

EDITOR'S
CHOICE

Is it cost effective to introduce paramedic practitioners for older people to the ambulance service? Results of a cluster randomised controlled trial

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ABSTRACT

Background: A scheme to train paramedics to undertake a greater role in the care of older people following a call for an emergency ambulance was developed in a large city in the UK.

Objectives: To assess the cost effectiveness of the paramedic practitioner (PP) scheme compared with usual emergency care.

Methods: A cluster randomised controlled trial was undertaken of PP compared with usual care. Weeks were allocated to the study group at random to the PP scheme either being active (intervention) or inactive (control). Resource use data were collected from routine sources, and from patient-completed questionnaires for events up to 28 days. EQ-5D data were also collected at 28 days.

Results: Whereas the intervention group received more PP contact time, it reduced the proportion of emergency department (ED) attendances (53.3% vs 84.0%) and time in the ED (126.6 vs 211.3 minutes). There was also some evidence of increased use of health services in the days following the incident for patients in the intervention group. Overall, total costs in the intervention group were £140 lower when routine data were considered ($p = 0.63$). When the costs and QALY were considered simultaneously, PP had a greater than 95% chance of being cost effective at £20 000 per QALY.

Conclusion: Several changes in resource use are associated with the use of PP. Given these economic results in tandem with the clinical, operational and patient-related benefits, the wider implementation and evaluation of similar schemes should be considered.

The UK Department of Health has developed a strategy to encourage the increased use of non-medical staff trained with extended skills to assess and treat patients, a role normally undertaken by doctors.¹ The introduction of new models of care, including further assessment, triage and treatment skills for paramedics, has been recommended to help manage ever-increasing demands for health-care.² However, current research evidence concerning safety, effectiveness and costs to support these changes in practice is lacking.³

In 2003, the South Yorkshire Ambulance Service (SYAS), UK, developed the Paramedic Practitioner Older People's Support scheme that set out to deliver patient-centred care to older people calling 999 for an ambulance with conditions triaged as not immediately life threatening. Paramedic practitioners (PP) were trained in extended skills to

assess and, when possible, treat older people in the community. Operational between the hours of 08:00 and 20:00 each day, the service was activated by a call to the ambulance service or by an ambulance crew attending an eligible patient. We conducted a cluster randomised controlled trial to evaluate this new service.⁴

The use of PP, with extended skills for responding to selected 999 calls relating to elderly patients, could have several important effects on costs and outcomes. The most obvious effects are that PP attendances are anticipated to spend longer at the scene of incidents, yet reduce the number of emergency department (ED) attendances and admissions to hospital. Other potential effects include additional costs of training, equipment and/or the greater use of other services due to the availability of new referral routes to intermediate care schemes, for example. An economic evaluation was therefore undertaken alongside the clinical evaluation to capture these changes in resource use.

In addition to a comparison of costs and benefits relating to normal care and PP care, a cost-utility analysis was also undertaken. A cost-utility analysis summarises health benefits as quality-adjusted life years (QALY), and the associated incremental cost per QALY ratio can then be used to draw conclusions about value for money.

METHODS

Patients were eligible for inclusion into the trial if they presented to the ambulance service: with a call originating from a UK Sheffield postcode; between 1 September 2003 and 26 September 2004; between 08:00 and 20:00 hours; were aged 60 years or older; with a presenting complaint that fell within the scope of practice of the PP working within the scheme.

The PP scope of practice was developed to address the needs of patients presenting with falls, lacerations, epistaxis, minor burns and foreign bodies. The additional skills that they possessed included local anaesthetic techniques, wound care, suturing, neurological, cardiovascular and respiratory system examination and protocol-led dispensing.

