM		0 1.00 ######### Consu	lan (	0 #NULL!
CS30038	0	3	7	0	06-Aug-16 7:45:00	M 9:01:00 PM 2/7 hx CCP	3	#NULL!	#NULL!	1 #NULL!	#NULL!	pneumonia	9:46:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
C\$30156	0	3	з	1	06-Aug-16 1:19:00 /	M 3:08:00 AM Headache took 24xParacetamol 500mg+4 kalms	2	#NUUU	1	1 #NUU	#NUUU	Paracetamol overdose	7-39-00 AM	#NULLI	#NUU1 #NUU1	#NUUU	#NULLI
C\$30320	0	3	5	0	06-Aug-16 1:55:00 A	M 4:00:00 AM Assault HI/Ift shoulder pain	4	#NULL!	1	1 #NULL!	#NULL!	Assault	5:55:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
C\$30351	0	3	3	1	06-Aug-16 2:02:00 A	M 4:16:00 AM Far Infection(flucloxacillin)	4	#NULL!	#NULL!	1 #NULL!	#NULL!	Otitis media	5:25:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
C\$30392	0	3	7	-	06-Aug-16 7:08:00 I	M 8:58:00 PM R flank nain		#NULLI	#NUULI	1 #NULLI	#NULLI	Renal colic	10:24:00 PM	#NULLI	#NULLI #NULLI	#NUILL	#NULLI
C\$30392	0	3	3	0	06-Aug-16 7:00:001	M 8:58:00 PM 2collanse - been drinking		#NULLI	#NULLI	1 #NUULI	#NULLI	Drunk	10:43:00 PM	#NULLI	#NULLI #NULLI	#NULLI	#NULLI
C\$20458	0	2	9	0	06 Aug 16 11:40:00 I	M 1:47:00 AM chost pain	2	#NULLI	#NULLI	1 #NUULI	#NULLI	Stable angina (disorder)	2:49:00 AM	#NULLI	#NULLI #NULLI	#NUULI	#NULLI
C\$20605	0	2	6	0	06 Aug 16 11.45.001	M 12:02:00 AM BTC 14brs age lower back pain beadache	1	#NULLI	#NULLI	1 #NUULI	#NULLI	Back pain	12:44:00 AM	#NULLI	#NULLI #NULLI	#NUULI	#NULLI
C530093	0	3	0	0	06 Aug 16 11:10:00 I	12.52.00 AM non opiloptic solver back part, readacte		#NULLI	#NULL!	1 #NUULI	#NULLL	Chronic confusion	10:12:00 AM	#NULLI	#NULL #NULL	#NULL!	#NULL!
C530654	0	3	3	1	06 Aug 16 0:09:001	11.14.00 PM OD (Montal health		#NULL!	#NULL!	1 #NULL!	#NULL!	Colf discharge	10.15.00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS31121	0	2	2	1	06-Aug-16 2:22:00 /	M 2:52:00 AM Passing small amounts uring	#NULL!	#NULL!	#INULL!	1 #NULL!	#NULL!	Ponal colic	12.20.00 AIVI	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
C531203	0	3	2	1	06 Aug 16 2:22:00 /	M 5/02/00 AM smoked signate feels funny	#INULL!	#NULL!	1	1 #NULL!	#NULL!	Cigaretta concumption	5.57.00 AIVI	#NULL!	#INULL! #INULL!	#NULL!	#NULL!
C331252	0	3	2	1	00-Aug-10 2:29:007	AND STORED PARTY STOKED CIGATETTE TEETS TURING	4	#NULL!	4511111	1 #NULL!	#INULL!	Cigarette consumption	5:42:00 AIVI	#INULL!	#INULL! #INULL!	#NULL!	#INULL!
0021250	0	3	4	1	UD-AUG-16 8:00:001	IVI 9:39:00 PIVI FLANK PAIN, KIDNEY STONES	4	#NULL!	#NULL!	1 #NULL!	#NULL!	Flarik pain (finding)	12:00:00 AM	#NULL!	#INULL! #INULL!	#NULL!	#NULL!
CS31358	0		2		OC 4 4C 4D									*****		#NITE	TTALL
CS31358 CS31534	0	3	3	1	06-Aug-16 12:45:00 /	M 2:08:00 AM Epigastric Pain	4	#NULL!	1	1 #NULL!	#NULL!	Gastritis	4:39:00 AM	#INULL!	#NULL! #NULL!	#INOLL:	#NOLL:
CS31358 CS31534 CS31607	0	3	3	1	06-Aug-16 12:45:00 / 06-Aug-16 1:41:00 /	M 2:08:00 AM Epigastric Pain M 3:08:00 AM Abdo/back Pain	4	#NULL! #NULL!	1 #NULL!	1 #NULL! 1 #NULL!	#NULL! #NULL!	Palpitations - fluttering	4:39:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!

Supplementary material 2, assessment of clinical adequacy questions

Excel spread sheet sent to each reviewer to complete for all records. One column for each record -

reviewer to fill in id number

	Questions *	Insert study ID number from top of record
		Drop down response options followed by a cell for free text if
		appropriate
1	Record of the patient's medical	Appropriate
	history	Or
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
		the patient might be harmed
	Free text on rationale or	
	comment on response to item 1	
2	Examination of the patient	Appropriate
		Or
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines
		and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
	Erectorit or retionals or	the patient might be narmed
	comment on response to item 2	
3	Paquast for radiography	Appropriate
5	Request for factography	Or
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines
		and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
		the patient might be harmed
	Free text on rationale or	
	comment on response to item 3	
4	Treatment plan and decision	Appropriate
		Or
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines
		and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
		the patient might be harmed
	Questions *	Insert study ID number from top of record Drop down response options followed by a cell for free text if appropriate
---	--	---
	Free text on rationale or comment on response to item 4	
5	Treatment plan and decision reviewed by senior doctor	YES Or NO
6	Advice given	Appropriate Or Error or omission – but unlikely to have resulted in harm or different treatment Or An error or omission seen that caused a breach in normal guidelines and procedures that would have altered the patient's treatment Or
	Free text on rationale or	An error or omission seen that resulted in significant probability that the patient might be harmed
	comment on response to item 6	
7	Follow-up	Appropriate Or Error or omission – but unlikely to have resulted in harm or different treatment Or An error or omission seen that caused a breach in normal guidelines and procedures that would have altered the patient's treatment Or An error or omission seen that resulted in significant probability that the patient might be harmed
	Free text on rationale or comment on response to item 7	
8	In your view what type of clinician attended this patient?	Doctor Or Physician associate Or Unable to decide
	Free text on rationale or	

with doctors in the ED.



### **OBSERVATION: AIDE MEMOIRE for researchers**

Our observation aims to support answering the four study research questions but specifically to

provide data on impact on organisation of services, other team members working practices and team relationships.

We wish to be able to consider this in terms of:

- Acceptability -how do they appear to be viewed or treated by others?
- Appropriateness how are they observed in terms of safety e.g. how do they check, how are they checked upon, how are they supervised?
- Equity who receives the PA service; do any patient groups appear to be over represented?
- Efficiency how do they appear to contribute to this? How are issues, such as prescribing, worked around?
- Effectiveness are the outcomes of PA care or contribution to the team observed?

We are observing context, relationships and activities.

#### **Conduct of the observation**

- Put up approved notices of our observation activity in the study setting places advised by the clinical team
- Provide the PA with the approved script to inform patients/ patients' representatives to gain permission for the researcher's presence. Each patient is to be asked for permission.
- Researcher to maintain an unobtrusive presence
- Record observations in the ethnographic tradition take detailed unstructured notes, bearing in mind the importance of capturing context, relationships and activities
- Record as much as possible at the time and add as soon as possible afterwards
- Length of observation to be pre-planned but also to allow for flexibility according to the PA's wishes, the demands of the clinical setting and researcher's length of focus
- Allow the PA to see the notes at any point

#### After the observation

- Add to the notes as soon as possible where detail was not able to be captured at the time
- Maintain a reflective diary associated with the observation conduct and analytical processes.
- Discuss the observation with local research team members to promote group understanding and consistency across researchers
- Transfer data into NVivo software.

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Supplementary data file 4: Tailored topic guides for the interview

#### Topic guide for senior managers and clinicians

Topic areas

- Confirm the person's job role
- Ask them to describe their involvement with physician associate employment in the hospital to date
- Ask questions on the factors supporting the adoption of the employment of physician associates
- Ask questions on the factors inhibiting the employment of physician associates
- Questions on their views of physician associates' impact on (ask for examples):
  - Organisation of services
  - Patient experience and outcomes
  - Other staff
  - Costs
- Anything else they would like to say?

**Interviewer to probe** on all answers to ensure the meaning is clear (e.g. that is an interesting point, can you explain a bit more about it) and check for understanding (e.g. so can I check I have understood you correctly)......

**Interviewer to check** for any routine management reports or data or evaluations that the hospital team would be willing to share with the researchers.

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data.

#### Topic guide for physician associate interviews

#### Topic areas

- Ask them to describe how long they have been a physician associate, how many posts, type and length as a physician associate
- Ask them to describe the work they undertake, with what type of medical/surgical team
- Ask about their supervising doctor and arrangements when they are not there
- Ask questions on their views of the factors supporting the adoption of the employment of physician associate in their experience

- Ask questions on their views of the factors inhibiting the employment of physician associate in their experience
- Ask how they have been received in the hospital as a new type of health professional?
- Ask how they explain to patients, family and staff who they are and what a physician associate is
- Questions on their views of their, or other physician associates, impact on (ask for examples):
  - Organisation of services
  - o Patient experience and outcomes
  - Other staff
  - Costs
- Anything else they would like to say?

**Interviewer to probe** on all answers to ensure the meaning is clear (e.g that is an interesting point, can you explain a bit more about it) and check for understanding (e.g. so can I check I have understood you correctly)......

**Interviewer to check** for any routine management reports or data or evaluations that the hospital team would be willing to share with the researchers .

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data.

#### Topic guide for all other types of professionals/managers interviews

- Confirm the person's job role
- Ask them to describe their involvement with physician associate employment in the hospital to date
- Ask questions on their views of any factors supporting the adoption of the employment of physician associates in their experience
- Ask questions on their views of any factors inhibiting the employment of physician associates in their experience
- Ask their views as to how the PAs have been received in that service/team, and probe for any explanations

- Questions on their views of physician associates' impact on (ask for examples):
  - Organisation of services
  - Boundaries between the job roles of different types of professionals e.g. with nurses
  - Patient experience and outcomes
  - Other staff
  - o Costs
  - Anything else they would like to say?

