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Original Article

General practitioner contribution to out-of-hospital cardiac arrest outcome: A national registry study

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KEY MESSAGE:

- Previous studies have shown GP participation in resuscitation can improve outcomes.
- This study, using routinely collected ambulance service data, is consistent with aforementioned.
- To our knowledge, this is the first study highlighting the compassionate responsibility of GPs in OHCA through enabling pronouncement of death at scene.

ABSTRACT

Background: There is a wide variation in reported survival from out-of-hospital cardiac arrest (OHCA). One factor in this variation may be the contribution of general practitioners to pre-hospital resuscitation. Studies using self-reported data describe increased survival proportions when general practitioners are involved.

Objectives: This study aims to investigate the contribution of general practitioner involvement in out-of-hospital cardiac arrest events.

Design and Setting: A retrospective observational study using data collected from ambulance records in the Republic of Ireland to describe general practitioner (GP) contribution to pre-hospital resuscitation attempts ($n = 2369$). Analysis is limited to patients with presumed cardiac cause and first arrest rhythm recorded as shockable ($n = 510$).

Results: When a GP is present at scene ($n = 199$) patients are less likely to achieve return of spontaneous circulation (ROSC) ($P < 0.001$) or be transported to hospital ($P < 0.001$). When GPs participate in resuscitation ($n = 92$), patients are more likely to have collapsed in a public place ($P < 0.01$), receive bystander CPR ($P < 0.001$) and survive to hospital discharge ($P < 0.001$). Multiple logistic analysis of survival suggests that GP participation in resuscitation increases the odds of survival (4.6; 95% CI 1.6–13.3) and having collapsed in a public place increases chances of survival (5.8; 95% CI 2.1–15.7).

Conclusion: Our analysis suggests that in this subgroup, GP participation in OHCA resuscitation attempts is associated with improved patient survival. Furthermore, resuscitation is more likely to be ceased at scene when a GP is present, highlighting the role that GPs play in the compassionate management of death in unviable circumstances.

Keywords: Out-of-hospital cardiac arrest, cardiopulmonary resuscitation, general practitioners

INTRODUCTION

Improving survival to hospital discharge (survival) from out-of-hospital cardiac arrest (OHCA) is a continuing challenge. This challenge is emphasized by the fact that reported survival ranges from 2% to 40% across countries and continents (1–3).

One potential source of variation may be the impact of a general practitioner (GP) in pre-hospital resuscitation. Colquhoun described the results of 555 self-reported resuscitation attempts by GPs who had been trained and equipped with defibrillators, reporting that 27% of patients were discharged alive from hospital

(4). In a five-year cross-sectional study ($n = 272$) also using self-reporting, Bury et al., reported that 18.7% of patients were discharged alive (5).

In November 2007, the Irish out-of-hospital cardiac arrest register (OHCAR) was established to facilitate improved survival from OHCA by providing feedback to those who provide pre-hospital emergency services (primarily ambulance services). It has been progressively rolled out across the Republic of Ireland since then (7). OHCAR collects data on OHCA incidents attended by ambulance services where resuscitation is attempted in the Republic of Ireland.

Ireland has approximately 2600 GPs serving a population of 4.3 million in a well-organized system of local provision of primary care, which contains both publically and privately funded elements. In the event of OHCA in Ireland, when the emergency numbers 999 or 112 are called, either the National Ambulance Service or the Dublin Fire Brigade, depending on the location of the patient, deploys an emergency ambulance. Irish GPs are not currently part of this statutory emergency response to OHCA, but may be present at scene at the request of friends or relatives, as part of an arrangement with local ambulance control centres or may be present as bystanders by chance.

There have been several programmes to equip and train GPs in defibrillation in Ireland, including the Medical Emergency Responders Integration and Training (MERIT) project. Between 2006 and 2012, MERIT supported immediate care training and together with its partner the North West Immediate Care Programme provided automated external defibrillators (AEDs) to 526 general practice locations across the country (52% of all general practice locations nationwide) (6). AEDs are available in many public locations across Ireland but to date a register of AED locations and availability has not been implemented.