Cluster randomisation was used for the main trial to reduce the risk of contamination and allow for evaluation at the service level rather than the individual patient level. Weeks were allocated at

Table 1 Unit costs

Resource	Unit cost (£2003/4)	Source
PP per minute (within-trial work patterns and salaries)	1.24	SYAS and Sheffield Teaching Hospitals NHS Trust (cost per call £103)
PP per minute (reduced utilisation and ECP salaries)	2.23	FRV work patterns and ECP salary (cost per call £186)
FRV/motorbike/PTSS per minute	4.73	SYAS (cost per call £144)
Emergency ambulance per minute	3.53	SYAS (cost per call £182)
ED cost per minute	0.37	Sheffield Teaching Hospitals NHS Trust
MIU attendance	38	NHS Reference Costs (discrete MIU) ⁵
Hospital social care assessment	157	Sheffield Teaching Hospitals NHS Trust*
Community social care assessment	75	Sheffield Primary Care Trust†
Inpatient day in other specialties	Various	Sheffield Teaching Hospitals NHS Trust financial returns 2003/4
Subsequent ambulance attendance	182	SYAS
Subsequent ED attendance	57	NHS reference costs, ED attendance (no treatment, referred/discharged) ⁵
GP visit	21	PSSRU (2004) ⁶
District nurse visit	20	PSSRU (2004) ⁶
Social services visit	36	PSSRU, intensive case manager for older people ⁶
Nursing/residential care day	52	PSSRU‡ (2004) ⁶

*A typical patient requires 2.5 h with a social worker, 1.5 h of occupational therapy, 1.5 h of physiotherapy and one in 20 requires 0.5 h with a consultant and liaison nurse. In addition, there are management and overheads of £15 per patient. †Typical initial assessment lasts 3 h from either occupational therapist or social worker. ‡Based on short-term resident cost per week for private nursing home, private, voluntary and local authority residential homes from the Personal Social Services Research Unit (PSSRU; 2004), then weighted by type of home and type of funding from PSSRU (1998).^{6,7} If private costs were to be included, the unit cost would increase to £66 per day. ECP, emergency care practitioner; ED, emergency department; FRV, fast response vehicle; GP, general practitioner; MIU, minor injuries unit; NHS, National Health Service; PP, paramedic practitioner; PTSS, patient travel subsidy scheme; SYAS, South Yorkshire Ambulance Service.

random before the start of the study, to the PP scheme either being active (intervention), or inactive (control). During inactive weeks, the PP were removed from operational duties within the ambulance service.

Patient recruitment

PP were central to dispatch and patient recruitment.⁸ During each week, a PP based in the ambulance service control room identified calls eligible for PP assessment by presenting complaint. During intervention weeks, eligible patients were then passed to a PP in the community, whereas during control weeks, patient details were passed to a PP in the ED for follow-up. All identified patients were approached face to face for written consent to follow-up.

Data collection

Routine clinical data, including investigations, treatment, diagnoses and outcome relating to the initial patient episode were collected by the research team from the hospitals' patient administration systems, ED and ambulance service records. A

postal questionnaire administered at 28 days documented health outcomes using the EQ-5D and subsequent contact with health services.⁹

The EQ-5D is a generic multidimensional quality of life instrument that produces a single score of health-related wellbeing, ranging from -0.6 to 1.0. Unity represents full health and zero represents death, or a health state considered to be as bad as being dead; negative scores represent health states considered to be worse than death. The EQ-5D score (or "utility") is then multiplied with the length of life measured in years to produce QALY, such that one year spent in full health is 1 QALY.

The economic evaluation followed the technology appraisal guidelines used by the National Institute for Clinical Excellence, and as such takes the National Health Service (NHS) and social service perspective.¹⁰

Costs

The following cost components were included in the economic evaluation: PP costs; other emergency responder costs; ED costs;