Interviewer to probe on all answers to ensure the meaning is clear (e.g that is an interesting point, can you explain a bit more about it ) and check for understanding (e.g. so can I check I have understood you correctly ).....

Interviewer to check for any routine management reports or data or evaluations that the hospital team would be willing to share with the researchers.

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data. 4. 4. 2. 0. 1.

#### **Topic guide for patient interviews**

Topic areas

- Confirm the person is/has been a patient •
- Ask them to outline the type of care they have been in receipt of without giving personal medical details e.g. in patient for x days
- Confirm the patient has met the physician associate •
- Explore what sort of involvement the physician associate has had with them
- Ask them how they understand the role of the physician associate in the medical/surgical team
- Ask them how they found receiving care from a physician associate
- If they were to need similar medical or surgical care, would they be content to receive • similar care from a physician associate in the future as they had this time (and can

they explain why) or would they prefer someone different? And if yes, can they explain why?

• Anything else they would like to say?

**Interviewer to probe** on all answers to ensure the meaning is clear (e.g. that is an interesting point, can you explain a bit more about it) and check for understanding (e.g. so can I check I have understood you correctly).

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data.

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O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health services research. J Health Serv Res Policy. 2008;13(2):92-98.

Box 1 Good Reporting of A Mixed Methods Study (GRAMMS)

GRAMMS criterion	Page in manuscript
(1) Describe the justification for using a mixed methods approach to the research question	8
(2) Describe the design in terms of the purpose, priority and sequence of methods	8
(3) Describe each method in terms of sampling, data collection and analysis	8-10
(4) Describe where integration has occurred, how it has occurred and who has participated in it	10
(5) Describe any limitation of one method associated with the present of the other method	18-19
(6) Describe any insights gained from mixing or integrating methods	18-19

S1	Title and abstract Title	Concise description of the nature and topic of the study Iden
S1	Title	Concise description of the nature and topic of the study Ident
THE REPORT OF TAXABLE PARTY.		the study as qualitative or indicating the approach (e.g., ethno grounded theory) or data collection methods (e.g., interview, group) is recommended
52	Abstract	Summary of key elements of the study using the abstract form the intended publication; typically includes background, purpo methods, results, and conclusions
an a	Introduction	
\$3	Problem formulation	Description and significance of the problem/phenomenon stud review of relevant theory and empirical work; problem stateme
S4	Purpose or research question	Purpose of the study and specific objectives or questions
	Methods	
\$5	Qualitative approach and research paradigm	Qualitative approach (e.g., ethnography, grounded theory, case phenomenology, narrative research) and guiding theory if appri identifying the research paradigm (e.g., postpositivist, construct interpretivist) is also recommended; rationale <sup>b</sup>
56	Researcher characteristics and reflexivity	Researchers' characteristics that may influence the research, inc personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or interaction between researchers' characteristics and the researc questions, approach, methods, results, and/or transferability
\$7	Context	Setting/site and salient contextual factors; rationale <sup>b</sup>
S8	Sampling strategy	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was ne (e.g., sampling saturation); rationale <sup>b</sup>
S9	Ethical issues pertaining to human subjects	Documentation of approval by an appropriate ethics review bo and participant consent, or explanation for lack thereof; other confidentiality and data security issues
\$10	Data collection methods	Types of data collected; details of data collection procedures in (as appropriate) start and stop dates of data collection and ana iterative process, triangulation of sources/methods, and modifi- of procedures in response to evolving study findings; rationale <sup>®</sup>
\$11	Data collection instruments and technologies	Description of instruments (e.g., interview guides, questionnair and devices (e.g., audio recorders) used for data collection; if/h instrument(s) changed over the course of the study
S12	Units of study	Number and relevant characteristics of participants, documents events included in the study; level of participation (could be rep in results)
\$13	Data processing	Methods for processing data prior to and during analysis, inclu transcription, data entry, data management and security, verific of data integrity, data coding, and anonymization/deidentificat excerpts
\$14	Data analysis	Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; references a specific paradigm or approach; rationale <sup>b</sup>
\$15	Techniques to enhance trustworthiness	Techniques to enhance trustworthiness and credibility of data a (e.g., member checking, audit trail, triangulation); rationale <sup>b</sup>
	Results/findings	
\$16	Synthesis and interpretation	Main findings (e.g., interpretations, inferences, and themes); m include development of a theory or model, or integration with research or theory
S17	Links to empirical data	Evidence (e.g., quotes, field notes, text excerpts, photographs)
	Discussion	suosianuare analytic miunigs
\$18	Integration with prior work implications	Short summary of main findings: explanation of how findings
	transferability, and contribution(s) to the field	and conclusions connect to, support, elaborate on, or challeng conclusions of earlier scholarship; discussion of scope of applic generalizability; identification of unique contribution(s) to scho in a discipline or field
S19	Limitations	Trustworthiness and limitations of findings
	Other	- 1955 Million - 1956 Million - Scholar Berlin, Scholar Berlin, Scholar Berlin, Scholar Berlin, Scholar Berlin, - Scholar Berlin - Scholar Berlin, Scholar Berlin, Scholar Berlin, Scholar Berlin, Scholar Berlin, Scholar Berlin
\$20	Conflicts of interest	Potential sources of influence or perceived influence on study of
CD 4	funding	and conclusions; how these were managed
521	Funding	sources or runging and other support; role of funders in data collection, interpretation, and reporting
The authors cr	eated the SRQR by searching the literature to identify guidelines, re	porting standards, and

choices influence study conclusions and transferability. As appropriate, the rationale for several items might

be discussed together. For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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### The RECORD statement: Checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	ltem Number	STROBE Items	RECORD Items	Page number
Title and Abstract				
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract. (b) Provide in the abstract an informative and balanced summary of what was done and what was found.	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	3
Introduction				
Background rationale	2	Explain the scientific background and rationale for the investigation being reported.		7
Objectives	3	State specific objectives, including any prespecified hypotheses.		7
Methods				
Study Design	4	Present key elements of study design early in the paper.		8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection.		8
Participants	6	(a) Cohort study: Give the eligibility criteria and the sources and methods of selection of participants. Describe methods of follow-up. <i>Case-control study</i> : Give the eligibility criteria and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls. <i>Cross-sectional study</i> : Give the eligibility criteria and the sources and methods of	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published	8

	ltem Number	STROBE Items	RECORD Items	Page numbe
		selection of participants. (b) Cohort study: For matched studies, give matching criteria and number of exposed and unexposed. Case- control study: For matched studies, give matching criteria and the number of controls per case.	elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	10, 12
Data sources/measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group.		8,10
Bias	9	Describe any efforts to address potential sources of bias.		10
Study size	10	Explain how the study size was arrived at.		9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.		8,10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding. (b) Describe any methods used to examine subgroups and interactions. (c) Explain how missing data were addressed. (d) <i>Cohort</i> <i>study:</i> If applicable, explain how loss to follow-up was addressed. <i>Case-control study:</i> If applicable, explain how matching of cases and controls was addressed. <i>Cross-sectional</i> <i>study:</i> If applicable, describe analytical methods taking account of sampling strategy. (e) Describe any sensitivity analyses.		10
Data access and cleaning methods		N/A	RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population, RECORD 12 2: Authors	8-9

	ltem Number	STROBE Items	RECORD Items	Page numbe
			should provide information on the data cleaning methods used in the study.	
Linkage		N/A	RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	8-9
Results				
Participants	13	(a) Report the numbers of individuals at each stage of the study (e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed). (b) Give reasons for nonparticipation at each stage. (c) Consider use of a flow diagram.	RECORD 13.1: Describe in detail the selection of the persons included in the study (i.e., study population selection), including filtering based on data quality, data availability, and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	11, 12, 13
Descriptive data	14	(a) Give characteristics of study participants (e.g., demographic, clinical, and social) and information on exposures and potential confounders. (b) Indicate the number of participants with missing data for each variable of interest. (c) <i>Cohort study</i> : summarise follow-up time (e.g., average and total amount).		12
Outcome data	15	<i>Cohort study</i> : Report numbers of outcome events or summary measures over time. <i>Case-control study</i> : Report numbers in each exposure category or summary measures of exposure. <i>Cross-sectional study</i> : Report numbers of outcome events or summary measures.		13
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included. (b) Report category boundaries when continuous variables were categorized. (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period.		13,14

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Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions and sensitivity analyses		15
Discussion				
Key results	18	Summarise key results with reference to study objectives.		17-18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.		19
Generalisability	21	Discuss the generalisability (external validity) of the study results.		18-19
Other Information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based.		5
Accessibility of protocol, raw data, and programming code		N/A	RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	24

N/A, not applicable

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#### Comparing physician associates and foundation year two doctors in training undertaking emergency medicine consultations in England: a mixed methods study of processes and outcomes

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Manuscript ID	bmjopen-2020-037557.R2
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46	27	Physician Assistants: physician associates: Emergency Service Hospital: emergency department:
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- 1 Comparing physician associates and foundation year two doctors in training
- 2 undertaking emergency medicine consultations in England: a mixed methods study of
- 3 processes and outcomes

#### 4 ABSTRACT

## 56 Objectives

- 7 To compare the contribution of physician associates to the processes and outcomes of emergency
- 8 medicine consultations to that of foundation year two doctors-in-training.

#### 9 Design

10 Mixed methods study: retrospective chart review using four months' anonymised clinical record data 11 of all patients seen by physician associates or foundation year two doctors-in-training in 2016; review

- 12 of a sub sample of 40 records for clinical adequacy; semi-structured interviews with staff and patients;
- 13 observations of physician associates.

#### 14 Setting

15 Three emergency departments in England

#### 16 Participants

- 17 The records of 8816 patients attended by six physician associates and 40 foundation year two doctors-
- 18 in-training; of these n=3197 had the primary outcome recorded (n=1129 PA, n=2068 doctor); 14
- 19 clinicians and managers and six patients or relatives for interview; five phyisican associates for
- 20 observation.
- 21 Primary and secondary outcome measures
- The primary outcome was unplanned re-attendance at the same emergency department within seven
   days. Secondary outcomes: consultation processes, clinical adequacy of care, and staff and patient
   experience.