With the use of national registry data, the aim of this study is to describe how often GPs are present at resuscitation attempts and to investigate if GP participation is associated with survival following OHCA in patients with presumed cardiac aetiology and a shockable presenting rhythm.

METHODS

Study design

This retrospective observational study is a post-hoc analysis of data collected from OHCAR. Ethical approval for research using non-identifiable OHCAR data was obtained from the Research Ethics Committee, National University of Ireland, Galway (ref: 07/SEP/12).

The Irish out-of-hospital cardiac arrest register (OHCAR)

The study includes all records that were entered on OHCAR from 1 November 2007 to 22 June 2012. It

includes patients from 22 of the 26 counties in the Republic of Ireland (91% of the Irish population).

OHCAR data is collected from ambulance records. Ambulance practitioners record whether the initial cardiac arrest rhythm was shockable or not and specify the presumed cause of the cardiac arrest. In line with the internationally accepted Utstein definition, a cardiac cause is presumed 'unless it is known or likely to have been caused by trauma, submersion, drug overdose, asphyxia, exsanguination, or any other non-cardiac cause as best determined by rescuers' (8).

Selection of study population

In our aim to focus the analysis and limit confounding by other factors, the analysis of GP involvement was limited to patients with an OHCA with presumed cardiac aetiology and a shockable presenting rhythm ($n = 510$). While this group constitutes a small percentage (22%) of the overall OHCAR database ($n = 2369$), inclusion of more patients would have introduced too much variation in terms of patient profile, call-response intervals by both ambulance services and GPs, presenting rhythms and cause of the collapse.

Determining GP presence at scene

Information on involvement of registered medical practitioners in resuscitation attempts is routinely collected as part of the OHCAR data. The presence or absence of a GP is determined by whether or not a GP name is recorded on the ambulance record.

The specialty of the registered medical practitioner is not always specified in the ambulance patient care record. In most cases, however, the fact that the practitioner is a GP can be deciphered from additional information recorded such as practice address if the GP was attending as part of an out-of-hours service or if the name of the attending GP matched the name of the patient's GP (recorded as part of patient information). This study therefore refers throughout to 'GP present' or 'GP not present' but may occasionally refer to doctors other than GPs. In some cases, the specialty of the doctor was specified as other than GP. In two cases, the doctors arrived as part of a mobile coronary care unit after defibrillation had been attempted. In the remaining case, the doctor was on duty in a residential care unit. These cases were excluded from further analysis.

GP participation in resuscitation

If the GP presence was recorded, it was assumed that interventions that were documented as having been carried by a doctor were carried out by the GP present. In those events where a GP was present, cases were further subdivided according to GP participation i.e., whether

the GP was actively involved in the resuscitation attempt. Data on how the GP came to be on the scene was not available. Fields that can contain data on GP actions are: attending GP's name; who witnessed collapse; who started chest compressions; who applied defibrillator pads; who delivered first shock; who inserted airway adjunct; who performed cannulation; who administered cardiac arrest medication; who first achieved return of spontaneous circulation (ROSC); who ceased resuscitation or was death confirmed by GP at scene?

Analysis

Patient demographics were compared between the 'GP present' and 'GP not present' groups. Similar univariable analysis was performed for the outcome survival i.e. patient discharged alive from hospital. Variables were compared in univariable analysis with a *t*-test for continuous variables and chi-square for categorical variables. In a multiple logistic regression analysis, variables significant at the *P* < 0.05 level in univariable analysis of survival, were included to correct for confounding

effects of co-variables on primary associations with GP presence.