Table 2 Main trial outcomes

Trial outcomes	Intervention weeks n (%)	Control weeks n (%)	Relative risk (95% CI)	p Value	ICC
ED attendance between 0–28 days (n = 3018)	970 (62.6)	1286 (87.5)	0.72 (0.68 to 0.75)	<0.001	0.00
Hospital admission between 0– 28 days (n = 3018)	626 (40.4)	683 (46.5)	0.87 (0.81 to 0.94)	<0.001	0.00
Patient very satisfied with care (n = 1482)	656 (85.5)	528 (73.8)	1.16 (1.09 to 1.23)	<0.001	0.00
Mortality at 28 days (n = 3018)	68 (4.4)	74 (5.0)	0.87 (0.63 to 1.21)	0.41	0.00
	Mean (SD)	Mean (SD)	Difference (SE, 95% CI)		
Total episode time, minutes (n = 2968)	235.1 (183.3)	277.8 (182.6)	-42.2 (8.8, -59.5 to -25.0)	<0.001	-

ED, emergency department; ICC, intraclass correlation coefficient.

inpatient costs; social care assessments; primary and community care costs; nursing/residential care costs.

Resource use for each of the first five components was collected from routine data. Resource use for primary and community care and nursing/residential care was obtained from the 28-day patient questionnaires. All episodes of care that were initiated within 28 days of the initial 999 call were included in the analysis.

Costs of training PP were based on the time spent by trainers and paramedics for the taught curriculum, supervised practice, study days plus examinations. Based on a 20-year working life after training, an annual equivalent cost of training was calculated using a 3.5% discount rate.¹⁰ The total cost of training per paramedic was calculated at £9145 (2003/4 prices), which produces an equivalent annual cost of £622. This additional cost was then used in the calculation of the unit costs of a PP call and minute of PP time.

The unit costs (2003/4 prices) are given in table 1. The main sources of the unit cost data are SYAS, Sheffield Teaching Hospitals, NHS reference costs and "unit costs of health and social care".^{5 6} Costs were not discounted as they all fell within one year.

Outcomes

The EQ-5D was administered to patients at 28 days following their initial 999 call. In order to estimate QALY over the month following treatment, an estimate of baseline utility is required. Despite the lack of baseline data, incremental QALY can still be estimated assuming a linear change in EQ-5D scores and that the two groups have identical scores at baseline. EQ-5D scores were estimated using the UK tariff based on time trade-off values.⁹

Analysis

Mean resource use, cost and QALY were compared between the study groups and confidence intervals around the differences presented. The main focus of the analysis was to plot the cost-effectiveness acceptability curve (CEAC) for the intervention and identify the probability that it is cost effective when QALY are valued at £20 000 per annum. The value of £20 000 per QALY is chosen as it is the lower funding threshold used by the National Institute for Clinical Excellence for its technology appraisals.¹⁰

Sensitivity analyses focused on the unit costs of the PP. The baseline unit cost of £103 per call (or £1.24 per minute) is based on paramedic salaries and the high levels of utilisation seen in the trial. If expanded, it is likely that the service would be staffed by emergency care practitioners (ECP) and face lower levels of utilisation. Both of these changes would increase the cost per call. Assuming work patterns similar to those of fast response vehicles (FRV) and staffing by ECP produces a cost per call of £186 (or £2.23 per minute).

Continuous data were analysed using the generalised estimating equation command in STATA together with an allowance for clustering by week. An additional set of analyses of total costs and QALY was undertaken using multiple imputation using the NORM package.¹¹ Five datasets were imputed, using cluster, ED attendance, admission to hospital, age, gender and place of residence as explanatory variables. Mean differences in costs and CEAC were then calculated from these five datasets.

RESULTS

Table 2 provides an overview of the main trial results.⁴ There were very few missing data for those cost components gathered using routine data (0–2.5%). The intraclass correlation coefficient for total costs is less than 0.00001. This is probably due to the large number of clusters ($n = 56$), with large numbers of observations within each (minimum 35, maximum 67, mean 51).

Resource use

Statistically significant differences ($p < 0.05$) were found in all resource use categories in table 3 except for the length of stay for same-day admissions. However, the direction of difference was not uniform. PP time was higher in the intervention group but other responders spent longer with the control group. Control group patients were more likely to go to the ED, spend longer in the ED, be admitted to hospital and spend longer as inpatients. Following these initial episodes of care, intervention patients had more secondary care contacts in the following 28 days and subsequently spent more time in hospital.

