Original Article

Paramedic Exposure to Out-of-Hospital Cardiac Arrest Resuscitation Is Associated With Patient Survival

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Background—Although out-of-hospital cardiac arrest (OHCA) is a major public health problem, individual paramedics are rarely exposed to these cases. In this study, we examined whether previous paramedic exposure to OHCA resuscitation is associated with patient survival.

Methods and Results—For the period 2003 to 2012, we linked data from the Victorian Ambulance Cardiac Arrest Registry to Ambulance Victoria's employment data set. We defined exposure as the number of times a paramedic attended an OHCA where resuscitation was attempted in the 3 years preceding each case. Using a multivariable model adjusting for known predictors of survival, we measured the association between paramedic OHCA exposure and patient survival to hospital discharge. During the study period, there were 4151 paramedics employed and 48 291 OHCAs (44% with resuscitation attempted). The median exposure of all paramedics was 2 (interquartile range 1–3) OHCAs/year. Eleven percent of paramedics were not exposed to any OHCA cases. Increased paramedic exposure was associated with reduced odds of attempted resuscitation ($P<0.001$). In the 3 years preceding each OHCA where resuscitation was attempted, the median exposure of the treating paramedics was 11 (interquartile range 6–17) OHCAs. Compared with patients treated by paramedics with a median of ≤6 exposures during the previous 3 years (7% survival), the odds of survival were higher for patients treated by paramedics with >6 to 11 (12%, adjusted odds ratio 1.26, 95% confidence interval 1.04–1.54), >11 to 17 (14%, adjusted odds ratio 1.29, 95% confidence interval 1.04–1.59), and >17 exposures (17%, adjusted odds ratio 1.50, 95% confidence interval 1.22–1.86). Paramedic years of experience were not associated with survival.

Conclusions—Patient survival after OHCA significantly increases with the number of OHCAs that paramedics have previously treated.   (***Circ Cardiovasc Qual Outcomes***. 2016;9:00-00. DOI: 10.1161/CIRCOUTCOMES.115.002317.)

Key Words: emergency medical services ■ employment ■ heart arrest ■ resuscitation ■ survival

Although out-of-hospital cardiac arrest (OHCA) is a major public health problem,[1] individual paramedics are rarely exposed to these cases.[2–7] Survival to hospital discharge from OHCA is infrequent (<10%)[8] and dependent on the quality and timing of treatment provided by paramedics.[9–15] Given that resuscitation skills decay over time[16] and OHCA treatment often falls short of the recommended standard,[9–14] the number of OHCAs that paramedics are exposed to may be contributing to low survival rates.

The limited literature available indicates that exposure to OHCA for individual paramedics is rare[2–7] and declining.[2,3] For example, in our region, we found that on average paramedics and first responders only treat 1.4 OHCAs a year.[2] Such low exposure may impact on the paramedics' ability to perform resuscitation skills according to the guidelines, which is vital to patient survival. However, data exploring the association between OHCA exposure and survival is lacking, with

a recent systematic review[17] finding only one previous study involving prehospital physicians[18] and no studies involving paramedics.

Therefore, in this study, we aimed to examine the association between paramedic exposure to OHCA resuscitation and patient survival to hospital discharge. We also examined the paramedics' decision to initiate resuscitation in OHCA and 2 other exposure variables: (1) paramedic career experience and (2) time since previous paramedic exposure to OHCA resuscitation.

Methods

We conducted a retrospective cohort study using 10 years of data from the Victorian Ambulance Cardiac Arrest Registry (VACAR) and the Ambulance Victoria (AV) employment database to measure the association between paramedic exposure to OHCA resuscitation and OHCA patient survival. This study was approved by the Monash University Human Research Ethics Committee (project number: CF13/971-2013000471). The need for patient consent was waived

WHAT IS KNOWN

- Paramedics are rarely exposed to cardiac arrest.
- Resuscitation skills decay over time and often fall short of the recommended standard.
- Survival from out-of-hospital cardiac arrest is dependent on the quality and timing of treatment provided by paramedics.

WHAT THE STUDY ADDS

- Patient survival increased with the number of cardiac arrests that paramedics had previously treated.
- Patient survival was lower when paramedics had not treated a cardiac arrest during the preceding 6 months.

by the Human Research Ethics Committee in accordance with the National Statement on Ethical Conduct in Human Research.[19]

Setting

Our study was set in the Australian state of Victoria, an area covering 227 000 km.[2] In 2012, Victoria had a population of 5.7 million; the majority (75%) of whom lived in the capital city of Melbourne.[20] In Australia, each state is serviced by a single emergency medical service (EMS). The state of Victoria is serviced by AV, which attends ≈5000 OHCAs a year.[21]

AV is predominantly staffed by advanced life support (ALS; 82%) and intensive care paramedics (14%), with the remainder being volunteers with basic life support training. Currently, paramedics in Victoria are required to undertake a 3-year bachelor degree in paramedicine followed by a supervised in-field graduate year. In addition to this training, intensive care paramedics complete a postgraduate diploma in emergency health. Where available, 2 intensive care paramedics and 2 ALS paramedics are dispatched concurrently to OHCAs. In addition, fire fighters and community emergency response teams provide a first response with automatic external defibrillators in select areas of Melbourne and rural communities.

OHCA management in Victoria is directed by the AV clinical practice guidelines[22] that are based on recommendations by the Australian Resuscitation Council.[23] ALS paramedics are authorized to perform manual defibrillation, administer intravenous adrenaline, and insert supraglottic airways. Additionally, intensive care paramedics are authorized to administer amiodarone, perform endotracheal intubation, insert intraosseous cannulae, and provide advanced post resuscitation care (rapid sequence induction, sedation, and adrenaline infusion). Resuscitation skills are not formally accredited after university training, and they are presumed to be maintained through exposure to OHCA and via continuing education with no mandatory recertification. ALS and intensive care paramedics can decide to withhold resuscitation when the first monitored rhythm is asystole and cardiac arrest duration is >10 minutes or where there is evidence of body decomposition, rigor mortis, or injuries incompatible with life. Resuscitation can be ceased in the field where ALS resuscitation has been performed for >30 minutes, the current rhythm is not shockable, and no other signs of life are present.

Data Sources

The VACAR contains prospectively collected data on all OHCAs that are responded to by an emergency ambulance in Victoria.[21] In addition to standard Utstein[24] data elements, the VACAR contains information on which paramedics were present at each OHCA. Our study cohort included adult OHCAs (≥15 years of age) of all etiologies attended by AV paramedics throughout Victoria for the years 2003 to 2012. Cases are recorded in the VACAR as presumed cardiac etiology where no other obvious cause (eg, trauma) is documented on the patient care record. EMS response times were recorded from the

receipt of the call for help to the arrival of the first EMS resource on scene (ambulance, firetruck, or community emergency response team). Survival to hospital discharge data are obtained from hospital medical records and validated against death records from the Victorian Registry of Births, Deaths, and Marriages. VACAR is approved as a quality assurance initiative by the Victorian Department of Health Human Research Ethics Committee, and the collection of patient outcomes is approved by the ethics committees of participating Victorian hospitals.

We successfully linked >99% of OHCAs where resuscitation was attempted with at least one paramedic in the AV employee database. The employee database contains the qualification and date of employment of all paramedics employed by AV. We included paramedics who were available to respond to an OHCA at any time during the outcome analysis period. The employee data set was current as of December 31, 2012, or the paramedic's last day of employment.

Study Definitions

We defined exposure to OHCA as attendance at an OHCA where resuscitation was attempted (cardiopulmonary resuscitation and defibrillation). To measure previous exposure, we counted the number of paramedic OHCA exposures in the preceding 3 years before each case. We considered 3 years to be the maximum amount of time in which a previous OHCA exposure could affect paramedic performance and patient outcome. The same time period was used by Wang et al[25] in their study of paramedic exposure to endotracheal intubation and OHCA survival. In our study, paramedic exposure was measured from January 1, 2003, to December 31, 2012, and outcomes were measured from January 1, 2006, to December 31, 2012.

To examine the effect of all paramedics on scene, we calculated the median previous exposures for all paramedics present at each OHCA. When we analyzed the secondary outcome (the paramedics' decision to attempt resuscitation), we only examined the previous OHCA exposures of the paramedics in the first ambulance to arrive on scene because they are responsible for the decision to commence resuscitation.

To measure the amount of time since paramedics were last exposed to OHCA, we counted the number of months since each paramedic last treated an OHCA. To measure paramedic career experience, we counted the number of years between the paramedic's first day of employment and the day of the arrest. We then calculated the median of these values for all paramedics present and the first paramedics to arrive on scene.