#### 25 Results

Re-attendances within seven days (n=194 [6.1%]) showed no difference between physician associates and foundation year two doctors-in-training (OR 0.87 [95% CI 0.61, 1.24], p=0.437). If seen by a physician associate, patients were more likely receive an x-ray investigation (OR 2.10 [95% CI 1.72, (4.24)], p<0.001), after adjustment for patient characteristics, triage severity of condition and statistically significant clinician intra-class correlation. Clinical reviewers found almost all patients' charts clinically adequate. Physician associates were evaluated as assessing patients in a similar way to foundation year two doctors-in-training and providing continuity in the team. Patients were 

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positive about the care they had received from a physician associate, but had poor understanding of the role.

#### Conclusions

Physician associates in emergency departments in England treated patients with a range of conditions

- safely, and at a similar level to foundation year two doctors-in-training, providing clinical operational
- efficiencies.

2		
3 4	1	Article summary
5	2	
o 7	3	Strengths and limitations of this study
8	4	
9 10	5	• This study provides a well-powered quantitative comparative analysis of the documented
11 12	6	processes and outcomes of patient care by physician associates and foundaion year two doctors-
13	7	in-training in three emergency departments in different parts of England.
14 15	8	• We believe this to be the first empirical study of the outcomes of care provided by UK-trained
16	9	physician associates in the emergency department, and the first internationally to include
17 18	10	interview and observation data.
19 20	11	• Patients' views have not been previously reported for physician associates in this setting.
20	12	• The low sensitivity of the emergency department triage system to identify conditions other than
22 23	13	the most serious was a problem and impaired the study's ability to describe case mix fully.
24	14	
25 26	15	The original protocol for the study
27	16	The protocol for the study is available at the funding body's website
28 29	17	https://www.journalslibrary.nihr.ac.uk/programmes/hsdr/141926/#/
30 31	18	
32	19	Funding
33 34	20	This project was funded by the National Institute for Health Research Health Services and Delivery
35	20	Research Programme (project number 14/19/26). This paper presents independent research
36 37	21	commissioned by the National Institute for Health Research (NIHR). The views and opinions
38	22	expressed by authors in this publication are those of the authors and do not necessarily reflect those of
40	23	the NHS the NIHP the Health Service and Delivery Research Programme or the Department of
41 42	24	Health
43	25	meann.
44 45	20	
46	27	Competing Interests
47 48	28	SdeL was head of the Department of Clinical and Experimental Medicine until June 2019 at the
49 50	29	University of Surrey, which launched a physician associate course in 2016. JP is the immediate past
50 51	30	chair of the UK and Ireland Board for Physician Associate Education and immediate past director of
52 53	31	the physician associate programme at the University of Birmingham. PB is honorary faculty at the
53 54	32	University of Birmingham and has taught on the physician associate programme since 2008. JE taught
55 56	33	part time on the University of Birmingham physician associate programme until 2020. VMD was a
57	34	HS&DR Board Member in 2015.
58 59	35	
60	36	

#### Main text

#### Introduction

8 0	3	Health care systems internationally are challenged to ensure good patient outcomes, within financial
10	4	constraints, as well as to attend to the work life of the workforce.[1] Health workforce shortages,
11 12	5	particularly of doctors, are resulting in the development of advanced clinical practitioners or non-
13	6	physician clinicians (NPCs), such as nurse practitioners (NPs) and physician assistants/associates
14 15	7	(PAs) in many countries.[2] Numerous countries are experiencing rising patient demand for
16	8	emergency services and concommittant shortages of doctors in emergency medicine.[3-7] This
17 18	9	situation has led to the development of NPC roles in emergency departments (EDs) in many countries
19 20	10	such as the United States (US),[8] Australia,[9] Canada,[10] and the United Kingdom (UK).[11] In the
20	11	US, 25% (n=14,360) of all emergency medicine clinicians are NPCs, and 68% of these are PAs.[8]
22 23	12	
24	13	PAs are trained in the medical model to take histories, diagnose illness, develop management plans
25 26	14	and prescribe medications as agreed with their supervising physician. PAs have a fifty year history in
27	15	the US and are a developing part of the workforce in some other countries such as Canada, the
28 29	16	Netherlands and Germany.[12] The PA workforce is growing in the UK (where they are known as
30 31	17	physician associates). In 2018 there was an estimated 600 qualified PAs with approximately 1000
32	18	graduating each year since then.[11] Their employment specialties include EDs,[11] where they are
33 34	19	deployed in both the minor and the major illness or injury sections.[8]
35	20	
36 37	21	Descriptive observations have been published concerning the positive contributions by US-trained
38	22	PAs employed in EDs in the UK,[13] Australia and New Zealand,[14] and by UK-trained PAs in
39 40	23	England.[15] Unlike in the US, PAs in these other countries cannot prescribe medicines or order
41 42	24	ionising radiation. PAs in North American EDs are reported to be well accepted by other staff and
43	25	patients, and reliable in assessing certain medical complaints and performing procedures.[16] No
44 45	26	difference is reported between patients attended by a PA and those attended by a doctor for wound
46	27	infection rates, or rate of revisit within 72 hours to a pediatric ED; but studies find less consistency in
47 48	28	practice when analysing prescribing patterns, length of stay and wait times of physicians, PAs and
49 50	29	NPs in the ED.[17] There is relatively little research evidence on their clinical effectiveness,[17] little
50	30	quantitative evidence on outcomes from outside of the US and no qualitative evidence of how PAs

deliver care in the ED. In this context our goal was to investigate the contribution of PAs to the processes and outcomes of emergency medicine consultations compared to that of foundation year two (FY2) doctors-in-training in EDs in English hospitals.

#### Methods

#### 3 Study design

We conducted a pragmatic, mixed methods convergence study in which we compare and contrast and simultaneously interpret quantitative and qualitative data[18] in three EDs in England, with three components. We undertook a quantitative observational retrospective chart review of patient consultations by PAs compared with FY2 doctors-in-training; and qualitatively we directly observed PAs' practice; and we conducted semi-structured interviews with members of the staff team. Our planned prospective study of patient records with a linked patient satisfaction and outcomes survey had to be revised to a pragmatic retrospective chart review due to practicalities within the participating NHS organisations in the period of the study.

#### 13 Population and sampling

14 Three consultant-led, 24 hour EDs with full resuscitation facilities ('type one') participated. Two EDs 15 had annual attendances in the range of 100,000 – 120,000 adult and pediatric patients and the third in 16 the range of 170,000 -190,000. One was an university hospital; two were district general hospitals. 17 The hospitals had been recruited as part of a larger study investigating the work and contribution of 18 PAs between 2016 and 2017.[19] We selected FY2 doctors-in-training as the comparator for PAs, as 19 PAs are offered as part of a solution to junior medical workforce shortages[7] and the most junior 20 doctors working in the UK ED at the time were FY2s.

#### 22 Selection of participants, measurements and outcomes

Our primary outcome was unplanned re-attendance at the same ED within seven days - one of the
 NHS clinical quality indicators for EDs in England.[20] Our secondary outcomes were: consultation
 processes (length of time in the ED, use of x-ray, prescriptions and referrals); clinical adequacy of
 care, referrals and planned follow up; and patient experience.

#### 28 Chart review

For a 16-week period (the standard duration of ED placement for FY2 doctors-in-training in the UK), we obtained anonymised, routinely-collected electronic records of all patients attended by a PA or FY2 doctor-in-training, provided in Microsoft Excel by the hospital information teams in each trust, using queries based on staff job role, dates and requested data items. Hospital staff extracted additional data items (supplementary material 1) – age, sex, acuity (as categorised by the Manchester 

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triage score [21]), x-ray orders, diagnosis, prescription issued, admission, area treated, overall time in the ED (from check in to discharge, in minutes), and re-consultation within seven days (the primary outcome). No data linkage was required. The researchers did not have access to the original data set and so could not identify if any patients appeared more than once in the dataset, and further data cleaning could not be performed.

We calculated a sample size for the primary outcome based on rate of 18.3% (the highest of two rates for nurse practitioners substituting for physicians, [at 28 days]).[22,23] Aiming to find a relative difference of 50%, in a non-inferiority hypothesis, we required 284 patients in each group (calculation from Stata v11.1 software) to compare 18.3% to 27.4% unplanned re-consultations, with conventional 80% power at 5% significance. We included an extra 20 to allow for adjustment for case mix, requiring a minimum of 304 patients in total in each group to achieve the said power. As 28 day data could not be collected we went on to use the seven day reattendance rate, with its national average of 7.4% (range 2.4% to 21.7%) for unplanned re-attendance at the same ED in England within for all patients.

Two of the participating EDs also agreed to take part in the analysis of clinical adequacy of documented care in every tenth case from the chart review sample (n=40), with equal numbers of cases seen by PA and FY2 doctors-in-training, and using the full anonymised clinical record. We recruited two specialty registrars (doctors in their sixth year of emergency medicine training), one PA lecturer with 20 years ED experience, and one emergency medicine consultant (with 17 years experience at consultant level) from outside the three study hospitals to review these records. All four clinicians independently recorded their judgement as to the clinical adequacy of care for each record using the categories of past medical history, examination, request for radiography, treatment plan and decision, advice given and follow up. Their assessments were blinded to the type of professional attending the patient and to each other's assessment, using a proforma (supplementary material 2) based on published studies.[22,23] As the senior clinician, we accepted the decision of the consultant in cases of disagreement.

#### 30 Observation

This element drew on the ethnographic tradition used in many health service research studies.[24] We invited all PAs working in the ED in our three study hospitals to participate (n=6). Five PAs volunteered and gave written informed consent to be observed. One of three researchers (CWh, LN, MH) observed each PA for two or three pre-arranged sessions, of varying lengths, on weekdays in periods between 08.00 and 22.00, following a broad guide (supplementary material 3). Researchers made notes on context, relationships and activities following this guide.We judged data saturation to **BMJ** Open

1 have been reached with individual PAs when the processes of care observed did not differ

- 2 significantly from previous observations. During the observation period, PAs asked for patient assent
- 3 to the researcher's presence. Researchers reflected on the observations, discussing them in pairs.

#### 5 Interview

Semi structured interviews [25] were undertaken with a purposive sample of managerial, medical and nursing ED staff who volunteered after receiving information about the study from the researcher during observation periods and/or via their site manager. We also opportunistically interviewed patients and/or their relative who were being seen by a PA in the ED, identified and invited to participate during observation periods, once they had been assessed and treated by the PA but before discharge from the ED. We used tailored topic guides (supplementary material 4) to explore interviewees' perceptions of the PA role and its impact on service organization, role boundaries, patient experience, patient outcomes, and activities and attitudes of other staff. We digitally recorded interviews or took notes if the participant preferred. Recordings were transcribed verbatim and anonymised.