RESULTS

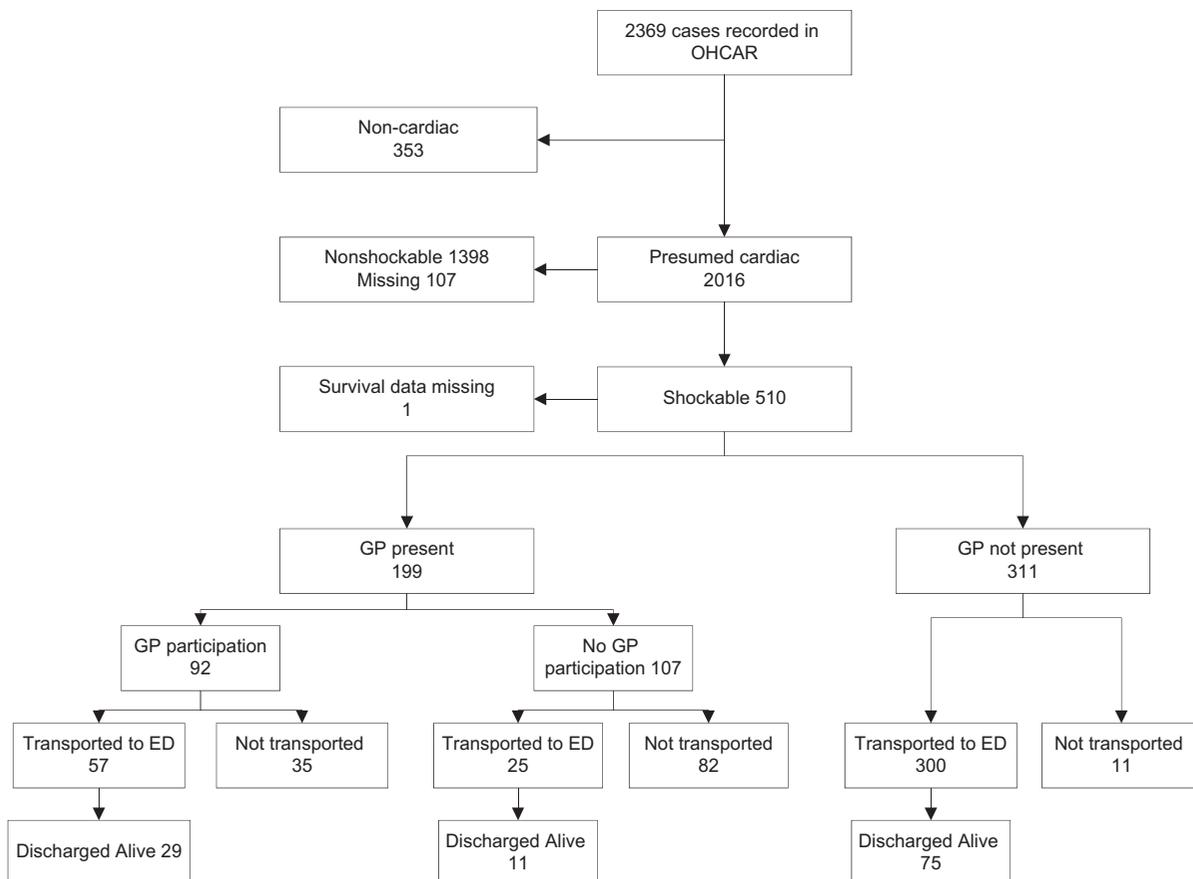
Patient flow

Data on 2369 patients was available on the OHCA Register. Analysis was limited to 510 patients with presumed cardiac cause who presented initially in a shockable rhythm. Overall mean age of patients was 64.3 years (\pm 18.4 years) and 45 (22.6%) were female.

Of this group, a GP was present for 199 calls and not for 311 calls (Figure 1).

GP presence

Table 1 shows there were no significant differences between patients from the 'GP present' and 'GP not present' groups in terms of age, ambulance service call-response interval, gender, if the collapse was witnessed, public location of event or survival to hospital discharge.



GP, general practitioner; ED, emergency department.