In the sub-cohort consisting of only those OHCA cases where resuscitation was attempted, we divided the exposure and experience measures into quartiles. For the purpose of comparison, we used the same categories to examine the secondary outcome in all OHCA cases.

Statistical Analysis

The primary outcome measure of this study was survival to hospital discharge. The paramedics' decision to attempt resuscitation was also analyzed as a secondary outcome. We used multivariable logistic regression models to measure the association between exposure and outcome measures, adjusting for known predictors of survival, as well as the number of paramedics on scene. The variables included in the multivariable regression analysis were patient age (continuous), patient sex (male/female), public location (home versus public location), rural location (yes/no), witness (bystander/EMS/not witnessed), bystander cardiopulmonary resuscitation (yes/no), EMS response time (continuous), shockable rhythm (yes/no), presumed cardiac etiology (yes/no), presence of an intensive care paramedic (yes/no), and number of paramedics on scene (continuous). For EMS-witnessed OHCAs, we entered the response time as zero minutes and indicated no bystander cardiopulmonary resuscitation. The independent variables entered in the model included median paramedic exposure to OHCA in the preceding 3 years (continuous and categorical in quartiles), median career experience of paramedics (categorical in quartiles), and the median number of months since the paramedics' previous OHCA exposures (categorical). When the independent variable was exposure or time since exposure, we adjusted for experience

in the model and conversely when experience was the independent variable we adjusted for exposure.

We performed several sensitivity analyses. First, we used 2 and 1 year exposure periods instead of the 3 year period to test the robustness of the results in our model. Second, we examined the most exposed individual paramedic at scene to compare the effect of an individual paramedic versus a team. Third, to examine whether differences in attempted resuscitation among exposure groups lead to selection bias, we examined paramedic OHCA exposure in all OHCAs, regardless of resuscitation being attempted. Finally, we examined paramedic OHCA resuscitation exposure in 2 specific OHCA cohorts: (1) paramedic-witnessed OHCAs and (2) bystander-witnessed OHCAs with a shockable initial rhythm. Statistical analysis was performed using Stata 12 (StataCorp), and *P* values <0.05 were considered significant.

Results

During the study period, there were 4151 paramedics employed by AV, and 48 291 OHCAs attended (Table 1). During the 7-year outcome analysis period (2006–2012), paramedics (n=3590) attended 34 494 OHCAs. Of these, 15 362 cases (45%) had resuscitation attempted by paramedics. Typically 4 paramedics (interquartile range [IQR] 2–4) attended OHCAs where resuscitation was attempted and 2 paramedics (IQR 2-2) attended cases where resuscitation was not attempted. During the outcome analysis period (2006–2012), survival to hospital discharge in cases where resuscitation was attempted was 12% overall and 30% in patients presenting in a shockable rhythm (initial cardiac arrest rhythm of ventricular fibrillation or ventricular tachycardia). The majority of paramedics were employed fulltime (86%), and 18% was working in intensive care paramedic roles (Table 2).

Paramedic Exposure to OHCA

The median exposure of all paramedics was 2 (IQR 1–3) OHCAs per year. Eleven percent of paramedics were not exposed to any OHCA cases receiving attempted resuscitation during the outcome analysis period. Across cases where resuscitation was attempted, the median exposure of the treating paramedics was 11 (IQR 6–17) OHCAs in the 3 years preceding each case. The adjusted odds of attempted resuscitation were significantly lower for patients where the first paramedics to arrive on scene had a median of >17 OHCA exposures (adjusted odds ratio [AOR] 0.82, 95% confidence interval [CI] 0.71–0.93) compared with those responded to by paramedics with ≤6 (Figure A; Tables I and II in the Data Supplement).

There was a 1% increase in the odds of patient survival for every additional increase in the median OHCA exposure of the paramedics (AOR 1.01, 95% CI 1.01–1.02). Compared with patients treated by paramedics with a median of ≤6 exposures during the previous 3 years (7% survival), the odds of survival were higher for patients treated by paramedics with >6 to 11 (12%, AOR 1.26, 95% CI 1.04–1.54), >11 to 17 (14%, AOR 1.29, 95% CI 1.04–1.59), and >17 exposures (17%, AOR 1.50, 95% CI 1.22–1.86; Figure B; Tables III and IV in the Data Supplement). The sensitivity tests examining exposure over shorter periods (1- and 2 years) revealed similar results (Figures I and II in the Data Supplement). Similar trends were also seen when using the number of OHCA exposures of the paramedic with the most exposures on scene and when the sample comprised (1) paramedic-witnessed OHCAs, (2) bystander-witnessed OHCAs with a shockable

initial rhythm, and (3) all OHCAs, regardless of resuscitation being attempted (Figures III–VI in the Data Supplement). The association between paramedic exposure to OHCA and patient survival was linear; therefore, there was no threshold number of OHCA exposures at which survival significantly improved.

Paramedic Career Experience

Across cases where resuscitation was attempted, the median career experience of the treating paramedics was 8 (IQR 5–11) years. Compared with patients where the first paramedics to arrive on scene had a median of ≤5 years of experience, the odds of paramedic-attempted resuscitation were lower for patients treated by paramedics with >5 to 8 (AOR 0.93, 95% CI 0.85–1.01), >8 to 11 (AOR 0.77, 95% CI 0.70–0.86), and >11 years of experience (AOR 0.62, 95% CI 0.57–0.67; Figure C; Tables V and VI in the Data Supplement). Paramedic experience was not significantly associated with patient survival (Figure D; Tables VII and VIII in the Data Supplement).

Time Since Paramedics Were Last Exposed to OHCA

The median time between OHCAs cases where resuscitation was attempted was 2 (IQR 1–4) months. Compared with patients attended by paramedics with a median of ≤1 month since their last OHCA exposure, the adjusted odds of resuscitation being attempted (AOR 0.87, 95% CI 0.79–0.95) and survival (AOR 0.70, 95% CI 0.54–0.91) were lower for those attended by paramedics with >6 months (Figure E and F; Tables IX–XII in the Data Supplement).

Discussion

This is the first study to examine the association between paramedic exposure to OHCA resuscitation and patient survival. We found that OHCA survival to hospital discharge significantly increased with the number of OHCAs that paramedics had treated in the previous 3 years. We also found that OHCA survival was lower when paramedics had not treated an OHCA during the preceding 6 months. On the other hand, we found that although increasing paramedic career experience significantly predicted paramedics choosing to withhold resuscitation, there was no association between paramedic career experience and patient survival.

As reported in a recent systematic review,[17] few previous studies have explored the influence of practitioner OHCA exposure on patient survival. Only one study by Bjornsson et al[18] directly examined the association between OHCA exposure and patient survival. They found no difference in survival to hospital discharge in patients resuscitated by prehospital physicians with exposure to ≤5 or >5 OHCA cases over 4 years, although this finding was limited by the study's small sample size (n=243 OHCA cases), reliance on self-reported exposure, and lack of adjustment for important predictors of survival. In a larger study, Wang et al[25] found that very high paramedic exposure to endotracheal intubation was associated with increased OHCA survival. This finding is consistent with our study, given that the majority of endotracheal intubations in their prehospital setting were performed on OHCA patients.

Table 1.   Characteristics of OHCAs Attended by Ambulance Victoria, 2003–2012

	All OHCA (2003–2012)	Outcome Analysis Period (2006–2012)		
		Resuscitation Attempted	Resuscitation Not Attempted	Total
Number, %	48 291	15 362 (45)	19 132 (55)	34 494
Age, y; median (IQR)	69 (52–80)	67 (51–79)	70 (52–82)	69 (51–81)
Female, %	16 305 (34)	4800 (31)	6885 (36)	11 685 (34)
Public location, %	9375 (19)	3951 (26)	2691 (14)	6642 (19)
Witnessed, %				
Bystander	14 387 (30)	7338 (48)	2730 (14)	10 068 (29)
Paramedic	3622 (8)	2411 (16)	370 (2)	2781 (8)
Bystander CPR, %	11 307 (23)	6822 (44)	1935 (10)	8757 (25)
Presumed cause of arrest, %				
Cardiac	34 306 (71)	11 720 (76)	12 678 (66)	24 398 (71)
Trauma	3667 (8)	718 (5)	1929 (10)	2647 (8)
Other	10 318 (21)	2924 (19)	4525 (24)	7449 (21)
Initial rhythm, %				
Asystole	34 794 (72)	6532 (43)	18 549 (97)	25 081 (73)
PEA	6033 (12)	3798 (25)	443 (2)	4241 (12)
VF	6512 (13)	4449 (29)	40 (0)	4489 (13)
VT	366 (1)	272 (2)	16 (0)	288 (1)
Unknown	586 (1)	311 (2)	84 (0)	395 (1)
Rural location, %	14 162 (29)	3971 (26)	6332 (33)	10 303 (30)
EMS Response time,* min; median (IQR)	8 (6–12)	8 (6–11)	9 (6–13)	8 (6–12)
Number of paramedics attending, median (IQR)	2 (2–4)	4 (2–4)	2 (2–2)	2 (2–4)
Number of teams attending, median (IQR)	1 (1–2)	2 (1–2)	1 (1-1)	1 (1–2)
Survival, %		1889 (12)		
Shockable		1422 (30)		
Successfully linked to ≥1 paramedic, %	46 636 (97)	15 149 (99)	18 582 (97)	33 748 (98)

CPR indicates cardiopulmonary resuscitation; EMS, emergency medical service; IQR, interquartile range; OHCA, out-of-hospital cardiac arrest; PEA, pulse-less electrical activity; VF, ventricular fibrillation; and VT, ventricular tachycardia.