#### 17 Analysis

Chart review: The characteristics of patients treated by PAs and FY2 doctors-in-training were compared using chi-squared tests. We carried out a logistic regression to examine whether the primary and binary secondary outcomes differed between PAs and FY2 doctors-in-training, while adjusting for confounding factors - patient age, sex and triage score. Since patients seen by the same clinician are likely to be correlated, we calculated intraclass correlation coefficients (ICC) for each outcome and report results using a random-effects model if the ICC is statistically significant. We report odds ratios, their confidence intervals (CI), and two-tailed p values. For length of stay, a linear regression was used for data transformed to logarithm scale to reduce heteroscedasticity and reflect the fact that the value of length of stay is positive. To account for unobserved heterogeneity, the unobserved component is modelled as a latent variable in a latent class linear model. The assessment of clinical adequacy is reported using descriptive statistics, sensitivity and specificity of the judgment of whether the record was that of a PA or FY2 doctor-in-training, and Fleiss kappa for inter-rater agreement, calculated for each of the four components of the assessment and per response. 

Qualitative: Our methods for the analysis of observation data drew on methods to identify ethnographic vignettes. [26] We employed thematic analysis [27] of all-specialty interview data for the wider study. Both are described in full elsewhere.[19] For the subsequent specialty-specific analysis we re-read all ED observation data and interview transcripts to identify all data related to the primary and secondary outcomes, and which both confirmed or disconfirmed findings. 

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2 3	1	
4	1 2	Mixed methods: Following the senarete quantitative and qualitative analyses, we (MH and VMD, in
5 6	2	consultation with all authors) merged [18] the quantitative and qualitative datasets by presenting the
7 8	1	quantitative results by study outcomes and following these with qualitative data findings (themes
9	4	qualitative results by study outcomes and following these with qualitative data mutigs (themes
10 11	5	and/or excerpts of quotes) that confirmed of discontinued the quantitative results.
12	6	
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15	8	Ethical approval
16 17	9	We gained approval from the NHS Health Research Authority London-Central Research Ethics
18	10	Committee (15/LO/1339).
19 20 21 22	11	Results
23	12	Characteristics of chart review subjects
24 25	13	
26 27	14	In the 16 week period studied, 8,816 patients seen by six PAs (n=2890) or forty FY2 doctors-in-
28	15	training (n=5926) were identified; some secondary outcomes were available for all cases. For 3197 of
29 30	16	these patient episodes (n=1129 by the six PAs and n= 2068 by 22 FY2 doctors-in-training) the
31	17	primary outcome was collected at site for the research team. Characteristics of the patients are shown
32 33	18	in Table 1. PAs saw a lower proportion of patients categorised on triage into the urgent category than
34	19	FY2 doctors-in-training.
35 36	20	
37	21	In interview, the type of patient seen, patient throughput and role of PAs and FY2 doctors-in-training
38 39	22	were described as similar:
40 41		
42	23	They're [the PAs] pretty much equal toa senior FY2 doctor in training level. As a consultant we
43 44	24	feel comfort because we know [PA name 1] can work in majors, she can clear [majors] pretty
45	25	much And [PA name 2], can clear paeds minors Participant 150 Emergency Medicine
46 47	26	consultant
48	27	However more than one participant tentatively suggested that PAs saw the less acutaly unwell
49 50	27	nowever more than one participant tentarivery suggested that I As saw the less activity unwen
51	28	patients
52 53	29	So my understanding is like they're [the PAs] equivalent to, I would put it like a certain level of like a
54	30	junior physicianI wouldn't say they would be at registrar levelI'd put them somewhere in
56	31	between. You know alot better than like a newly qualified physician because they've got the skills
57 58	32	and stuff, so in that gap of what I would say equivalent to maybe like a second to four years post
59	33	qualified doctor. Participant 144, Registrar
60		- · · · ·

#### 3 Characteristics of interview and observation participants

The staff interviewed included four PAs, two managers, five nurses and three senior doctors; six

6 patients and/or their relatives were also interviewed, spread across the three sites. We observed four

7 PAs, at three sites; we do not report further demographic details due to concerns about anonymity in a

8 small population.

For peer teries only

Chausstanistic	$\begin{array}{c} \mathbf{PA} \\ (N = 2381) \end{array}$	<b>FY2 doctor</b> (N = 6435)	<b>Total</b> (N = 8816)	p-value	
Characteristic	N (%)	N (%)	N (%)		
Age band					
0-20	300 (13.0%)	656 (10.3%)	956 (11.0%)		
21-40	543 (23.5%)	1493 (23.5%)	2036 (23.5%)		
41-60	530 (22.9%)	1406 (22.1%)	1936 (22.3%)		
61-80	551 (23.8%)	1596 (25.1%)	2147 (24.7%)	0.002	
81 and over	390 (16.9%)	1212 (19.0%)	1602 (18.5%)		
Unknown					
Sex				I	
Male	1132	2933 (45.6%)	4065 (46.1%)		
Female	1249	3501 (54.4%)	4750 (53.9%)	0.102	
Unknown					
Manchester triage score				1	
1 Immediate	10 (0.6%)	3 (0.1%)	13 (0.2%)		
2 Very urgent	163 (9.3%)	565 (11.1%)	728 (10.6%)		
3 Urgent	770 (43.8%)	2841 (55.7%)	3611 (52.6%)		
4 Standard	811 (46.1%)	1681 (32.9%)	2492 (36.3%)	< 0.001	
5 Non Urgent	5 (0.3%)	12 (0.2%)	17 (0.2%)		
Unknown			4		
ED area treated in				I	
Minor	369 (20.1%)	275 (6.8%)	644 (10.9%)		
Major	1266 (68.8%)	3601 (88.4%)	4867 (82.3%)		
Resuscitation	2 (0.1%)	4 (0.1%)	6 (0.1%)		
Paediatrics	181 (9.8%)	174 (4.3%)	355 (6.0%)	< 0.001	
Clinical decision unit or primary care	21 (1.1%)	20 (0.5%)	41 (0.7%)		
Unknown					

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#### The primary outcome: rate of return to the ED within seven days

Re-attendance within seven days was found following 6.1% (N = 194) of the 3197 index visits for which these data were available. The high rate of unknown data is accounted by one site where these data were not captured in the electronic dataset and were only retrieved manually for a random sample (n=205) for the purposes of this study. After adjustment for confounding, no statistically significant difference was found for cases seen by PAs or FY2 doctors-in-training; see Table 2.

Table 2: Re-attendance at the same ED within seven days

<b>Re-attendance</b>	PA	FY2 doctor	Total	Unadjusted odds ratio	Adjusted odds ratio
at the same ED within seven	(N = 1129)	(N = 2068)	(N = 3197)	(95% CI) and p-value	(95% CI) and p-value
days				(PA relative to FY2	(PA relative to FY2
				doctor-in-training) in	doctor-in-training) in
				rate of re-attendance	rate of re-attendancee†
No	1066 (04 4%)	1027 (02 7%)	3003		
INO	1000 (94.470)	1937 (93.770)	(93.9%)	0.87 (0.64, 1.19)	0.87 (0.61, 1.24)
Vac	(2)(5)(0/)	121 (6 29/)	194	p=0.388	p=0.437
1 05	03 (3.0%)	131 (0.3%)	(6.1%)		
Unknown	1251	4368	5619	-	-

†Adjustment made for triage score (as a measure of acuity), age band, sex, admission, x-ray and site; no
adjustment was made for clustering as the ICC by individual staff member on outcome was small (0.008) and
statistically insignificant (p= 0.236).

#### 14 Secondary outcome: consultation processes

No differences were found between patients attended by PAs or by FY2 doctors-in-training in: whether prescriptions were given, admission to hospital from the ED, or if a discharge summary was completed. However, patients seen by a PA were more likely to have an x-ray performed in the ED (Table 3), less likely to be admitted to hospital, and to have a shorter length of stay in the ED (by 35 minutes), after adjustment for age, sex, acuity, whether admitted, x-ray taken, and site, as well as for clustering by individual clinician, although no account was able to be taken of the staffing level.
We observed PAs being the first member of the medical team to carry out assessment of patients

following triage to either the major, minor or paediatric areas of the ED. We noted that PAs saw

25 patients independently, following a medical history taking and examination model, before reporting in

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3 4	1	person to the senior ED physician in the same way as nurse practitioners and FY2 doctors-in-training
5	2	did.
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#### 1 Table 3 Clinical process measures

Clinical process measure	PA (N = 2381)	FY2 doctor (N = 6435)	Total (N = 8816)	Unadjusted odds ratio (95% CI) and p-value (PA relative to FY2 doctor-in- training) in rate of re- attendance	Adjusted odds ratio (95% CI) and p-value (PA relative to FY2 doctor-in-training) in rate of re-attendancee†			
X-ray investigatio	ons performed							
	559 (49.4%)	1701	2260					
No		(82.3%)	(70.7%)	4 76 (4 04 5 59) p<0 001	2.70 (1.72, 4.24) p<0.00			
Yes	572 (50.6%)	366 (17.7%)	938 (29.3%)		, (,)p			
Unknown	1250	4368	5618	-	-			
Prescriptions give	en in the ED	6						
No	174 (58.0%)	157 (51.8%)	331 (54.9%)		/			
Yes	126 (42.0%)	146 (48.2%)	272 (45.1%)	0.79 (0.56, 1.07) p=0.127	1.35 (0.08, 23.5) p=0.83			
Unknown	2081	6132	8213					
Admitted as an in	patient from th	ne ED	R.					
No	883 (78.2%)	1436	2319					
110		(70.1%)	(73.0%)	0.65(0.55, 0.77) p<0.001	0.78 (0.55, 1.1) p=0.158			
Yes	246 (21.8%)	613 (29.9%)	859 (27.0%)	0.05 (0.55, 0.77) p<0.001				
Unknown	1762	3876	5638	2				
Discharge summa	ary completed			0.				
No	86 (42.4%)	71 (34.6%)	157 (38.5%)					
Yes	117 (57.6%)	134 (65.4%)	251 (61.5%)	0.72 (0.48, 1.08) p=0.109	1.57 (0.93, 2.66) p=0.09			
Unknown	2178	6230						
†Adjustment made	for MTS (as a 1	neasure of acuit	ty), age band, se	ex, and site, and for clustering	where the ICC			
(and p-value) is sig discharge summary	gnificant: x-ray ( y <0.001 (p=0.4)	0.04 (p<0.001), 98)	prescriptions 0.	73 (p<0.001), admitted 0.02 (j	p=0.001),			

PAs were differentiated from FY2 doctors-in-training by many of our interviewees for not being able to prescribe medications or order tests utilising ionising radiation. Some participants considered this to have a detrimental impact on PAs and patients:

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1 [prescribing] would make a massive difference for them as well and [for] patients because at the end 2 of the day they're having to wait for the PAs to go talk through [with] the physicians what's going on 3 and then probably see somebody else. Participant 118 Nurse practitioner

However, PAs were observed taking on several roles in relation to prescriptions and x-ray orders, for example suggesting medications to or charting the medication for a senior doctor to sign off:

8 So when one of my PAs comes to me and says "This patient has a temperature of 38, they're coughing 9 up horrible green sputum and they're tachycardic and I listened to their chest and they've got

10 crackles at the left base, can we order a chest x-ray and prescribe sepsis drugs for, you know,

pneumonia?" I say "Yes" and I sign it. With probably more confidence at this stage having had 11

12 [number] PAs here for a year than I would with a junior physician in training on day two. And the

13 irony of that is of course, the junior physician in training doesn't need to come and ask me,

technically, they can prescribe themselves. Participant 21 Emergency Medicine consultant 14

16 PAs were also observed making referrals to medical and surgical teams outside of the ED, completing 17 discharge summary information, and carrying out procedures, most commonly cannulation, 18 phlebotomy and suturing.