When questionnaire data are examined, much higher amounts of missing data are present (57–66%) with the problem being slightly worse in the control group. These data show (not tabulated) similar patterns of primary and community care utilisation in the 28 days following the initial 999 call and a

Table 3 Resource use for patients available from routine data

Item	Intervention n = 1549–1510	Control n = 1469–1437	Mean difference (95% CI of the difference)
PP minutes	58.3	0.0	+58.3 (+55.9 to +60.8)
Other responder minutes	43.4	65.1	–21.7 (–24.2 to –19.3)
No of ambulance activations	1.6	1.2	+0.4 (+0.4 to +0.4)
ED attendance (%)	53.3	84.0	–30.7 (–33.7 to –27.5)
Length of time in ED (minutes)	126.6	211.3	–84.7 (–96.8 to –72.6)
Hospital admission (%)	28.1	38.2	–10.1 (–13.4 to –6.7)
Length of stay for same-day admissions (days)	7.5	9.1	–1.6 (–3.1 to +0.1)
Hospital social care referrals (%)	2.8	5.1	–2.3 (–3.8 to –0.9)
Community social care referrals (%)	5.1	0.0	+5.1 (+4.1 to +6.3)
Other secondary care (contacts)*	0.5	0.4	+0.1 (+0.0 to +0.2)
Length of stay for subsequent admissions (days)	3.4	2.1	+1.3 (+0.5 to +2.2)

*Includes ambulance attendances, emergency department (ED) attendances and admissions. PP, paramedic practitioner.

Table 4 Health and social care costs per patient with allowance for clustering

Item	Routine data			Routine data plus patient reported data of primary/social care and nursing/residential care		
	Intervention* Mean n = 1446	Control* Mean n = 1408	Mean difference† (95% CI of the difference)†	Intervention* Mean n = 496	Control* Mean n = 442	Mean difference† (95% CI of the difference)†
PP	73	0	+73 (+70 to 76)	73	0	+73 (+68 to +78)
Other responders	155	232	-77 (-88 to -66)	146	216	-71 (-90 to -51)
ED/MIU attendance	46	78	-32 (-38 to -26)	39	71	-32 (-41 to -23)
Inpatient stay for same-day admissions	2696	3188	-490 (-1024 to +44)	1425	1710	-286 (-851 to +280)
Assessments‡	8	8	+0 (-2 to +3)	7	10	-3 (-7 to +2)
Subsequent secondary care contacts§	44	38	+6 (-1 to +12)	24	29	-5 (-15 to +5)
Subsequent inpatient stays	944	572	+374 (+103 to +644)	315	551	-244 (-625 to +136)
Subsequent primary and social care costs	-	-	-	39	38	+2 (-5 to +9)
Nursing and residential care costs	-	-	-	35	16	+18 (-7 to +43)
Total cost	3966	4116	-140 (-694 to +415)	2102	2641	-551 (-1170 to +67)

*Actual means. †Adjusted estimates using the "xtgee" command in STATA. ‡Hospital and community social care assessment assessments. §Includes ambulance attendances and emergency department (ED) attendances. MIU, minor injuries unit; PP, paramedic practitioner.

slightly greater use of nursing/residential care in the intervention group (+0.4 days, $p = 0.046$).

Costs

When costs based on routine data are examined, missing data rates increase slightly to 6.7% and 4.2% in the intervention and control groups, respectively. Additional PP costs of £73 per patient are similar in magnitude to the additional costs of other responders of £77 per patient in the control group (table 4). Statistically significant differences are also seen in same-day ED costs with the PP group costing £32 less and subsequent inpatient costs with the PP group costing £372 more. Overall, the PP group cost £140 less, although this difference is not statistically significant ($p = 0.63$).

When patient-reported cost data relating to primary/community care and nursing/residential care are included, the results change markedly (table 4). This is primarily due to changes in inpatient costs that are consistent with the notion that those responding to the 28-day questionnaire were less sick at baseline. Consequently, these costs may incorporate a selection bias.