*Excludes EMS witnessed.

Our finding of a lack of association between paramedic career experience and patient survival is consistent with 2 previous international studies.[6,7] However, we also found that paramedic experience was a strong predictor of resuscitation being withheld. In other studies, physicians were also less likely to attempt resuscitation as they become more experienced,[26,27] which may indicate that experience leads to more confident decision-making or, alternatively, pessimism. Therefore, it is important that all studies examining the effect of practitioner factors in OHCA consider the influence these factors will also have on the decision to attempt resuscitation to prevent misinterpretation of results.[28]

We found that patient survival decreased when paramedics had not treated an OHCA for >6 months. This period of time is similar to the time in which ALS skills deteriorate (6–12 months) after training.[16] This suggests that 6-month exposure to either OHCA cases or resuscitation training might be required to prevent skill deterioration and to maximize patient survival.

Across our large region and workforce, individual exposure to OHCA cases that received an attempted resuscitation was low. On average, individual paramedics were exposed to 2 OHCAs a year, and 1 in 10 had no exposures in the 7-year period. These findings highlight the need for EMS agencies to monitor individual paramedic exposure to critical skills, such as OHCA resuscitation. Such information can inform the need for additional training when exposure is low or when there is an extended period between exposures.

Although our study did not collect any data on the quality of treatment provided, it is likely that paramedics who frequently and repeatedly use their OHCA resuscitation skills may be more adept at early defibrillation and high quality chest compressions. One possible supplement to actual resuscitation exposure is simulation training, which could help paramedics attain the higher survival rates achieved by paramedics with high exposure to actual OHCAs. In the hospital setting, simulation has been shown to improve practitioner skill performance,[29–34] and there is some indication that it may improve patient survival.[31,35] Another option is formal debriefing, which helps paramedics to learn from every OHCA that they attend. Hospital studies have shown that debriefing after cardiac arrests can improve cardiopulmonary resuscitation quality,[36,37] return of spontaneous circulation,[36] and survival with favorable neurological outcome.[37]

Table 2. Characteristics of Operational Ambulance Victoria Paramedics During the Outcome Analysis Period, 2006–2012

	Total	Exposure to OHCA*	No Exposure to OHCA
Number	4032	3590 (89)	442 (11)
Fulltime, %	3483 (86)	3256 (93)	227 (7)
Part-time/casual, %	540 (13)	334 (62)	206 (38)
Location,† %			
Metropolitan	2453 (61)	2344 (96)	109 (4)
Rural	1300 (32)	1246 (96)	54 (4)
Unknown	279 (7)	0 (0)	279 (100)
Qualification, %			
Intensive care	569 (14)	540 (95)	29 (5)
ALS	3284 (82)	2977 (91)	307 (9)
Unknown	179 (4)	73 (41)	106 (59)
Experience, y; median (IQR)	6 (3–13)	7 (3–13)	2 (1–8)
Annual OHCA exposure, median (IQR)	2 (1–3)	2 (1–4)	N/A

ALS indicates advanced life support; CPR, cardiopulmonary resuscitation; IQR, interquartile range; and OHCA, out-of-hospital cardiac arrest.

*Defined as any treatment of OHCA, that is, CPR or defibrillation.

†Location unknown for paramedics who did not attend any OHCA cases.

Other healthcare disciplines have attempted to address the problem of infrequent exposure to complex skills through practitioner specialization and the development of specialist centers, such as trauma centers.[38,39] However, these options are limited for OHCAs that can happen anywhere in the community and require an immediate response from the closest
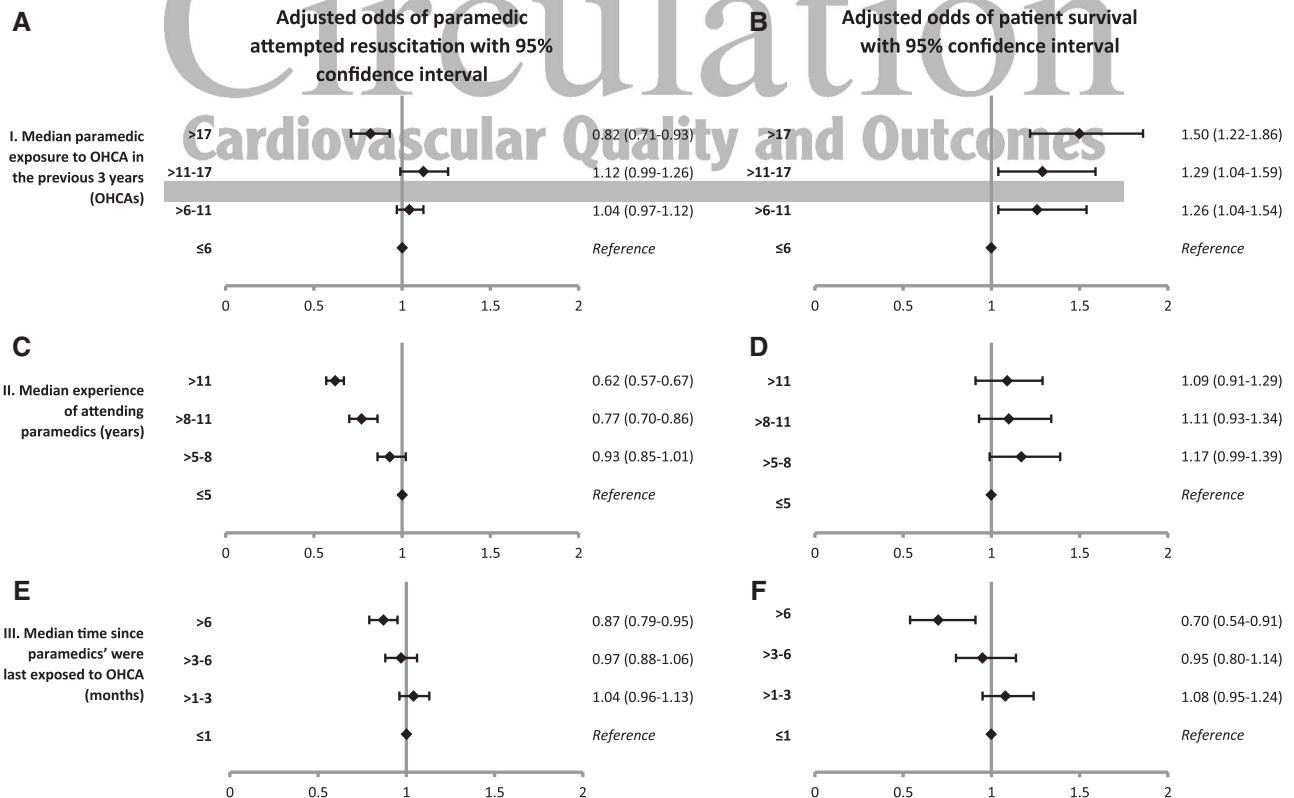

Figure. Adjusted odds of paramedic attempted resuscitation (**A**, **C**, and **E**)* and patient survival to hospital discharge (**B**, **D**, and **F**) by (I) paramedic out-of-hospital cardiac arrest (OHCA) resuscitation exposure, (II) paramedic career experience, and (III) time since paramedics were last exposed to OHCA resuscitation. Adjusted for age, sex, public location, bystander witnessed, paramedic witnessed, bystander cardiopulmonary resuscitation, emergency medical service response time, shockable rhythm, presumed cardiac pathogenesis, year of arrest, metropolitan location, intensive care paramedics present†, and number of paramedics present†. In addition, when the independent variable was exposure or time since exposure, we adjusted for experience in the model and conversely when experience was the independent variable we adjusted for exposure. *First paramedics to arrive on scene only. †Survival to hospital analyses only.

paramedics. This is especially true in regions where there is an extensive service area and large paramedic workforce. One possible strategy in this setting is the use of intensive care paramedics (who had the highest exposure to OHCA in our study), who can act as cardiac arrest specialists in a team, modifying the effect of widespread low exposure. Intensive care paramedics are more likely to respond to other high acuity cases, such as major trauma, where they may be exposed to technical and nontechnical skills which are also used in OHCA resuscitation.