20 Secondary outcome: clinical adequacy

21 Our reviewers found the chart documentation to have been 'appropriate' or 'with no errors or 22 omissions that resulted in significant probability that the patient might be harmed' in 36/40 cases for 23 all of the key consultation components (Table 4). In the three records (two of FY2 doctors-in-training 24 and one of a PA) judged as having errors or omissions at the level of a breach in normal guidelines 25 and procedures that would have altered the patient's treatment, all reviewers agreed that a senior 26 doctor review had occurred in one case; this was unclear in the other cases. Our observation data 27 suggest that such a senior review was undertaken for all assessment and clinical decision making in 28 the 'majors' sections of the ED, but that 'minors' care was often completed independently. 29

30 Our reviewers were 40% sensitive, 46% specific on judging the clinician type: 68% (13/19) of the PA 31 records were thought to be of a FY2 doctor-in-training and 60% (9/15) vice versa (kappa score for 32 inter-rater agreement 0.15).

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#### 35 Table 4: Chart reviewers' assessments of clinical adequacy

		Judgment of appropriateness																							
PA or FY2		Past	medic	al hist	ory	Exa	ninati	on		Req	uest fo	r		Trea	tment	plan a	and	Advice given				Follow up			
consultati	on									radiography*			decision												
record		A	Erro	r or		AI	Error	r or		AI	Error or		≥ Error or			≥ Error or				≥ Error or					
		prop	omis	nission		prop	omis	omission		prop	omis	sion		prop	omis	sion		prop	omis	sion		oprop	omis	sion	
		priate	Harm Altered treatment Harm unlikely priate	riate	Harm unlikely	Altered treatment	Harm	riate	Harm unlikely	Altered treatment	Harm	oriate	Harm unlikely	Altered treatment	Harm	riate	Harm unlikely	Altered treatment	Harm	oriate	Harm unlikely	Altered treatment	Harm		
FY2	n	14	6	0	0	15	5	0	0	9	0	1	0	14	5	1	0	4	1	1	0	16	3	0	0
	%	70	37	0	0	75	25	0	0	45	0	5	0	70	25	5	0	20	5	5	0	80	15	0	0
PA	n	13	5	1	0	11	7	1	0	9	3	0	0	13	5	1	0	3	1	1	0	13	4	1	0
	%	65	25	5	0	55	35	5	0	45	15	0	0	65	25	5	0	15	5	5	0	65	20	5	0
Not	n			1			1	1		18			1				29				3				
rated*	%		2	.5			2	.5			4	15		2.5				73				7.5			
Total	n	27	11	1	0	26	12	1	0	18	3	1	0	27	10	2	0	7	2	2	0	29	7	1	0
	%	68	28	3	0	65	30	3	0	45	8	3	0	66	25	5	0	18	5	5	0	73	18	3	0
Agreemen	t	0.01				0.15				0.26				0.15				-0.03				0.30			
(Fleiss kap	pa,																								
combined)																									
Agreemen	t	0.04	-0.02	-0.04	n/a	0.17	0.12	0.15	n/a	0.29	0.11	0.33	n/a	0.24	0.01	0.14	n/a	-0.00	0.11	0.08	n/a	0.36	0.20	0.28	n/a
(Fleiss kap	pa,																								
per respon	se)																								

 37 \*Missing rating or rated as 'not applicable' if no request for radiography was made or no advice given

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2		
3 1	1	Interviewees also presented other aspects related to clinical adequacy, particularly the PAs' stability
5	2	in the team. The clinicians' familiarity with the longer standing team member PA/s - in contrast to
6 7	3	FY2 doctors-in-training on rotation - was raised repeatedly:
8	4	
9 10	5	If there was a junior physician over here, and he said oh, what do you think of this wound,
11	6	which they do ask us. And I say yeah, it needs suturing. I then have to say, but can you suture
12 13	7	or do you want me to suture it?Because I don't know, and some will say oh no, I
14	8	can'tI've never sutured before, and some will say oh yeah, that's fine, I'll suture
15 16	9	itWhereas I know with PAs they'll suture their own. Because I know that they've got that
17 18	10	skill set. Participant 177 Advanced nurse practitioner
19	11	
20 21	12	Secondary outcome: patient experience
22	13	
23 24	14	Patients were positive about the care they had received from the PA, but had not understood what the
25 26	15	PA role meant, with two participants believing they had been seen by a doctor and another unsure in
27 28	16	the context of multiple ED staff:
29 30	17	I presumed he was a fully-qualified physician, yes his approach and everything was
31 32	18	absolutely 100%. Participant 120 Patient
33 34	19	Most of our patient participants were receptive to the role on the grounds that it might speed up care,
35	20	although they were not without concern for the difference in training from a doctor and the
36 37 38	21	diminishment of a senior medical workforce:
39	22	It's good to have another person, another opinionbut would it not perhaps be better to have
40 41 42	23	another doctor? Participant 083 Patient's relative
43 44 45	24	
46 47	25	Discussion
48 49	26	
50 51	27	Summary of findings
52	28	The study presents evidence from three English EDs and has demonstrated no difference in safety or
53 54	29	appropriateness between PAs and FY2 doctors-in-training. We report no difference in re-attendance
55	30	rates. Those patients seen by a PA (within PA working hours 08-22.00) had a shorter average length
50 57	31	of stay in the ED than those seen by doctors-in-training (24 hour working period). Our review of
58 50	32	clinical adequacy found few errors and no difference between PAs and FY2 doctors-in-training.
60	33	Patients appeared relatively unconcerned with the title of the clinician treating them and thought they
		Page 18 of 25

had been treated by a doctor; however they were keen to know that the employment of PAs would not
 represent a widespread substitution for doctors in the ED.

#### How this study is similar or different from prior studies

We believe this to be the first empirical study of the outcomes of care provided by UK-trained PAs in the ED, and the first internationally to include interview and observation data. Additonally, patients' views do not appear to have been previously gathered at the time of the visit (and qualitaitvely), although there have been previous questionnaire studies in the USA of patient satisfaction,

administered after the visit.[28,29,30]

We reported few differences in the the practice and processes of care – other than prescribing (which PAs currently cannot do independently in the UK) – between PAs and doctors in their second foundation year of training. Our finding of no difference in the primary outcome (ED reattendance rate within seven days) for patients of PAs and FY2 doctors-in-training is consistent with the comparisons of nurse-qualified NPCs and FY2 doctors-in-training on which we based our study design [22,23] and other PA literature from the USA.[16] It should be noted that for patients in the majors section of ED, all assessment and treatment plans by FY2 doctors-in-training and NPCs were reviewed and agreed by a senior clinician. Our participants commented frequently on the transient nature of FY2 doctors-in-training, whose rotation in the ED only last four months. In contrast, PAs remained long-term and provided continuity in the team. Their accumulated knowledge of the policies and practices (clinical and otherwise) of the department, the consultants and the hospital was reported to enable operational efficiencies. Simlar observations about PAs providing continuity within the medical/surgical team have been made in North America and the Netherlands[31-33] and also for other NPCs.[34]

This study's strengths lie in its mixed-methods approach to the study of PAs in the ED, allowing consideration of different types of data on their contribution, compared to that of FY2 doctors-intraining, to be considered. We were able to carry out a well-powered quantitative comparative analysis of the documented processes and outcomes of patient care by PAs and FY2 doctors-in-training in three EDs in different parts of the country, and to gather qualitative data on PAs 'in practice'. The qualitative component of our mixed methods approach enabled contextual explanations of the quantitative analysis.

Our study however has several limitations. Our comparison of PAs and doctors working in all areas of
 the ED introduced the potential for PAs and FY2 doctors-in-training to be attending to patients of
 different acuity and complexity. We sought to mitigate this by using three different EDs, taking a

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1 sample across a 16 week period at all times of day and night (although the FY2 doctors-in-training 2 worked over the 24 hour period when staff:patient ratios may have fluctuated). We also made statistical 3 adjustments that included triage category. The low sensitivity of most ED triage systems to 4 identification of conditions other than the most serious, however, is a drawback.[35] The prevention of 5 collection of 28 day outcomes by NHS organisations was also a barrier, particularly as we had based 6 our sample size calculation on that, as opposed to the lower 7-day return rate.

7 The level of missing data for some variables in the routinely collected data, and not having data from 8 which to take into account whether PA reduced the staff: patient ratio (or fully replaced FY2 doctors-9 in-training) is a further limitation and needs to be borne in mind in the comparisons we present. 10 Likewise, our observation data illustrated care is predominently delivered by teams which creates 11 difficulties in attributing outcomes or processes to individual staff, and compromised our ability to 12 undertake an economic evaluation.

Our interview invitations yielded relatively small numbers of participants, particularly amongst patients/relatives. While we attribute this in part to the fast patient throughput of the ED and limited availability of the researcher, this limits our analysis

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#### 17 Implications for policy and practice

have observed, particularly the cost effectiveness.