Figure 1. Flowchart of events included in the Irish out-of-hospital cardiac arrest register (OHCA). GP, general practitioner; ED, emergency department.

Table 1. Overview of patients with presumed cardiac aetiology and initial shockable rhythm according to general practitioner (GP) presence.

Variable	GP present	GP not present	P-value
	(n = 199) Mean (SD)	(n = 311) Mean (SD)	
Age in years	67 (13)	65 (15)	ns
Call-response interval in minutes ^a	16 (12) n (%)	16 (72) n (%)	ns
Gender female	45 (23)	84 (27)	ns
Collapse witnessed	164 (84)	264 (87)	ns
Public location ^b	74 (37)	118 (38)	ns
Bystander CPR	121 (63)	153 (51)	0.009
Epinephrine administered	123 (62)	164 (53)	0.041
Transported to ED	82 (41)	300 (96)	0.001
Ambulance service started CPR	71 (37)	145 (49)	0.013
Ambulance service applied pads	141 (71)	274 (88)	0.001
Resuscitation attempted by ambulance service at scene	187 (94)	307 (99)	0.04
ROSC any stage	69 (35)	153 (53)	0.001
ROSC on arrival at ED	53 (27)	127 (45)	0.001
Survival to hospital discharge	40 (20)	75 (24)	ns

SD, standard deviation; ns, not significant; ROSC, return of spontaneous circulation; ED, emergency department.

^aInterval from receipt of emergency call in ambulance control to arrival of first ambulance resource on scene.

^bCollapse occurred in location other than private residence or residential institution.

Patients in the 'GP not present' group were more likely to be transported to the hospital, have resuscitation attempted by ambulance services and have the resuscitation attempt started by ambulance services. There were also significant differences in terms of epinephrine administration, bystander CPR, return of spontaneous circulation at any stage (ROSC) and ROSC on arrival in the emergency department (ED). Patients in the 'GP present' group were more likely to receive bystander CPR but were less likely to achieve ROSC.

GP's role in transportation to emergency department

Patients in the 'GP present' group were less likely to be transported to the emergency department (41 versus 96%). Of the 382 patients transported to the ED, 180 (47%) had ROSC on arrival. Patients in the 'GP present' group were more likely to have ROSC at any stage during the resuscitation attempt (79 versus 55%), ROSC on arrival in ED (68 versus 47%) and were more likely to survive to hospital discharge (51 versus 26%) (see Table 2).

Table 2. Outcomes for patients transported to the emergency department.

Variable	GP present	GP not present	P-value
	(n = 82) n (%)	(n = 300) n (%)	
ROSC any stage	63 (79)	152 (55)	0.001
ROSC on arrival at ED	53 (68)	127 (47)	0.001
Survival to hospital discharge	40 (51)	75 (26)	0.001

ROSC, return of spontaneous circulation; ED, emergency department.

In those incidents where a GP was present but the patient was not transported to the hospital, a decision was made to cease resuscitation and confirm death at the scene. GP and ambulance staff would have contributed to this decision but the registered medical practitioner carries legal responsibility for the decision in these cases.

GP present: participation in resuscitation

In 92/199 (46.2%) of 'GP present' cases, the ambulance service record indicated that the GP contributed to the active resuscitation process. GPs who carried out the intervention(s) are listed in Table 3. Table 4 indicates that active GP participation was associated with much higher likelihood of transportation to the hospital, ROSC and survival.

Table 4 compares the patient characteristics of the groups that had GP participation and no participation in

Table 3. Frequency of interventions commenced by general practitioners (GPs) (n = 92).

Intervention	Frequency (%) ^a
Chest compressions	42 (46)
Application of defibrillator pads	31 (34)
Defibrillation attempted	34 (37)
Airway adjunct inserted	6 (7)
Cannulation IV/IO	57 (62)

^aGPs may have commenced more than one intervention at a scene, therefore total number of interventions commenced by GPs is greater than 92.

IV/IO, intravenous/intraosseous.