Limitations

There were several limitations to our study. First, this is an observational study. Although we adjusted for many of the known predictors of survival, there may be other unknown or unmeasured factors that we were unable to include, such as hospital volume or capability. Second, a small number of OHCA cases could not be linked to the employment records of all paramedics present. However, 99% of OHCAs where resuscitation was attempted were successfully linked with at least one paramedic in the AV employee database. Third, our results may not apply to other smaller services because this study was conducted in the context of a large EMS servicing both urban and rural areas where regular resuscitation training was not routinely provided. Fourth, the odds of attempted resuscitation varied across exposure and experience categories, which may have led to selection bias in the analysis of patient survival. However, the association between exposure and survival was consistent when all OHCAs were included in the analysis, regardless of resuscitation being attempted and persisted in paramedic-witnessed OHCAs where selection bias is less likely to occur because of the higher attempted resuscitation rate. Fifth, the 3-year period we used to measure previous exposure was chosen arbitrarily. However, a sensitivity analysis using 1- and 2-year periods of exposure yielded similar results. We deliberately chose not to use cumulative exposure to OHCA because this figure would closely reflect career experience, and many paramedics started their careers before the data collection period. Finally, our study focused on the exposure of the whole team of paramedics rather than analyzing exposure at an individual level. However, when we examined the effect of the most exposed paramedic on scene, a similar trend was observed.

Notwithstanding these limitations, our study has a number of strengths. It is a large population-based study and the first to examine the association between paramedic exposure to OHCA and patient survival. Also, paramedics were unlikely to be exposed to cardiac arrest in other settings because 86% of paramedics were employed fulltime, and AV is the sole provider of emergency medical services in the state of Victoria and only operates in the prehospital setting.

Conclusions

Patient survival significantly increases with the number of OHCAs that paramedics have treated during the previous 3 years. In addition, outcomes are improved if it has been <6 months since the paramedics last treated an OHCA. These findings suggest that paramedic exposure to OHCA resuscitation needs to be monitored, and strategies to supplement exposure, such as simulation training, should be explored.

Disclosures

None.

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SUPPLEMENTAL MATERIAL

Supplemental Table 1. Characteristics and odds of attempted resuscitation of all OHCAs by paramedic exposure categories, attended by Ambulance Victoria, 2006-2012.

	Median paramedic exposure to OHCA in the previous 3 years* (OHCAs)				
	≤6	>6-11	>11-17	>17	p-value†
Number (%)	15,002 (44)	10,684 (32)	2,945 (9)	5,014 (15)	
Age (years; median [IQR])	69 (53-81)	70 (54-81)	70 (52-81)	68 (51-80)	<0.001
Female (%)	5,036 (34)	3,756 (35)	1,027 (35)	1,570 (31)	<0.001
Public location (%)	2,803 (19)	1,889 (18)	607 (21)	1,083 (22)	<0.001
Witnessed (%)					
Bystander	4,121 (27)	2,955 (28)	969 (33)	1,807 (36)	<0.001
Paramedic	1,166 (8)	894 (8)	221 (8)	454 (9)	0.017
Bystander CPR (%)	3,503 (24)	2,620 (26)	846 (29)	1,670 (34)	<0.001
Presumed cardiac aetiology (%)	10,619 (71)	7,690 (72)	2,100 (71)	3,481 (69)	0.009
Initial Rhythm (%)					
Asystole	11,432 (76)	7,743 (72)	1,991 (68)	3,214 (64)	<0.001
PEA	1,559 (10)	1,396 (13)	433 (15)	797 (16)	<0.001
Shockable (VF/VT)	1,825 (12)	1,455 (14)	486 (17)	946 (19)	<0.001
Rural location (%)	7,119 (48)	2,096 (20)	585 (20)	236 (5)	<0.001
EMS response time‡ (minutes; median [IQR])	9 (7-14)	8 (6-11)	8 (6-11)	8 (6-10)	<0.001
Number of paramedics attending (median [IQR])	2 (2-3)	2 (2-4)	2 (2-4)	2 (2-4)	<0.001
Number of teams attending (median [IQR])	1 (1-2)	1 (1-2)	1 (1-2)	1 (1-2)	<0.001
Attempted resuscitation (%)	6,183 (41)	4,777 (45)	1,489 (51)	2,687 (54)	<0.001
Shockable (VF/VT)	1,802 (99)	1,455 (99)	481 (99)	939 (99)	0.456
Odds of attempted resuscitation (95% CI)					
Crude	ref	1.15 (1.10-1.21)	1.46 (1.35-1.58)	1.65 (1.54-1.76)	
Minimally adjusted§	ref	1.16 (1.10-1.22)	1.47 (1.35-1.59)	1.62 (1.52-1.73)	
Adjusted‖	ref	1.04 (0.97-1.12)	1.12 (0.99-1.26)	0.81 (0.71-0.93)	

IQR, inter quartile range; CPR, cardiopulmonary resuscitation; PEA, pulse-less electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia; EMS, emergency medical service.

*First paramedics to arrive on scene only.

†Kruskal-Wallis test used for non-parametric data and Chi-squared test used for proportions.

‡Excludes EMS witnessed.

§Adjusted for age and sex.

‖Adjusted for age, sex, public location, bystander witnessed, paramedic witnessed, bystander cardiopulmonary resuscitation, emergency medical service response time, shockable rhythm, presumed cardiac aetiology, year of arrest, metropolitan location and median paramedic experience.

Supplemental Table 2. Multivariable analysis of paramedic exposure to OHCA and attempted resuscitation.

Variables	Adjusted odds of attempted resuscitation (95% Confidence interval)	p-value
Median paramedic exposure to OHCA in the previous 3 years* (OHCAs)		
≤6	ref	
>6-11	1.04 (0.97-1.12)	0.281
>11-17	1.12 (0.99-1.26)	0.064
>17	0.81 (0.71-0.93)	0.002
Median paramedic experience*	0.97 (0.96-0.97)	<0.001
Age	0.99 (0.99-0.99)	<0.001
Female	0.93 (0.87-0.99)	0.020
Public location	1.05 (0.96-1.16)	0.291
Not witnessed	ref	
Witnessed by public	5.99 (5.58-6.45)	<0.001
Witnessed by EMS	25.20 (21.88-29.02)	<0.001
Bystander CPR†	6.30 (5.87-6.77)	<0.001
EMS response time†	0.98 (0.97-0.98)	<0.001
Shockable rhythm	57.92 (43.89-76.44)	<0.001
Cardiac aetiology	1.59 (1.48-1.71)	<0.001
Year		
2006	ref	
2007	1.06 (0.95-1.20)	0.289
2008	0.86 (0.76-0.97)	0.013
2009	0.85 (0.75-0.95)	0.005
2010	0.97 (0.86-1.09)	0.588
2011	0.89 (0.79-1.00)	0.042
2012	1.75 (1.56-1.95)	<0.001
Metropolitan location	1.28 (1.18-1.39)	<0.001
Intensive care presence	1.67 (1.51-1.84)	<0.001

OHCA, out-of-hospital cardiac arrest; EMS, emergency medical services; CPR, cardiopulmonary resuscitation.
*First paramedics to arrive on scene only.
†For EMS witnessed OHCAs: bystander CPR='no' and response time=0.

Supplemental Table 3. Characteristics and odds of survival of OHCAs with attempted resuscitation by paramedic exposure categories, attended by Ambulance Victoria, 2006-2012.