PAs in the ED are acceptable to patients and can help to relieve staffing pressures and improve efficiency in the delivery of care. They are able to treat patients safely with a range of conditions and FY2 doctors-in-training deliver similar care to that provided by doctors in their second year of training. Deployment of PAs within ED teams is a potential solution to the situation of growing patient demand and predicted shortage of junior doctors in the British NHS[7], of which FY2 doctors on rotation in specialties such as the ED are one part; it is not our intention to raise or limit PAs to one particular junior doctor comparator level, but we have used this here as the closest pragmatic comparator. An alternative, which is to hire locum doctors, comes at a higher costs and loss of team continuity, and has potential implications for patient safety. Moves to regulate the PA profession under the General Medical Council were started in 2019.[36] The findings of this study support employment of appropriately trained, supervised PAs with professional registration in ED teams. Further research is needed to investigate fully the impacts we

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### 1 Supplementary material

- 2 Supplementary material 1: Extract of the chart review dataset
- 3 Supplementary material 2: Proforma for the assessment of clinical adequacy
- 4 Supplementary material 3: Observation guide
- 5 Supplementary material 4: Tailored topic guides for the interview
  - 7 Author Statement
- 8 VMD (PhD, health policy and service delivery research), MH (PhD, health services research), JP
- 9 (MD, general practice and clinical education), HG (PhD, health economics), SdeL (MD[Res], general
- 10 practice and information science), JG (PhD, medical sociology), SB (BSc, patient and public
- 11 engagement), and PB (PhD, audiology and strategic management) conceived and designed the study
- 12 and obtained research funding. VMD, MH, JP supervised the conduct of the study and data collection.
- 13 VMD, MH, JP undertook recruitment of participating centers and managed the data, including quality.
- 14 CWa (PhD, statistics) undertook the statistical analysis; CW (PhD, health services research), LN
- 15 (PhD,health services research), MH, JE (MSc, physician associate and education) and VMD
- 16 undertook qualitative data collection and thematic analysis and HG considered the economic aspects.
- 17 MH drafted the manuscript, and all authors contributed substantially to its revision. VMD takes
- 18 responsibility for the paper as a whole.
- All authors attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
- 26 The Patient and Public Involvement statement

27 The patient and public voice was important to this study and informed the design, conduct, analysis, interpretation and final reporting. We brought the views of our public and patient representative forum 28 29 for a previous study on physician associates into the research questions and design of the study. These 30 were views such as how do patients understand this new role. Sally Brearley, as a public voice 31 representative, was a co-applicant and member of the research team. The study advisory group had 32 two public voice members who were reimbursed for their time, following NIHR INVOLVE guidance. 33 Two patient and public voice groups were formed: one in London and the other in the West Midlands 34 and members reimbursed as per NIHR Involve guidelines. The patient and public voice groups 60

informed the design of the research tools such as topic guides and participant information sheets, developed coding frameworks and analysed interview transcripts, and participated in the overall synthesis of findings. Sally Brearley continues to be involved in the dissemination of the study.

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#### Data statement

No additional data are available.

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#### Supplementary file 1: Extract of the chart review dataset (first 50 cases, according to date of attendance)

study id same	nle case site	numbage for	matted sex for	ormatted a	arrival date arrival tim	e seen time presenting complaint	mts	ews	ed stream pro	fessior gravs fo	rr nxn forr	m diagnosis	discharge timed	estination g	rr discharge discharge disch	arge reattend	reattend dat
C\$30115	0	3	5	0	05-Aug-16 9:10:00	2M 10:56:00 PM Flank Pain(renal colic 3vrs ago)	#NULL!	#NULL	1	1 #NULL	#NUU	Benal colic	2:07:00 AM	#NULL!	#NULL! #NULL!	#NUIII	#NULL!
C\$30197	0	3	6	1	05-Aug-16 7:54:00	10:01:00 PM Abdo/Back Pain 5/7	3	#NUILI	#NUU1	1 #NULL	#NULL	Generally unwell	1:40:00 AM	#NULL!	#NULLI #NULLI	#NUI11	#NULLI
C\$30415	0	3	4	1	05-Aug-16 4:51:00	7:05:00 PM 21/40 ?DVT on clexane	3	#NUILI	#NULL!	1 #NULL	#NULL	Acute coronary syndrome	8:50:00 PM	#NULL!	#NULLI #NULLI	#NUI11	#NULLI
C\$30514	0	3	5	1	05-Aug-16 1:08:00	2:15:00 PM swelling to arm/band 2clot	3	#NULLI	#NULLI	1 #NULL	#NUUU	Deen venous thromhosis	5:07:00 PM	#NULLI	#NULLI #NULLI	#NUUU	#NULLI
C\$30726	0	3	3	-	05-Aug-16 11:45:00	1:12:00 AM HEADACHE	2	#NUILI	1	1 #NULL	#NULL	Unknown problem	1:58:00 AM	#NULL!	#NULLI #NULLI	#NUI11	#NULL!
C\$30962	0	3	4	0	05-Aug-16 4:26:00	6:59:00 PM Back Pain(mr maurice bulging disc)	3	#NUILI	#NUU1	0 #NULL	#NULL	Chronic back pain	8:20:00 PM	#NULL!	#NULLI #NULLI	#NUI11	#NULLI
C\$30993	0	3	4	1	05-Aug-16 6:57:00	8:00:00 AM Enigestric Pain 13months on/off	4	#NULLI	#NULLI	1 #NULL	#NULLI	Acute gastritis	10:54:00 AM	#NULLI	#NULLI #NULLI	#NULLI	#NULLI
CS21042	0	2	9	1	05 Aug 16 10:49:00	12:00:00 AM AD 21/TL	4	#NULLI	#NULLI	1 #NULL	#NULLI	LITL - Urinary tract infection	2:12:00 AM	#NULLI	#NULLI #NULLI	#NULL1	#NULLI
CS31043	0	3	2	1	05-Aug-16 0:56:00	11:21:00 PM PV Plood+cramps(bloods with an pad)	4	#NUULL!	#NULLI	1 #NULL	#NULLI	Monorrhagia	1:56:00 AM	#NULLI	#NULLI #NULLI	#NULL!	#NULLI
CS21275	0	2	9	1	05-Aug-16 9:55:00	10:50:00 PM epigastric pain		#NUULL!	1	0 #NULL	#NULLI	Menormagia	12:29:00 AM	#NULLI	#NULLI #NULLI	#NULL!	#NULLI
CS31275	0	2	1	1	05-Aug-16 4:26:00	5:48:00 PM not passing uring /fooding unsettled	2	#NUULL!	#NUULI	0 #NULL	#NULLI	Woll child	6-52-00 PM	#NULLI	#NULLI #NULLI	#NULL!	#NULL!
CS21572	0	2	2	0	05 Aug 16 4:20:00	12:42:00 AM Sickle coll attack	2	#NULLI	#NULLI	1 #NULL	#NULLI	Sickle coll anomia crisis	2:19:00 A M	#NULLI	#NULLI #NULLI	#NULLL	#NULLI
CS31572	0	3	0	1	05-Aug-10 11.20.00	M 0/29/00 AM HI unwitnessed stumbling on street	3	#NUULL:	#NULL!	1 #NULL	#NULLI	Head injung	12:50:00 PM	#NULL!	#NULL #NULL	#NULL!	#NULL!
CS31640	0	3	0	1	05-Aug-10 8.55.007	10:32:00 AM FALL	2	#NULL!	#NULL!	1 #NULL!	#NULL!	Fall	12.30.00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
C531040	0	3	0	1	05-Aug-16 10.24.007		3	#NULL!	#NULL!	1 #NULL!	#NULL!	Fainting	2.25.00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
C551041	0	3	3	1	05-Aug-16 10.46.007		4	#NULL!	#NULL!	1 #NULL!	#NULL!	ramung	2.05.00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS31642	0	3	1	0	05-Aug-16 3:04:00	3:55:00 PM unwell vomiting yellow	450001	#NULL!	#NULL!	1 #NULL	#NULL!	Control on the stained	6:01:00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#INULL!
CS31644	0	3	8	1	05-Aug-16 8:17:00	10:06:00 PM abdo pain	#INULL!	#NULL!		1 #NULL!	#NULL!	Gastroententis	12:17:00 AIVI	#NULL!	#NULL! #NULL!	#NULL!	#INULL!
CS32315	0	3	4	1	05-Aug-16 9:35:00	10:24:00 PM headaches	3	#NULL!	#NULL!	1 #NULL!	#NULL!	Abdensiael asia	2:49:00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#INULL!
CS32354	0	3	2	1	05-Aug-16 8:43:00	10:24:00 PM early pregnant, abdominal pain	3	#NULL!	#NULL!	1 #NULL	#NULL!	Abdominal pain	12:18:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS32524	0	3	9	1	05-Aug-16 2:48:00	2M 3:46:00 PM FALL unwitnessed, unsteady (dementia)	3	#NULL!	#NULL!	1 #NULL!	#NULL!	Fall - accidental	6:44:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS326/1	0	3	6	0	05-Aug-16 3:10:00	4:02:00 PM ?SEIZURE, hand was twitching (ca brain)	3	#NULL!	#NULL!	0 #NULL	#NULL!	Partial seizure	7:10:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS32693	0	3	8	1	05-Aug-16 10:20:00	PM 11:23:00 PM RUQ Pain 3/7	4	#NULL!	1	1 #NULL!	#NULL!	Abdominal pain	2:19:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS32/13	0	3	9	0	05-Aug-16 4:09:00	4:37:00 PM UNWELL(bradycardia atropine given)	3	#NULL!	#NULL!	0 #NULL!	#NULL!	Acute confusion	8:09:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS32840	0	3	7	0	05-Aug-16 11:06:00	M 12:02:00 PM SOB/Right sided CP (PE, pneumonia)	3	#NULL!	#NULL!	1 #NULL	#NULL!	Pulmonary embolism	3:07:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS32973	0	3	6	0	05-Aug-16 6:32:00	PM 9:01:00 PM Paraphimosis	4	#NULL!	#NULL!	1 #NULL!	#NULL!	Paraphimosis	10:02:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
												Alconol intoxication	10 51 00 01 1				
CS33011	0	3	8	1	05-Aug-16 6:52:00	2 ALCO PM SUICIDAL/INTOXICATED (ETCH)	#NULL!	#NULL!	1	1 #NULL!	#NULL!	(disorder)	10:51:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS33793	0	3	/	1	05-Aug-16 2:25:00	3:14:00 PM COLLAPSED/AP ?seizure	3	#NULL!	#NULL!	1 #NULL	#NULL!	Small bowel obstruction	6:25:00 PIVI	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS33926	0	3	/	1	05-Aug-16 11:44:00	12:45:00 PM painfull red eyej	2	#NULL!	#NULL!	1 #NULL!	#NULL!	Red eye	3:05:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS34018	0	3	8	0	05-Aug-16 11:05:00	2M 12:34:00 AM 2011	3	#NULL!	#NULL!	1 #NULL!	#NULL!	Urinary tract infection	2:57:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS34076	0	3	3	1	05-Aug-16 6:35:00	2M 8:54:00 PM ? chronns flare up/black stools	4	#NULL!	#NULL!	1 #NULL!	#NULL!	Crohn's disease (disorder)	10:34:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS31018	1	3	9	1	05-Aug-16 6:26:00	2M 8:19:00 PM SOB(inpatient langley green)	4	#NULL!	#NULL!	0	1 #NULL!	Pneumonia	4:57:00 AM		1 1.00 ######## SPR		0 #NULL!
CS31643	1	3	5	0	05-Aug-16 8:03:00	PM 10:05:00 PM Flank Pain(renal colic)	3	C	0 1	0	0 #NULL!	Left flank pain	11:13:00 PM		0 1.00 ######## Consu	tlan (	0 #NULL!
CS32456	1	3	7	0	05-Aug-16 7:27:00	PM 9:39:00 PM sudden onset pain L testis	4	(	) #NULL!	0	0 #NULL!	O/E - testicular swelling	11:23:00 PM		0 1.00 ######## Consu	.tlan (	0 #NULL!
CS30038	0	3	7	0	06-Aug-16 7:45:00	PM 9:01:00 PM 2/7 hx CCP	3	#NULL!	#NULL!	1 #NULL	#NULL!	pneumonia	9:46:00 PM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS30156	0	3	3	1	06-Aug-16 1:19:00	M 3:08:00 AM Headache took 24xParacetamol 500mg+4 kalms	2	#NULL!	1	1 #NULL	#NULL!	Paracetamol overdose	7:39:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS30320	0	3	5	0	06-Aug-16 1:55:00	4:00:00 AM Assault HI/Lft shoulder pain	4	#NULL!	1	1 #NULL	#NULL!	Assault	5:55:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
CS30351	0	3	3	1	06-Aug-16 2:02:00	4:16:00 AM Ear Infection(flucloxacillin)	4	#NULL!	#NULL!	1 #NULL	#NULL!	Otitis media	5:25:00 AM	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
C\$30392	0	3	7	0	06-Aug-16 7:08:00	8:58:00 PM B flank nain	4	#NUILI	#NUU11	1 #NUU	#NULL	Benal colic	10.24.00 PM	#NULLI	#NULLI #NULLI	#NUI11	#NULLI
C\$30398	0	3	3	0	06-Aug-16 7:00:00	8:58:00 PM ?collanse - been drinking	3	#NUILI	#NULLI	1 #NULL	#NULL	Drunk	10:43:00 PM	#NULL!	#NULLI #NULLI	#NUI11	#NULLI
C\$30458	0	3	9	0	06-Aug-16 11:49:00	1:47:00 AM chest pain	3	#NULLI	#NULLI	1 #NULL	#NULLI	Stable angina (disorder)	3:49:00 AM	#NULLI	#NULLI #NULLI	#NUUU	#NULLI
C\$30695	0	3	6	0	06-Aug-16 9:49:00	12:02:00 AM BTC 1/brs ago lower back pain beadache	4	#NULLI	#NULLI	1 #NULL	#NULLI	Back nain	12:44:00 AM	#NULLI	#NULLI #NULLI	#NUUU	#NULLI
C\$20824	0	2	8	0	06 Aug 16 11:19:00	12:55:00 AM non opiloptic solauro	2	#NULLI	#NULLI	1 #NULL	#NULLI	Chronic confusion	10:12:00 AM	#NULLI	#NULLI #NULLI	#NULLL	#NULLI
CS30834	0	3	2	1	06-Aug-16 9:09:00	11:14:00 PM OD/Montal health	#NI II 1 1	#NUULL:	#NULLI	1 #NULL	#NULLI	Solf-dischargo	12:26:00 AM	#NULLI	#NULLI #NULLI	#NULL!	#NULLI
C\$31205	0	3	3	1	06-Aug-16 2-22-00	3:53:00 AM Passing small amounts uring	#NULL!	#NULL!	1	1 #NUULL	#NULL!	Renal colic	5-37-00 AM	#NUULI	#NULLI #NULLI	#NULL!	#NULL:
CS21252	0	2	3	1	06-Aug-16 2:22:007	5.02.00 AM smoked cigarette feels funny	#INULL!	#NULL!	1	1 #NULL!	#NULL!	Cigaratte consumption	5.37.00 AIVI	#NULL!	#NULL! #NULL!	#NULL!	#NULL!
C331252	0	3	2	1	00-Aug-16 2:29:00	0.20:00 PM FLANK DAINL KIDNEK CTONES	4	#NULL!	1	1 #INULL!	#INULL!	Cigarette consumption	5:42:00 AM	#NULL!	#INULL! #INULL!	#NULL!	#NULL!
0021250	0	3	4	1	00-Aug-16 8:00:00	VIVI 9:39:00 PIVI FLANK PAIN, KIDNEY STONES	4	#NULL!	#NULL!	1 #NULL!	#INULL!	Flank pain (finding)	12:00:00 AM	#NULL!	#INULL! #NULL!	#NULL!	#INULL!
CS31358	0			-	00.1 10 10 10 10					a			4 30 00 2 2 2			4451111	
CS31358 CS31534	0	3	3	1	06-Aug-16 12:45:00	M 2:08:00 AM Epigastric Pain	4	#NULL!	1	1 #NULL	#NULL!	Gastritis	4:39:00 AM	#NULL!	#NULL! #NULL!	#INULL!	#NULL!
CS31358 CS31534 CS31607	0	3	3	1	06-Aug-16 12:45:00 06-Aug-16 1:41:00	M 2:08:00 AM Epigastric Pain   M 3:08:00 AM Abdo/back Pain	4	#NULL! #NULL!	1 #NULL!	1 #NULL	#NULL! #NULL!	Gastritis Palpitations - fluttering	4:39:00 AM 4:37:00 AM	#NULL!	#NULL! #NULL! #NULL! #NULL!	#NULL!	#NULL!