The sensitivity analysis examined changes in PP unit costs. Assuming PP vehicles have the same level of utilisation as ordinary FRV and are staffed by ECP reduces the mean cost difference such that PP are £92 less costly (using costs based on routine data).

Missing data rates for the EQ-5D are 58.3% and 61.3% in the intervention and control groups, respectively (table 5). EQ-5D scores (or "utility") are slightly higher in the control group, as too are QALY. The QALY advantage in the control group is less than 0.001 ($p = 0.13$).

Combining cost and QALY data requires the examination of patients with both sets of data and results in a further increase

in the missing data rates to 72.7% and 73.3% in the intervention and control groups, respectively. Within this complete case analysis, PP are £680 less costly and produce 0.0003 fewer QALY. The cost-effectiveness acceptability curve indicates that at £20 000 per QALY the PP scheme has a greater than 95% chance of being cost effective (fig 1).

When missing data are imputed, the mean cost difference of £680 seen in the complete cases analysis reduces to £162, which is much more similar to that seen in the analysis of routine data (table 4). This has a large impact on the CEAC, reducing the probability of the scheme being cost effective to 73% at the funding threshold of £20 000 per QALY.

DISCUSSION

The study shows statistically significant changes in the use of NHS resources when PP are used. More specialist PP resources are consumed, as too are more community social care assessments and secondary care in the days following the initial 999 call. These are offset, in cost terms, by the reduced use of other ambulances for the initial call, reduced ED and inpatient resources.

The increased use of PP time and reduction in other responders is not surprising, as the intervention is to a large extent a simple substitution of labour. The statistically significant and wide-ranging nature of the other effects is interesting. The biggest of these effects is the reduction in ED attendances and inpatient length of stay. The PP seem to precipitate a greater use of some services in the days following their intervention. Further work examining unplanned hospital attendances has been undertaken by independently assessing patient records and this found that these events were not attributable to the type of care received.¹²

Table 5 EQ-5D and QALY for respondents in the two groups

Item	Intervention Mean n = 646	Control Mean n = 568	Mean difference (95% CI of the difference)
EQ-5D	0.484	0.513	-0.029 (-0.068 to +0.009)
QALY over 28 days*	0.038	0.039	-0.001 (-0.003 to +0.000)

QALY, quality-adjusted life years.

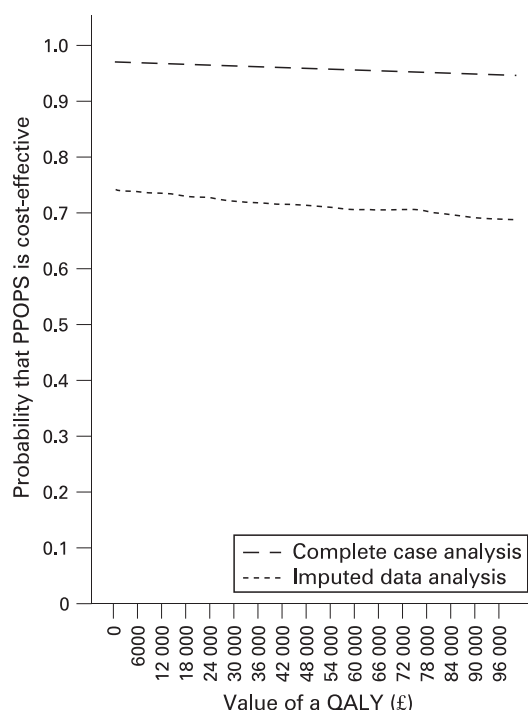


Figure 1 Cost-effectiveness acceptability curves for the paramedic practitioner scheme. PPOPS, Paramedic Practitioner Older People's Support; QALY, quality-adjusted life years.