	Median paramedic exposure to OHCA in the previous 3 years (OHCAs)				
	≤6	>6-11	>11-17	>17	p-value*
Number (%)	3,949 (26)	4,167 (28)	3,258 (21)	3,762 (25)	
Age (years; median [IQR])	69 (54-80)	69 (54-80)	67 (53-79)	67 (52-79)	<0.001
Female (%)	1,259 (32)	1,349 (32)	1,010 (31)	1,111 (30)	0.037
Public location (%)	971 (25)	1,078 (26)	838 (26)	990 (26)	0.346
Witnessed (%)					
Bystander	1,747 (44)	1,944 (47)	1,629 (50)	1,904 (51)	<0.001
Paramedic	616 (16)	632 (15)	508 (16)	620 (17)	0.481
Bystander CPR (%)	1,700 (45)	1,870 (46)	1,481 (47)	1,689 (46)	0.314
Presumed cardiac aetiology (%)	3,006 (76)	3,169 (76)	2,520 (77)	2,867 (76)	0.541
Initial Rhythm (%)					
Asystole	1,998 (51)	1,853 (45)	1,231 (38)	1,350 (36)	<0.001
PEA	810 (21)	1,025 (25)	897 (28)	1,022 (27)	<0.001
Shockable (VF/VT)	1,017 (27)	1,220 (30)	1,091 (34)	1,328 (36)	<0.001
Rural location (%)	2,484 (63)	1,100 (26)	264 (8)	77 (2)	<0.001
EMS response time† (minutes; median [IQR])	9 (7-14)	8 (6-11)	8 (6-11)	8 (6-10)	<0.001
Number of paramedics attending (median [IQR])	3 (2-4)	3 (2-4)	4 (3-4)	4 (2-4)	<0.001
Number of teams attending (median [IQR])	1 (1-2)	2 (1-2)	2 (2-2)	2 (1-2)	<0.001
Survival (%)	287 (7)	496 (12)	453 (14)	624 (17)	<0.001
Shockable (VF/VT)	218 (23)	364 (30)	350 (33)	470 (36)	<0.001
Odds of survival (95% CI)					
Crude	*ref*	1.71 (1.46-1.99)	2.04 (1.74-2.38)	2.51 (2.17-2.91)	
Minimally adjusted‡	*ref*	1.71 (1.47-1.99)	2.00 (1.71-2.34)	2.44 (2.11-2.84)	
Adjusted§	*ref*	1.26 (1.04-1.54)	1.29 (1.04-1.59)	1.50 (1.22-1.86)	

IQR, inter quartile range; CPR, cardiopulmonary resuscitation; PEA, pulse-less electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia; EMS, emergency medical service.

*Kruskal-Wallis test used for non-parametric data and Chi-squared test used for proportions.

†Excludes EMS witnessed.

‡Adjusted for age and sex.

§Adjusted for age, sex, public location, bystander witnessed, paramedic witnessed, bystander cardiopulmonary resuscitation, emergency medical service response time, shockable rhythm, presumed cardiac aetiology, year of arrest, metropolitan location, intensive care paramedics present, number of paramedics present and median paramedic experience.

Supplemental Table 4. Multivariable analysis of paramedic exposure to OHCA and patient survival.

Variables	Adjusted odds of survival (95% Confidence interval)	p-value
Median paramedic exposure to OHCA in the previous 3 years (OHCAs)		
≤6	*ref*	
>6-11	1.26 (1.04-1.54)	0.018
>11-17	1.29 (1.04-1.59)	0.020
>17	1.50 (1.22-1.86)	<0.001
Median paramedic experience	1.00 (0.99-1.02)	0.447
Number of paramedics on scene	0.97 (0.92-1.03)	0.366
Age	0.97 (0.97-0.98)	<0.001
Female	1.08 (0.94-1.23)	0.300
Public location	1.65 (1.46-1.86)	<0.001
Not witnessed	*ref*	
Witnessed by public	2.02 (1.70-2.39)	<0.001
Witnessed by EMS	5.69 (4.42-7.33)	<0.001
Bystander CPR*	1.25 (1.07-1.45)	0.005
EMS response time*	0.93 (0.91-0.95)	<0.001
Shockable rhythm	9.36 (8.09-10.84)	<0.001
Cardiac aetiology	1.54 (1.28-1.86)	<0.001
Year		
2006	*ref*	
2007	1.16 (0.91-1.49)	0.221
2008	1.37 (1.08-1.74)	0.009
2009	1.53 (1.22-1.94)	<0.001
2010	1.53 (1.22-1.93)	<0.001
2011	1.58 (1.26-1.99)	<0.001
2012	1.56 (1.25-1.96)	<0.001
Metropolitan location	1.63 (1.35-1.97)	<0.001
Intensive care presence	1.25 (1.01-1.56)	0.044

OHCA, out-of-hospital cardiac arrest; EMS, emergency medical services; CPR, cardiopulmonary resuscitation.
*For EMS witnessed OHCAs: bystander CPR='no' and response time=0.

Supplemental Table 5. Characteristics and odds of attempted resuscitation of all OHCAs by paramedic experience categories, attended by Ambulance Victoria, 2006-2012.

	Median experience of attending paramedics* (years)				
	≤5	>5-8	>8-11	>11	p-value†
Number (%)	13,244 (39)	6,319 (19)	4,451 (13)	9,627 (29)	
Age (years; median [IQR])	70 (53-81)	70 (53-81)	68 (52-80)	69 (52-80)	<0.001
Female (%)	4,627 (35)	2,128 (34)	1,466 (33)	3,166 (33)	0.006
Public location (%)	2,311 (17)	1,168 (18)	881 (20)	2,030 (21)	<0.001
Witnessed (%)					
Bystander	3,671 (28)	1,928 (30)	1,393 (31)	2,857 (30)	<0.001
Paramedic	1,131 (9)	456 (7)	349 (8)	799 (8)	0.012
Bystander CPR (%)	3,158 (24)	1,741 (28)	1,242 (29)	2,498 (26)	<0.001
Presumed cardiac aetiology (%)	9,468 (71)	4,490 (71)	3,132 (70)	6,798 (72)	0.375
Initial Rhythm (%)					
Asystole	9,701 (73)	4,534 (72)	3,101 (70)	7,040 (73)	<0.001
PEA	1,692 (13)	812 (13)	613 (14)	1,068 (11)	<0.001
Shockable (VF/VT)	1,715 (13)	917 (15)	692 (16)	1,388 (15)	<0.001
Rural location (%)	3,033 (23)	1,699 (27)	1,340 (30)	3,960 (41)	<0.001
EMS Response time‡ (minutes; median [IQR])	8 (6-12)	8 (6-12)	8 (6-12)	9 (7-13)	<0.001
Number of paramedics attending (median [IQR])	2 (2-4)	2 (2-4)	2 (2-4)	2 (2-3)	<0.001
Number of teams attending (median [IQR])	1 (1-2)	1 (1-2)	1 (1-2)	1 (1-2)	<0.001
Attempted resuscitation (%)	6,029 (46)	2,969 (47)	2,078 (47)	4,059 (42)	<0.001
Shockable (VF/VT)	1,689 (98)	909 (99)	689 (100)	1,369 (99)	0.107
Odds of attempted resuscitation (95% CI)					
Crude	ref	1.06 (1.00-1.13)	1.05 (0.98-1.12)	0.87 (0.83-0.92)	
Minimally adjusted§	ref	1.05 (1.00-1.12)	1.05 (0.98-1.13)	0.88 (0.83-0.93)	
Adjusted||	ref	0.93 (0.85-1.01)	0.77 (0.70-0.86)	0.62 (0.57-0.67)	

IQR, inter quartile range; CPR, cardiopulmonary resuscitation; PEA, pulse-less electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia; EMS, emergency medical service.

*First paramedics to arrive on scene only.

†Kruskal-Wallis test used for non-parametric data and Chi-squared test used for proportions.

‡Excludes EMS witnessed.

§Adjusted for age and sex.

||Adjusted for age, sex, public location, bystander witnessed, paramedic witnessed, bystander cardiopulmonary resuscitation, emergency medical service response time, shockable rhythm, presumed cardiac aetiology, year of arrest, metropolitan location and median paramedic OHCA exposure.

Supplemental Table 6. Multivariable analysis of paramedic experience and attempted resuscitation.

Variables	Adjusted odds of attempted resuscitation (95% Confidence interval)	*p*-value
Median experience of attending paramedics* (years)		
≤5	*ref*	
>5-8	0.93 (0.85-1.01)	0.071
>8-11	0.77 (0.70-0.86)	<0.001
>11	0.62 (0.57-0.67)	<0.001
Median paramedic exposure to OHCA*	0.99 (0.99-1.00)	<0.001
Age	0.99 (0.99-0.99)	<0.001
Female	0.93 (0.87-0.99)	0.024
Public location	1.05 (0.96-1.15)	0.302
Not witnessed	*ref*	
Witnessed by public	5.98 (5.56-6.43)	<0.001
Witnessed by EMS†	25.13 (21.82-28.94)	<0.001
Bystander CPR†	6.28 (5.85-6.75)	<0.001
EMS response time	0.98 (0.97-0.98)	<0.001
Shockable rhythm	58.01 (43.97-76.55)	<0.001
Cardiac aetiology	1.59 (1.48-1.72)	<0.001
Year		
2006	*ref*	
2007	1.07 (0.95-1.20)	0.276
2008	0.86 (0.76-0.97)	0.011
2009	0.84 (0.75-0.94)	0.003
2010	0.96 (0.86-1.08)	0.514
2011	0.88 (0.79-0.99)	0.032
2012	1.74 (1.55-1.94)	<0.001
Metropolitan location	1.33 (1.23-1.44)	<0.001
Intensive care presence	1.69 (1.54-1.86)	<0.001

OHCA, out-of-hospital cardiac arrest; EMS, emergency medical services; CPR, cardiopulmonary resuscitation.
*First paramedics to arrive on scene only.
†For EMS witnessed OHCAs: bystander CPR='no' and response time=0.