Supplementary material 2, assessment of clinical adequacy questions

Excel spread sheet sent to each reviewer to complete for all records. One column for each record -

reviewer to fill in id number

	Questions *	Insert study ID number from top of record
		Drop down response options followed by a cell for free text if
		appropriate
1	Record of the patient's medical	Appropriate
	history	Or
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
		the patient might be harmed
	Free text on rationale or	
	comment on response to item 1	
2	Examination of the patient	Appropriate
		Or
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines
		and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
	Erectorit or retionals or	the patient might be narmed
	comment on response to item 2	
2	Request for rediography	Appropriate
5	Request for factography	Or
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines
		and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
		the patient might be harmed
	Free text on rationale or	
	comment on response to item 3	
4	Treatment plan and decision	Appropriate
		Or
		Error or omission – but unlikely to have resulted in harm or different
		treatment
		Or
		An error or omission seen that caused a breach in normal guidelines
		and procedures that would have altered the patient's treatment
		Or
		An error or omission seen that resulted in significant probability that
		the patient might be harmed

	Questions *	Insert study ID number from top of record Drop down response options followed by a cell for free text if appropriate
	Free text on rationale or comment on response to item 4	
5	Treatment plan and decision reviewed by senior doctor	YES Or NO
6	Advice given	Appropriate Or Error or omission – but unlikely to have resulted in harm or different treatment Or An error or omission seen that caused a breach in normal guidelines and procedures that would have altered the patient's treatment Or
	Free text on rationale or	An error or omission seen that resulted in significant probability that the patient might be harmed
	comment on response to item 6	
7	Follow-up	Appropriate Or Error or omission – but unlikely to have resulted in harm or different treatment Or An error or omission seen that caused a breach in normal guidelines and procedures that would have altered the patient's treatment Or An error or omission seen that resulted in significant probability that the patient might be harmed
	Free text on rationale or comment on response to item 7	
8	In your view what type of clinician attended this patient?	Doctor Or Physician associate Or Unable to decide
	Free text on rationale or	

with doctors in the ED.



# **OBSERVATION: AIDE MEMOIRE for researchers**

Our observation aims to support answering the four study research questions but specifically to

provide data on impact on organisation of services, other team members working practices and team relationships.

We wish to be able to consider this in terms of:

- Acceptability -how do they appear to be viewed or treated by others?
- Appropriateness how are they observed in terms of safety e.g. how do they check, how are they checked upon, how are they supervised?
- Equity who receives the PA service; do any patient groups appear to be over represented?
- Efficiency how do they appear to contribute to this? How are issues, such as prescribing, worked around?
- Effectiveness are the outcomes of PA care or contribution to the team observed?

We are observing context, relationships and activities.

#### **Conduct of the observation**

- Put up approved notices of our observation activity in the study setting places advised by the clinical team
- Provide the PA with the approved script to inform patients/ patients' representatives to gain permission for the researcher's presence. Each patient is to be asked for permission.
- Researcher to maintain an unobtrusive presence
- Record observations in the ethnographic tradition take detailed unstructured notes, bearing in mind the importance of capturing context, relationships and activities
- Record as much as possible at the time and add as soon as possible afterwards
- Length of observation to be pre-planned but also to allow for flexibility according to the PA's wishes, the demands of the clinical setting and researcher's length of focus
- Allow the PA to see the notes at any point

#### After the observation

- Add to the notes as soon as possible where detail was not able to be captured at the time
- Maintain a reflective diary associated with the observation conduct and analytical processes.
- Discuss the observation with local research team members to promote group understanding and consistency across researchers
- Transfer data into NVivo software.

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Supplementary data file 4: Tailored topic guides for the interview

#### Topic guide for senior managers and clinicians

Topic areas

- Confirm the person's job role
- Ask them to describe their involvement with physician associate employment in the hospital to date
- Ask questions on the factors supporting the adoption of the employment of physician associates
- Ask questions on the factors inhibiting the employment of physician associates
- Questions on their views of physician associates' impact on (ask for examples):
  - Organisation of services
  - Patient experience and outcomes
  - Other staff
  - Costs
- Anything else they would like to say?