Table 4. Overview of out-of-hospital cardiac arrest (OHCA) and characteristics of patients with presumed cardiac aetiology and initial shockable rhythm and general practitioner (GP) present at the scene ($n = 199$), according to GP participation.

Variable	GP participation in resuscitation ($n = 92$)	No GP participation in resuscitation ($n = 107$)	<i>P</i> -value
	Mean (SD)	Mean (SD)	
Age in years	65 (13)	67 (13)	ns
Call response interval in minutes ^a	17 (15)	16 (10)	ns
	<i>n</i> (%)	<i>n</i> (%)	
Gender female	19 (21)	26 (24)	ns
Collapse witnessed	79 (88)	85 (81)	ns
Public location ^b	43 (47)	31 (29)	0.01
Bystander CPR ^c	71 (81)	50 (49)	0.001
Epinephrine administered	60 (66)	63 (59)	ns
Transported to ED	57 (62)	25 (23)	0.001
Ambulance service started CPR	16 (18)	55 (51)	0.001
Ambulance service applied pads	50 (55)	90 (85)	0.001
Resuscitation attempted by ambulance service at scene	82 (89)	105 (98)	0.007
ROSC any stage (%)	48 (53)	21 (20)	0.001
ROSC on arrival at ED (%)	39 (42)	14 (13)	0.001
Survival to hospital discharge (%)	29 (32)	11 (10)	0.001

^aInterval from receipt of emergency call in ambulance control to arrival of first ambulance resource on scene.

^bLocations other than private residence or residential institution.

^cExcludes CPR by GP or ambulance service.

active resuscitation. These groups showed no differences in terms of age, gender, call-response interval or whether the event was witnessed. Public location of the event, bystander CPR, ROSC and survival were significantly higher when a GP participated in resuscitation.

Univariable analysis of outcome (Table 5) shows that the public location, witnessed collapse, female gender and GP participation are all associated with an increased chance of survival. Administration of epinephrine is not associated with increased survival.

In multivariable analysis of outcome, active GP participation in resuscitation increases the odds of survival to 4.6 (OR 95% CI 1.6–13.3). Occurrence of the OHCA in a public place increases the odds of survival to 5.8 (OR 95% CI 2.1–15.7) as does female gender (OR 8.5; 95% CI

1.5–49.8). EMS call-response interval, bystander CPR or patient age does not significantly change these odds. Collinearity and interactions were checked and not found to be significant. The final model included the four significant variables and explains 17% of the variation with a R^2 (Nagelkerke) of 0.23.

DISCUSSION

Main findings

Data suggest that in OHCA patients with presumed cardiac aetiology and shockable presenting rhythm is recorded, GP participation in resuscitation is positively associated with survival. Collapse in a public place and

Table 5. Analysis of outcomes of patients with presumed cardiac aetiology and initial shockable rhythm and general practitioner (GP) presence at scene ($n = 199$).

Variable	Death ($n = 156$)	Survival ($n = 40$)	Crude OR (95% CI)	Adjusted OR (95% CI)
	Mean (SD)	Mean (SD)		
Age in years	67 (14)	64 (12)		
	<i>n</i> (%)	<i>n</i> (%)		
Female	40 (26)	5 (13)	2.4 (0.9–6.7)	8.5 (1.5–49.8)
Public location	44 (28)	27 (68)	5.3 (2.5–11.2)	5.8 (2.1–15.7)
GP participation (%)	61 (39)	29 (73)	4.1 (2.0–8.8)	4.6 (1.6–13.3)
Bystander CPR	93 (61)	25 (69)	1.4 (0.7–3.1)	0.5 (0.2–1.5)
Epinephrine administered	112 (72)	9 (23)	0.1 (0.05–0.25)	0.07 (0.02–0.2)
Witnessed	121 (80)	40 (100)	1.3 (1.2–1.5) ^a	

^aDue to empty cell, crude OR only for information, no adjusted calculated.