Supplemental Table 7. Characteristics and odds of survival of OHCAs with attempted resuscitation by paramedic experience categories, attended by Ambulance Victoria, 2006-2012.

	Median experience of attending paramedics (years)				
	≤5	>5-8	>8-11	>11	p-value*
Number (%)	3,983 (26)	4,222 (28)	3,040 (20)	3,891 (26)	
Age (years; median [IQR])	70 (54-81)	68 (53-79)	67 (53-79)	67 (53-78)	<0.001
Female (%)	1,302 (33)	1,332 (32)	919 (30)	1,176 (30)	0.079
Public location (%)	932 (23)	1,029 (24)	826 (27)	1,090 (28)	<0.001
Witnessed (%)					
Bystander	1,747 (44)	2,091 (50)	1,542 (51)	1,844 (47)	<0.001
Paramedic	595 (15)	648 (15)	459 (15)	674 (17)	0.011
Bystander CPR (%)	1,677 (44)	1,871 (46)	1,412 (48)	1,780 (47)	0.002
Presumed cardiac aetiology (%)	2,994 (75)	3,223 (76)	2,356 (76)	2,989 (77)	0.123
Initial Rhythm (%)					
Asystole	1,967 (49)	1,730 (41)	1,148 (38)	1,587 (41)	<0.001
PEA	903 (23)	1,133 (27)	823 (27)	895 (23)	<0.001
Shockable (VF/VT)	1,030 (26)	1,294 (31)	1,022 (34)	1,310 (35)	<0.001
Rural location (%)	1,072 (27)	856 (20)	650 (21)	1,347 (35)	<0.001
EMS Response time† (minutes; median [IQR])	8 (6-11)	8 (6-11)	8 (6-11)	8 (7-12)	<0.001
Number of paramedics attending (median [IQR])	3 (2-4)	4 (3-4)	4 (3-4)	3 (2-4)	<0.001
Number of teams attending (median [IQR])	2 (1-2)	2 (2-2)	2 (1-2)	2 (1-2)	<0.001
Survival (%)	386 (10)	549 (13)	410 (14)	515 (13)	<0.001
Shockable (VF/VT)	296 (30)	395 (31)	313 (31)	398 (31)	0.829
Odds of survival (95% CI)					
Crude	*ref*	1.39 (1.21-1.60)	1.46 (1.26-1.69)	1.43 (1.24-1.64)	
Minimally adjusted‡	*ref*	1.37 (1.19-1.58)	1.42 (1.22-1.65)	1.38 (1.20-1.59)	
Adjusted§	*ref*	1.17 (0.99-1.39)	1.11 (0.93-1.34)	1.09 (0.91-1.29)	

IQR, inter quartile range; CPR, cardiopulmonary resuscitation; PEA, pulse-less electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia; EMS, emergency medical service.

*Kruskal-Wallis test used for non-parametric data and Chi-squared test used for proportions.

†Excludes EMS witnessed.

‡Adjusted for age and sex.

§Adjusted for age, sex, public location, bystander witnessed, paramedic witnessed, bystander cardiopulmonary resuscitation, emergency medical service response time, shockable rhythm, presumed cardiac aetiology, year of arrest, metropolitan location, intensive care paramedics present, number of paramedics present and median paramedic OHCA exposure.

Supplemental Table 8. Multivariable analysis of paramedic experience and patient survival.

Variables	Adjusted odds of survival (95% Confidence interval)	p-value
Median experience of attending paramedics (years)		
≤5	*ref*	
>5-8	1.17 (0.99-1.39)	0.070
>8-11	1.11 (0.93-1.34)	0.248
>11	1.08 (0.91-1.29)	0.352
Median paramedic exposure to OHCA	1.01 (1.00-1.02)	0.001
Number of paramedics on scene	0.98 (0.93-1.05)	0.603
Age	0.97 (0.97-0.98)	<0.001
Female	1.08 (0.94-1.23)	0.293
Public location	1.64 (1.45-1.86)	<0.001
Not witnessed	*ref*	
Witnessed by public	2.01 (1.69-2.38)	<0.001
Witnessed by EMS	5.71 (4.44-7.35)	<0.001
Bystander CPR*	1.24 (1.07-1.45)	0.005
EMS Response time*	0.93 (0.91-0.95)	<0.001
Shockable rhythm	9.42 (8.13-10.91)	<0.001
Cardiac aetiology	1.54 (1.27-1.86)	<0.001
Year		
2006	*ref*	
2007	1.16 (0.91-1.48)	0.242
2008	1.37 (1.08-1.73)	0.011
2009	1.53 (1.21-1.93)	<0.001
2010	1.52 (1.21-1.92)	<0.001
2011	1.57 (1.25-1.98)	<0.001
2012	1.56 (1.25-1.95)	<0.001
Metropolitan location	1.70 (1.43-2.03)	<0.001
Intensive care presence	1.24 (1.00-1.55)	0.052

OHCA, out-of-hospital cardiac arrest; EMS, emergency medical services; CPR, cardiopulmonary resuscitation.

*For EMS witnessed OHCAs: bystander CPR='no' and response time=0.

Supplemental Table 9. Characteristics and odds of attempted resuscitation of all OHCAs by time since last paramedic exposure categories, attended by Ambulance Victoria, 2006-2012.

	Median time since paramedics' were last exposed to OHCA* (months)				
	≤1	>1-3	>3-6	>6	p-value†
Number (%)	7,748 (23)	9,463 (28)	8,301 (25)	7,932 (24)	
Age (years; median [IQR])	69 (53-81)	70 (52-81)	69 (52-81)	70 (54-81)	0.864
Female (%)	2,588 (34)	3,215 (34)	2,867 (35)	2,666 (34)	0.488
Public location (%)	1,487 (19)	1,829 (19)	1,538 (19)	1,483 (19)	0.481
Witnessed (%)					
Bystander	2,447 (32)	2851 (30)	2,306 (28)	2,189 (28)	<0.001
Paramedic	634 (8)	776 (8)	693 (8)	617 (8)	0.637
Bystander CPR (%)	2,203 (29)	2,567 (28)	1,955 (24)	1,879 (24)	<0.001
Presumed cardiac aetiology (%)	5,493 (71)	6,719 (71)	5,911 (71)	5,634 (71)	0.978
Initial Rhythm (%)					
Asystole	5,317 (76)	6,700 (71)	6,124 (74)	6,068 (77)	<0.001
PEA	1,126 (15)	1,238 (13)	1,000 (12)	808 (10)	<0.001
Shockable (VF/VT)	1,220 (16)	1,420 (16)	1,101 (13)	956 (12)	<0.001
Rural location (%)	1,415 (18)	2,266 (24)	2,463 (30)	3,723 (47)	<0.001
EMS response time‡ (minutes; median [IQR])	8 (6-11)	8 (6-12)	8 (6-12)	9 (7-14)	<0.001
Number of paramedics attending (median [IQR])	2 (2-4)	2 (2-4)	2 (2-4)	2 (2-3)	<0.001
Number of teams attending (median [IQR])	1 (1-2)	1 (1-2)	1 (1-2)	1 (1-2)	<0.001
Attempted resuscitation (%)	3,824 (49)	4,521 (49)	3,591 (43)	3,140 (40)	<0.001
Shockable (VF/VT)	1,211 (99)	1,399 (99)	1,089 (99)	942 (99)	0.281
Odds of attempted resuscitation (95% CI)					
Crude	ref	0.94 (0.88-1.00)	0.78 (0.74-0.83)	0.67 (0.63-0.72)	
Minimally adjusted§	ref	0.93 (0.88-0.99)	0.78 (0.73-0.83)	0.68 (0.63-0.72)	
Adjusted||	ref	1.04 (0.96-1.13)	0.97 (0.88-1.06)	0.87 (0.79-0.95)	

IQR, inter quartile range; CPR, cardiopulmonary resuscitation; PEA, pulse-less electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia; EMS, emergency medical service.
*First paramedics to arrive on scene only.
†Kruskal-Wallis test used for non-parametric data and Chi-squared test used for proportions.
‡Excludes EMS witnessed.
§Adjusted for age and sex.
||Adjusted for age, sex, public location, bystander witnessed, paramedic witnessed, bystander cardiopulmonary resuscitation, emergency medical service response time, shockable rhythm, presumed cardiac aetiology, year of arrest, metropolitan location and median paramedic experience.