**Interviewer to probe** on all answers to ensure the meaning is clear (e.g. that is an interesting point, can you explain a bit more about it) and check for understanding (e.g. so can I check I have understood you correctly)......

**Interviewer to check** for any routine management reports or data or evaluations that the hospital team would be willing to share with the researchers.

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data.

## Topic guide for physician associate interviews

#### Topic areas

- Ask them to describe how long they have been a physician associate, how many posts, type and length as a physician associate
- Ask them to describe the work they undertake, with what type of medical/surgical team
- Ask about their supervising doctor and arrangements when they are not there
- Ask questions on their views of the factors supporting the adoption of the employment of physician associate in their experience

- Ask questions on their views of the factors inhibiting the employment of physician associate in their experience
- Ask how they have been received in the hospital as a new type of health professional?
- Ask how they explain to patients, family and staff who they are and what a physician associate is
- Questions on their views of their, or other physician associates, impact on (ask for examples):
  - Organisation of services
  - o Patient experience and outcomes
  - Other staff
  - Costs
- Anything else they would like to say?

**Interviewer to probe** on all answers to ensure the meaning is clear (e.g that is an interesting point, can you explain a bit more about it) and check for understanding (e.g. so can I check I have understood you correctly)......

**Interviewer to check** for any routine management reports or data or evaluations that the hospital team would be willing to share with the researchers .

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data.

## Topic guide for all other types of professionals/managers interviews

- Confirm the person's job role
- Ask them to describe their involvement with physician associate employment in the hospital to date
- Ask questions on their views of any factors supporting the adoption of the employment of physician associates in their experience
- Ask questions on their views of any factors inhibiting the employment of physician associates in their experience
- Ask their views as to how the PAs have been received in that service/team, and probe for any explanations

- Questions on their views of physician associates' impact on (ask for examples):
  - Organisation of services
  - Boundaries between the job roles of different types of professionals e.g. with nurses
  - Patient experience and outcomes
  - Other staff
  - o Costs
  - Anything else they would like to say?

Interviewer to probe on all answers to ensure the meaning is clear (e.g that is an interesting point, can you explain a bit more about it ) and check for understanding (e.g. so can I check I have understood you correctly ).....

Interviewer to check for any routine management reports or data or evaluations that the hospital team would be willing to share with the researchers.

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data. 4. 4. 2. 0. 1.

### **Topic guide for patient interviews**

Topic areas

- Confirm the person is/has been a patient •
- Ask them to outline the type of care they have been in receipt of without giving personal medical details e.g. in patient for x days
- Confirm the patient has met the physician associate •
- Explore what sort of involvement the physician associate has had with them
- Ask them how they understand the role of the physician associate in the medical/surgical team
- Ask them how they found receiving care from a physician associate
- If they were to need similar medical or surgical care, would they be content to receive • similar care from a physician associate in the future as they had this time (and can

they explain why) or would they prefer someone different? And if yes, can they explain why?

• Anything else they would like to say?

**Interviewer to probe** on all answers to ensure the meaning is clear (e.g. that is an interesting point, can you explain a bit more about it) and check for understanding (e.g. so can I check I have understood you correctly).

Thank them and ask if they would like to receive updates on the study and a final summary of the findings. If so could they please give contact details which will be kept separate from the interview data.

O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health services research. J Health Serv Res Policy. 2008;13(2):92-98.

Box 1 Good Reporting of A Mixed Methods Study (GRAMMS)

GRAMMS criterion	Page in manuscript
(1) Describe the justification for using a mixed methods approach to the research question	8
(2) Describe the design in terms of the purpose, priority and sequence of methods	8
(3) Describe each method in terms of sampling, data collection and analysis	8-10
(4) Describe where integration has occurred, how it has occurred and who has participated in it	10
(5) Describe any limitation of one method associated with the present of the other method	18-19
(6) Describe any insights gained from mixing or integrating methods	18-19

	Topic	Item
	Title and abstract	
S1	Title	Concise description of the nature and topic of the study Identi the study as qualitative or indicating the approach (e.g., ethno grounded theory) or data collection methods (e.g., interview, f group) is recommended
52	Abstract	Summary of key elements of the study using the abstract form the intended publication; typically includes background, purpor methods, results, and conclusions
	Introduction	
\$3	Problem formulation	Description and significance of the problem/phenomenon stud review of relevant theory and empirical work; problem stateme
S4	Purpose or research question	Purpose of the study and specific objectives or questions
	Methods	
55	Qualitative approach and research paradigm	Qualitative approach (e.g., ethnography, grounded theory, case phenomenology, narrative research) and guiding theory if appri identifying the research paradigm (e.g., postpositivist, construct interpretivist) is also recommended; rationale <sup>b</sup>
56	Researcher characteristics and reflexivity	Researchers' characteristics that may influence the research, inc personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or interaction between researchers' characteristics and the researc questions, approach, methods, results, and/or transferability
\$7	Context	Setting/site and salient contextual factors; rationale <sup>b</sup>
58	Sampling strategy	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was ne (e.g., sampling saturation); rationale <sup>b</sup>
\$9	Ethical issues pertaining to human subjects	Documentation of approval by an appropriate ethics review bo and participant consent, or explanation for lack thereof; other confidentiality and data security issues
\$10	Data collection methods	Types of data collected; details of data collection procedures in (as appropriate) start and stop dates of data collection and ana iterative process, triangulation of sources/methods, and modifie of procedures in response to evolving study findings; rationale <sup>®</sup>
\$11	Data collection instruments and technologies	Description of instruments (e.g., interview guides, questionnair and devices (e.g., audio recorders) used for data collection; if/h instrument(s) changed over the course of the study
\$12	Units of study	Number and relevant characteristics of participants, documents events included in the study; level of participation (could be rep in results)
\$13	Data processing	Methods for processing data prior to and during analysis, inclu transcription, data entry, data management and security, verific of data integrity, data coding, and anonymization/deidentificati excerpts
\$14	Data analysis	Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; i references a specific paradigm or approach; rationale <sup>b</sup>
S15	Techniques to enhance trustworthiness	Techniques to enhance trustworthiness and credibility of data a (e.g., member checking, audit trail, triangulation); rationale <sup>b</sup>
	Results/findings	
\$16	Synthesis and interpretation	Main findings (e.g., interpretations, inferences, and themes); m include development of a theory or model, or integration with research or theory
S17	Links to empirical data	Evidence (e.g., quotes, field notes, text excerpts, photographs)
	Discussion	substantiate anarytic findings
\$18	Integration with prior work, implications	Short summary of main findings: explanation of how findings
	transferability, and contribution(s) to the field	and conclusions connect to, support, elaborate on, or challeng conclusions of earlier scholarship; discussion of scope of applici generalizability; identification of unique contribution(s) to schol in a discipline or field
\$19	Limitations	Trustworthiness and limitations of findings
	Other	
\$20	Conflicts of interest	Potential sources of influence or perceived influence on study of
	Euclina	Sources of funding and other support: role of funders in data

choices influence study conclusions and transferability. As appropriate, the rationale for several items might

be discussed together. For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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S8 P9-10			
S9 P10			
S10 P9-10			
S11 P10 (refers to detail	l elsewhere)		
S12 P11			
S13 P10 (refers to detail	l elsewhere)		
S14 P10 (refers to detail S14 As above	l elsewhere)		
S16 P11-17, embedded S17 As above	alongside quant		
S18 P17-19			
S19 P18-19			
S20&21 P5			



# The RECORD statement: Checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	ltem Number	STROBE Items	RECORD Items	Page number
Title and Abstract				
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract. (b) Provide in the abstract an informative and balanced summary of what was done and what was found.	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	3
Introduction				
Background rationale	2	Explain the scientific background and rationale for the investigation being reported.		7
Objectives	3	State specific objectives, including any prespecified hypotheses.		7
Methods				
Study Design	4	Present key elements of study design early in the paper.		8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection.		8
Participants	6	(a) Cohort study: Give the eligibility criteria and the sources and methods of selection of participants. Describe methods of follow-up. <i>Case-control study</i> : Give the eligibility criteria and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls. <i>Cross-sectional study</i> : Give the eligibility criteria and the sources and methods of	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published	8

	ltem Number	STROBE Items	RECORD Items	Page numbe
		selection of participants. (b) Cohort study: For matched studies, give matching criteria and number of exposed and unexposed. Case- control study: For matched studies, give matching criteria and the number of controls per case.	elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	10, 12
Data sources/measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group.		8,10
Bias	9	Describe any efforts to address potential sources of bias.		10
Study size	10	Explain how the study size was arrived at.		9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.		8,10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding. (b) Describe any methods used to examine subgroups and interactions. (c) Explain how missing data were addressed. (d) <i>Cohort</i> <i>study</i> : If applicable, explain how loss to follow-up was addressed. <i>Case-control study</i> : If applicable, explain how matching of cases and controls was addressed. <i>Cross-sectional</i> <i>study</i> : If applicable, describe analytical methods taking account of sampling strategy. (e) Describe any sensitivity analyses.		10
Data access and cleaning methods		N/A	RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population, RECORD 12.2: Authors	8-9

	ltem Number	STROBE Items	RECORD Items	Page numbe
			should provide information on the data cleaning methods used in the study.	
Linkage		N/A	RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	8-9
Results				
Participants	13	(a) Report the numbers of individuals at each stage of the study (e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed). (b) Give reasons for nonparticipation at each stage. (c) Consider use of a flow diagram.	RECORD 13.1: Describe in detail the selection of the persons included in the study (i.e., study population selection), including filtering based on data quality, data availability, and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	11, 12, 13
Descriptive data	14	(a) Give characteristics of study participants (e.g., demographic, clinical, and social) and information on exposures and potential confounders. (b) Indicate the number of participants with missing data for each variable of interest. (c) <i>Cohort study</i> : summarise follow-up time (e.g., average and total amount).		12
Outcome data	15	Cohort study: Report numbers of outcome events or summary measures over time. Case-control study: Report numbers in each exposure category or summary measures of exposure. Cross-sectional study: Report numbers of outcome events or summary measures.		13
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included. (b) Report category boundaries when continuous variables were categorized. (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period.		13,14

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	ltem Number	STROBE Items	RECORD Items	Page number
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions and sensitivity analyses		15
Discussion				
Key results	18	Summarise key results with reference to study objectives.		17-18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.		19
Generalisability	21	Discuss the generalisability (external validity) of the study results.		18-19
Other Information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based.		5
Accessibility of protocol, raw data, and programming code		N/A	RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	24

N/A, not applicable