SD, standard deviation; 95% CI, 95% confidence interval.

female gender were associated with increased survival, while epinephrine administration was negatively associated with survival. Only these variables significantly contributed to predicting survival in the final model and less than a fifth of the variation could be explained by these variables.

When a GP was not present, the patient was transported to the hospital (96%), in almost all cases. When a GP was present, only 41% of patients were transported to the hospital, highlighting a role for GPs in the compassionate on scene management of death.

Strengths and limitations

A major strength of this study is, that it is the first to use independently reported data and multivariable regression analysis, to show an association between GP participation in pre-hospital resuscitation and survival. A weakness is that while the association is positive, a substantial amount of unexplained variation exists in the results and it is not possible to elucidate what it is about GP participation in resuscitation that improves patient outcome.

The weaknesses in this study stem from the fact that it is a post-hoc analysis and therefore data collection was not initially designed to answer the research question posed and a number of assumptions about data quality have been made. There may also be other factors that affect survival in this group, which were not included in the analysis e.g. variables explaining the reasons why GPs are on scene and GPs' time to arrival.

It was assumed (in the absence of evidence to the contrary) that all doctors recorded as being on the scene on ambulance records were GPs. While there is a possibility in some cases that the attending doctor was not a GP, in Ireland the GP presence at OHCA scenes is a common occurrence while hospital doctor attendance as part of the emergency response is relatively rare. It is also assumed that GP presence has been reliably and accurately recorded by the ambulance practitioners attending the scene. Therefore, it is possible that GP presence on the scene may have been underestimated.

Interpretation of findings

The data does not fully explain the positive association between GP participation and survival, but rapid response, good quality CPR and prompt defibrillation are known predictors of survival from OHCA while the value of more advanced techniques such as epinephrine administration and advanced airway management are not conclusive (10–12). In the era of advanced paramedics, it might be argued that the role of GPs with necessary and/or advanced life support training is unclear. The reality is that internationally, ambulance services

struggle to achieve adequate response times and the need for skilled, competent responders in the community remains (13–16). Greek, British and Asian studies suggest that many GPs would be willing to be part of emergency response programmes (17–19). This study has shown an association between GP participation and positive OHCA outcomes, despite the ad hoc manner in which GPs came to be present at the scene, suggesting that integration of skilled and willing GPs into statutory emergency response systems might further enhance this positive association.

It is of note that GPs did not participate in the resuscitation in over half of the cases in which they were present. Our data does not provide an explanation for this but there are several possible reasons: GPs may be called to pronounce death after the resuscitation attempt was ceased; the resuscitation attempt was well established when the GP arrived, the GP may not have been confident about joining an established resuscitation attempt.

When GPs were present, cessation of resuscitation was more likely to take place at scene, reducing the rate of emergency transport to hospital. Registered paramedics and advanced paramedics in Ireland have had the authority to cease resuscitation of an adult asystolic patient since 2006 but must transport all others where a doctor is not available to declare death (20). The implementation of cessation of resuscitation protocols is difficult in practice. Reasons for practitioner non-compliance may include family distress, short transport time and public location (21). This study contains no details about the decision to cease resuscitation and other studies investigating the impact of GP presence on the decision to transport have not been carried out. It seems likely, however, that GP presence significantly reduced emergency ambulance transportation and contributed to a more dignified end to life for those patients and avoided extended emergency retrieval to a receiving hospital—a major potential contributor to the safety of ambulance staff.

Conclusion

It has been suggested that there are between 113 000 and 586 000 OHCA events in Europe annually where a GP might participate in a resuscitation attempt (22). This study adds to the evidence that GP participation can positively affect survival from OHCA and contribute to the compassionate management of death at scene. While it does not fully explain the reason for the positive association, this study highlights the need for studies that include data on GP call-response intervals and additional detail on why GPs were on scene to understand fully the impact of GP resuscitation on OHCA survival and management of death at scene.

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