Supplemental Table 10. Multivariable analysis of time since paramedics' previous OHCA exposures and attempted resuscitation.

Variables	Adjusted odds of attempted resuscitation (95% Confidence interval)	*p*-value
Median time since paramedics' were last exposed to OHCA* (months)		
≤1	*ref*	
>1-3	1.04 (0.96-1.13)	0.343
>3-6	0.97 (0.88-1.06)	0.455
>6	0.87 (0.79-0.95)	0.004
Median paramedic experience*	0.97 (0.96-0.97)	<0.001
Age	0.99 (0.99-0.99)	<0.001
Female	0.93 (0.87-0.99)	0.019
Public location	1.06 (0.96-1.16)	0.241
Not witnessed	*ref*	
Witnessed by public	5.97 (5.55-6.42)	<0.001
Witnessed by EMS	25.24 (21.91-29.08)	<0.001
Bystander CPR†	6.32 (5.88-6.79)	<0.001
EMS response time†	0.98 (0.97-0.98)	<0.001
Shockable rhythm	57.64 (43.68-76.08)	<0.001
Cardiac aetiology	1.59 (1.48-1.72)	<0.001
Year		
2006	*ref*	
2007	1.06 (0.94-1.19)	0.323
2008	0.87 (0.77-0.98)	0.018
2009	0.84 (0.75-0.94)	0.003
2010	0.96 (0.86-1.08)	0.513
2011	0.88 (0.78-0.99)	0.027
2012	1.70 (1.52-1.90)	<0.001
Metropolitan location	1.18 (1.09-1.27)	<0.001
Intensive care presence	1.44 (1.34-1.56)	<0.001

OHCA, out-of-hospital cardiac arrest; EMS, emergency medical services; CPR, cardiopulmonary resuscitation.
*First paramedics to arrive only
†For EMS witnessed OHCAs: bystander CPR='no' and response time=0.

Supplemental Table 11. Characteristics and odds of survival of OHCAs with attempted resuscitation by time since last paramedic exposure categories, attended by Ambulance Victoria, 2006-2012.

	Median time since paramedics' were last exposed to OHCA (months)				
	≤1	>1-3	>3-6	>6	p-value*
Number (%)	4,658 (31)	5,832 (39)	2,865 (19)	1,756 (12)	
Age (years; median [IQR])	68 (53-79)	68 (53-79)	68 (53-79)	68 (54-79)	0.744
Female (%)	1,439 (31)	1,808 (31)	919 (32)	557 (32)	0.674
Public location (%)	1,143 (25)	1,534 (26)	735 (26)	458 (26)	0.213
Witnessed (%)					
Bystander	2,262 (49)	2,835 (49)	1,321 (46)	797 (45)	0.019
Paramedic	724 (16)	946 (16)	431 (15)	271 (16)	0.525
Bystander CPR (%)	2,089 (46)	2,595 (46)	1,270 (46)	775 (45)	0.935
Presumed cardiac aetiology (%)	3,572 (77)	4,446 (76)	2,182 (76)	1,326 (76)	0.760
Initial Rhythm (%)					
Asystole	1,825 (39)	2,388 (41)	1,310 (46)	895 (51)	<0.001
PEA	1,267 (27)	1,480 (25)	656 (23)	348 (20)	<0.001
Shockable (VF/VT)	1,494 (33)	1,859 (32)	836 (30)	460 (27)	<0.001
Rural location (%)	614 (13)	1,160 (20)	1,061 (37)	1,069 (61)	<0.001
EMS response time† (minutes; median [IQR])	8 (6-11)	8 (6-11)	9 (7-12)	7 (7-14)	<0.001
Number of paramedics attending (median [IQR])	4 (3-4)	4 (3-4)	3 (2-4)	2 (2-4)	<0.001
Number of teams attending (median [IQR])	2 (1-2)	2 (1-2)	2 (1-2)	1 (1-2)	<0.001
Survival (%)	631 (14)	800 (14)	312 (11)	115 (7)	<0.001
Shockable (VF/VT)	480 (33)	588 (32)	246 (30)	86 (20)	<0.001
Odds of survival (95% CI)					
Crude	*ref*	1.02 (0.91-1.14)	0.78 (0.68-0.91)	0.45 (0.37-0.56)	
Minimally adjusted‡	*ref*	1.01 (0.91-1.14)	0.79 (0.69-0.92)	0.45 (0.37-0.56)	
Adjusted§	*ref*	1.08 (0.95-1.24)	0.95 (0.80-1.14)	0.70 (0.54-0.91)	

IQR, inter quartile range; CPR, cardiopulmonary resuscitation; PEA, pulse-less electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia; EMS, emergency medical service.

*Kruskal-Wallis test used for non-parametric data and Chi-squared test used for proportions.

†Excludes EMS witnessed.

‡Adjusted for age and sex.

§Adjusted for age, sex, public location, bystander witnessed, paramedic witnessed, bystander cardiopulmonary resuscitation, emergency medical service response time, shockable rhythm, presumed cardiac aetiology, year of arrest, metropolitan location, intensive care paramedics present, number of paramedics present and median paramedic experience.

Supplemental Table 12. Multivariable analysis of time since paramedics' previous OHCA exposures and patient survival.
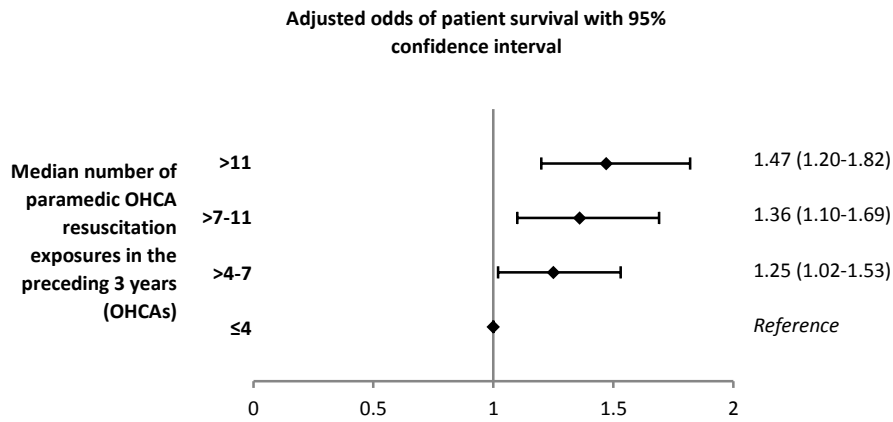
Variables	Adjusted odds of survival (95% Confidence interval)	p-value
Median time since paramedics' were last exposed to OHCA (months)		
≤1	*ref*	
>1-3	1.08 (0.95-1.24)	0.256
>3-6	0.95 (0.80-1.14)	0.593
>6	0.69 (0.54-0.91)	0.007
Median paramedic experience	1.01 (1.00-1.02)	0.146
Number of paramedics on scene	0.96 (0.91-1.02)	0.199
Age	0.97 (0.97-0.98)	<0.001
Female	1.07 (0.93-1.23)	0.330
Public location	1.64 (1.45-1.86)	<0.001
Not witnessed	*ref*	
Witnessed by public	2.01 (1.70-2.38)	<0.001
Witnessed by EMS	5.66 (4.39-7.28)	<0.001
Bystander CPR*	1.25 (1.07-1.46)	0.004
EMS response time*	0.93 (0.91-0.95)	<0.001
Shockable rhythm	9.41 (8.12-10.90)	<0.001
Cardiac aetiology	1.54 (1.27-1.85)	<0.001
Year		
2006	*ref*	
2007	1.14 (0.89-1.46)	0.292
2008	1.38 (1.09-1.75)	0.008
2009	1.50 (1.19-1.89)	0.001
2010	1.50 (1.19-1.88)	0.001
2011	1.54 (1.23-1.94)	<0.001
2012	1.52 (1.21-1.90)	<0.001
Metropolitan location	1.78 (1.50-2.12)	<0.001
Intensive care presence	1.30 (1.04-1.61)	0.018