We must also recognise that this scheme operated in a single area, with the cooperation of a single ambulance service. Hospital trusts and ambulance services may have different work patterns that may have an impact on cost differences. For example, ambulance services that have lower rates of transfer to the ED will have a reduced scope to lower this further with a PP scheme. Such issues of generalisability have been assessed for other emergency care evaluations and need to be considered by potential providers of a PP scheme.¹³

In addition, we should consider whether there are any patient subgroups for which service consequences, and hence cost effectiveness, varies significantly. However, approximately 90% of the patients presented as a result of a fall, leaving very few observations relating to the other conditions. As a result, subgroup analyses are not informative in this instance.

Whereas the missing data rates for the study questionnaires are similar to other studies in this setting, the differences in the characteristics of the responders make interpretation difficult.^{14–16} Data imputation was used in an attempt to counter this problem, and although this has an impact, it does not change the fundamental finding that the scheme is likely to be cost effective.

The incorporation of the EQ-5D and QALY data is perhaps unnecessary. Some may argue that the difference in QALY is so small that it should be judged as insignificant and therefore not be included in the overall assessment of cost effectiveness. Such an approach was widespread until recently; studies were re-branded cost-minimisation analyses and QALY data were ignored. However, the advent of more advanced analytical techniques, such as cost-effectiveness acceptability curves, has emboldened some economists to argue that no QALY change is too small to ignore.¹⁷ This latter approach was adopted in this study, but less technical interpretations of the cost data in tandem with the clinical results led to similar conclusions in this instance.⁴

In the context of this study, an important difference in EQ-5D scores was not expected, and the self-selection that is apparent means that these data are to be used with caution even with the use of imputation. We would argue that these data and the derived cost-per-QALY estimates should be used judiciously in order that the main findings of the study are not obscured.

One final point on the interpretation of the results is worth making. Lower costs in the intervention group should not be equated to “cost savings”; it is almost inconceivable that expenditure will be released by the introduction of PP. However, in operational terms, the additional investment required is offset by generating additional capacity throughout the system, thereby increasing its ability to meet response time performance targets.

CONCLUSION

Several changes in resource use are associated with the use of PP, which overall amount to a reduced cost of service of £140 per patient, although this difference is not statistically significant. In tandem with this, the clinical evaluation showed reductions in the episode length, admissions to ED and hospital, and increased patient satisfaction for those patients who responded to the follow-up questionnaire.

Including broader costs (primary and nursing home care) and health outcomes adds some uncertainty due to the self-selected nature of the patient providing these additional data. However, after imputation of missing data, the results appear to reinforce the conclusion that PP are cost effective. In conclusion, given these economic results in tandem with the clinical, operational and patient-related benefits, we would recommend consideration of the wider implementation and evaluation of similar schemes. In particular, further evaluations would allow the generalisability of the results in the face of different admission rates and intermediate care services.

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Images in emergency medicine

Beware the tree of heaven! (*Ailanthus altissima*)

A 32-year-old tree surgeon presented to the emergency department with an 8-day history of a skin rash, which developed after he was exposed to the sap of the “tree of heaven” at work.

On examination he had a well-demarcated, urticarial, erythematous rash with multiple excoriations on both his forearms (see fig 1). He was discharged home on piriton, with a likely diagnosis of contact dermatitis, after discussion with the National Poisons Centre.

He then re-presented within 48 h with spreading of the rash to his genitals, lower abdomen and thighs. He remained systemically well. He was referred to the dermatologists who treated him with a reducing regime of steroids, fusidic cream and dermivate, and the rash resolved within 30 days.

The tree of heaven was brought to Britain from its native China in 1751, and is rapidly spreading throughout the UK (see fig 2.)

A recent case report describes how a patient presented with myocarditis after being exposed to the sap through ruptured blisters on his skin.¹

There is only one other documented case of contact dermatitis after exposure to the sap, and in that case the patient's rash was also successfully treated with topical steroids and antihistamines.²



Figure 1 Rash present on patient's forearms on initial presentation to the emergency department.



Figure 2 Tree of heaven (*Ailanthus altissima*)

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