OHCA, out-of-hospital cardiac arrest; EMS, emergency medical services; CPR, cardiopulmonary resuscitation.
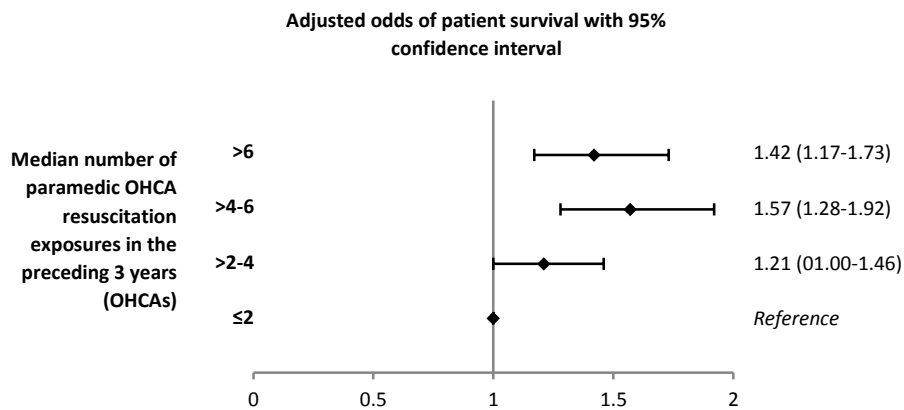
*For EMS witnessed OHCAs: bystander CPR='no' and response time=0.
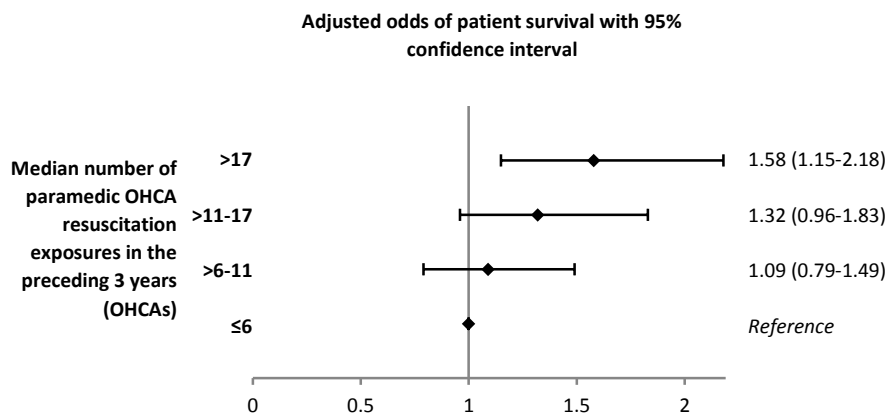
Supplemental Figures

Supplemental Figure 1. Sensitivity analysis of paramedic exposure to OHCA and patient survival using exposure in the previous two years.
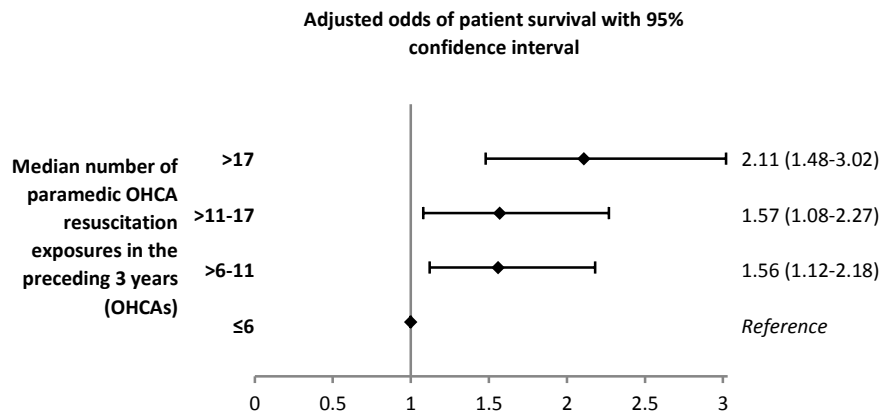
Adjusted odds of patient survival with 95% confidence interval

Median number of paramedic OHCA resuscitation exposures in the preceding 3 years (OHCAs)	>11	1.47 (1.20-1.82)
	>7-11	1.36 (1.10-1.69)
	>4-7	1.25 (1.02-1.53)
	≤4	Reference

Supplemental Figure 2. Sensitivity analysis of paramedic exposure to OHCA and patient survival using exposure in the previous year.

Adjusted odds of patient survival with 95% confidence interval

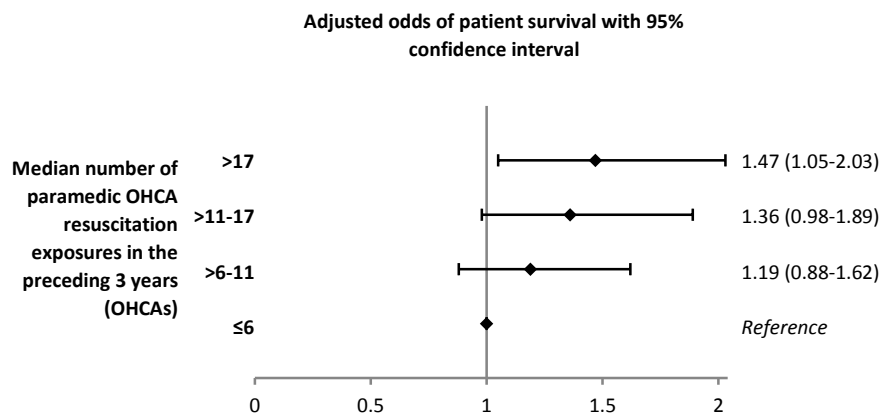|		
Median number of paramedic OHCA resuscitation exposures in the preceding 3 years (OHCAs)	>6	1.42 (1.17-1.73)
	>4-6	1.57 (1.28-1.92)
	>2-4	1.21 (01.00-1.46)
	≤2	Reference

Supplemental Figure 3. Sensitivity analysis of paramedic exposure to OHCA and patient survival using only the most exposed paramedic.
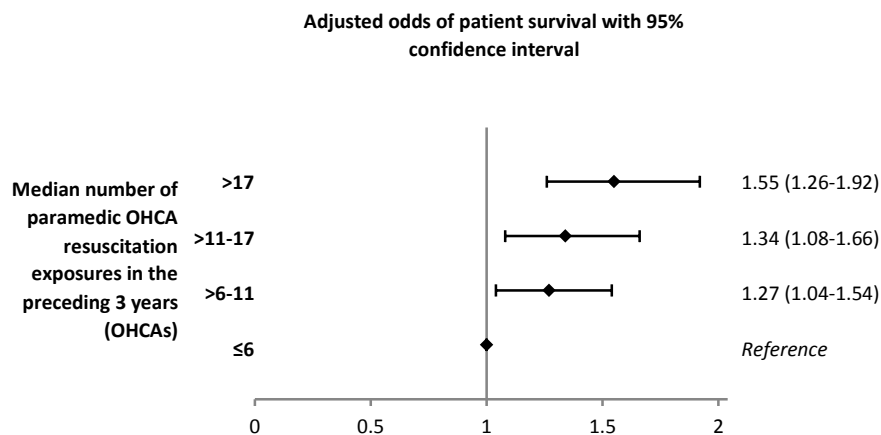
Adjusted odds of patient survival with 95% confidence interval

Median number of paramedic OHCA resuscitation exposures in the preceding 3 years (OHCAs)	>17	1.58 (1.15-2.18)
	>11-17	1.32 (0.96-1.83)
	>6-11	1.09 (0.79-1.49)
	≤6	Reference

Supplemental Figure 4. Sensitivity analysis of paramedic exposure to OHCA and patient survival in paramedic witnessed cases.

Adjusted odds of patient survival with 95% confidence interval

Median number of paramedic OHCA resuscitation exposures in the preceding 3 years (OHCAs)	
>17	2.11 (1.48-3.02)
>11-17	1.57 (1.08-2.27)
>6-11	1.56 (1.12-2.18)
≤6	Reference

Supplemental Figure 5. Sensitivity analysis of paramedic exposure to OHCA and patient survival in bystander witnessed cases with a shockable initial rhythm.

Adjusted odds of patient survival with 95% confidence interval

Median number of paramedic OHCA resuscitation exposures in the preceding 3 years (OHCAs)	
>17	1.47 (1.05-2.03)
>11-17	1.36 (0.98-1.89)
>6-11	1.19 (0.88-1.62)
≤6	Reference

Supplemental Figure 6. Sensitivity analysis of paramedic exposure to OHCA and patient survival in all OHCAs regardless of resuscitation being attempted.

Adjusted odds of patient survival with 95% confidence interval

Median number of paramedic OHCA resuscitation exposures in the preceding 3 years (OHCAs)	
>17	1.55 (1.26-1.92)
>11-17	1.34 (1.08-1.66)
>6-11	1.27 (1.04-1.54)
≤6	Reference

Paramedic Exposure to Out-of-Hospital Cardiac Arrest Resuscitation Is Associated With Patient Survival
Kylie Dyson, Janet E. Bray, Karen Smith, Stephen Bernard, Lahn Straney and Judith Finn

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