Published in final edited form as:
Resuscitation. 2008 January ; 76(1): 43–46.

Predictors of ROSC in Witnessed Aeromedical Cardiac Arrests

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Abstract

Introduction—Aeromedical agencies are used routinely to transport critically ill patients to specialty centers. The characteristics of patients suffering a cardiac arrest during transport by aeromedical flight personnel are not well documented. We completed a retrospective analysis of aeromedical patient care records in order to describe the pre-arrest characteristics and the return of spontaneous circulation (ROSC) in this subset of patients.

Materials and Methods—A retrospective chart review of patients suffering cardiac arrest while being treated by a single aeromedical transport service between 1998 and 2000. Crew configurations were paramedic/nurse or paramedic/physician. Data were directly abstracted by the authors and descriptive data of patient demographics, vital signs and medical history were obtained. Data were separated into medical and traumatic arrests and analyzed by chi-square and t-test. Logistic regression analyses were performed to determine predictors of ROSC.

Results—During the 24-month interval, 12,140 patient transports occurred. Of these, 134 cardiac arrests occurred (1.1%) and are reviewed. Of these, 57 were medical arrests and 76 were traumatic arrests. Nine medical arrests and 37 traumatic arrests were excluded as the patient was in cardiac arrest prior to crew arrival. In the medical arrest cohort, the presence of a peripheral IV prior to crew arrival and initial rhythm of arrest were associated with ROSC at destination. (p=0.05) In the traumatic arrest cohort, patients with lower diastolic blood pressures had a trend toward lower rates of ROSC. (p=0.06)

Conclusion—Cardiac arrest during aeromedical transport is infrequent. Patients with poor IV access are less likely to experience ROSC should they experience a cardiac arrest. Patients with traumatic injury and diastolic hypotension may be less likely to survive cardiac arrest during transport.

Keywords

cardiac arrest; aeromedical; resuscitation; trauma; intravenous line; return of spontaneous circulation

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Conflict of Interest Statement None.

1. Introduction

Aeromedical transport is used routinely to transport critically ill patients from outlying facilities to larger tertiary-care centers. However, the characteristics of patients suffering a cardiac arrest during transport by aeromedical flight personnel are poorly understood. earlier work in this patient group has demonstrated return of spontaneous circulation (ROSC) rates of between 13 and 19%. [1,2] However, these studies examined small cohorts. We completed a retrospective analysis of aeromedical flight crew run sheets in order to describe these patients more accurately.

2. Methods

We completed a retrospective chart review of patients treated by an aeromedical transport service between 1998 and 2000. The University of Pittsburgh Institutional Review Board approved this study. STAT MedEVAC (a division of the Center for Emergency Medicine of Western Pennsylvania) provides aeromedical transport for patients in Eastern Ohio, Pennsylvania, New York and Maryland and completes approximately 12,000 transports each year. [17 base sites and 3 fixed-wing aircraft] The crew consists of a flight paramedic and flight nurse, both of whom have extensive training in critical care and prehospital medicine. A physician may substitute for the flight nurse on some crews. Transportation records were sought from the central database and patient identifiers were removed. We obtained records on all patients that experienced a cardiac arrest during the care of the aeromedical flight crew.

Data were directly abstracted from the chart by the authors and recorded in a database. Two logistic regression analyses were completed to determine predictors of ROSC. The first was designed to examine subject patho-physiology at the time of presentation in order to determine if pre-arrival conditions are associated with ROSC. The candidate variables in this analysis included: initial heart rate, initial systolic blood pressure, initial diastolic blood pressure, ECG prior to arrest, tracheal intubation performed by the referring agency, and presence of a peripheral intravenous line. These variables were chosen as they represent data that are readily available to the flight crew upon arrival and may heighten clinical suspicion for a potential cardiac arrest victim. The second analysis was designed to determine if the interventions delivered by the flight crew predicted ROSC. These candidate variables included: initial rhythm of arrest, number of defibrillations, pacing, tracheal intubation by flight crew, epinephrine (adrenaline) use, and needle thoracostomy. The Hosmer-Lemeshow test was used to assess goodness of fit. Groups were compared via chi square analysis. Descriptive data record mean and 95% CI. The median and interquartile range were recorded for time data points. Data were analyzed using STATA 9.0.

3. Results

During the 24-month interval, 12,140 patient transports occurred. A breakdown of transports by nature of illness is shown in Table 1. One hundred thirty four cardiac arrests occurred and were reviewed. The overall incidence is 1.1%. Fifty-seven were medical patients and 76 were patients with traumatic injuries. Cardiac arrest occurred in 9 medical patients and 37 trauma patients before the arrival of the aeromedical crew and were excluded. All medical patients with cardiac arrest were interfacility flights. Vital signs for the medical patient cohort are depicted in Table 2. Seventy five percent of these patients experienced ROSC. In these 36 patients, initial heart rate, systolic blood pressure, and diastolic blood pressure were not different from the patients without ROSC. Twelve of the 36 medical patients with ROSC did not require chest compressions, only defibrillation.

In the presenting physiology logistic regression analysis, the presence of a peripheral IV before arrival strongly predicted both ROSC during the flight and presence of pulses at the receiving facility (p=0.05). Both models had good fit with Hosmer-Lemeshow values of 0.34 for ROSC and 0.94 for ROSC at receiving facility (Tables 3 and 4). In the intervention analysis, only initial rhythm predicted ROSC during the flight and pulses at the receiving facility ($p \leq 0.05$). Both models had good fit with Hosmer-Lemeshow values of 0.61 and 0.28. While ventricular fibrillation/ventricular tachycardia had the highest rates of ROSC, pulseless electrical activity and asystole also had significant rates of ROSC (Table 5).

In the 39 trauma patients, 8 experienced ROSC (21%). Vital signs for the trauma cohort are depicted in Table 6. Heart rate and systolic blood pressure were not different between these groups. However, diastolic blood pressure was lower in those patients who did not experience ROSC ($p<0.05$). In the presenting physiology regression model, subjects with lower diastolic blood pressure experienced a trend toward lower rates of ROSC (p=0.06). No interventions were associated with pulses at destination. Thirteen patients received needle thoracostomy during resuscitation from traumatic arrest. Two of these experienced immediate ROSC and did not require chest compressions.

4. Discussion

To our knowledge, this is the first study describing witnessed aeromedical cardiac arrests of both medical and traumatic etiology. The overall incidence was 1.1% and is lower than the 0.1% noted in large out-of hospital cardiac arrest cohorts. [3-5] In the medical cohort, we noted an excellent rate of ROSC (75%). This response is buttressed by the 1/3 of patients who required a single rescue shock to return pulses. It is alarming that even though the entire medical cohort originated from outlying medical facilities, a significant proportion did not have intravenous access prior to the arrival of the aeromedical crew. Subjects suffering medical cardiac arrest during aeromedical transport who did not have a peripheral IV prior to arrival were much less likely to experience ROSC at destination than patients who had a peripheral IV before the arrival of the aeromedical crew. Interestingly, in all four of these patients, a central line had been established by the referring facility. Three of these patients suffered cardiac arrest in the intensive care unit before the crew departed. The fourth patient suffered a cardiac arrest from a ruptured abdominal aortic aneurysm while en route. After pulses were restored, the patient was taken to the operating room for repair. We feel that the lack of a peripheral IV in a patient already identified as sufficiently ill for aeromedical transport may identify a patient with significant potential for cardiac arrest.

Our rates of ROSC for VF/VT are not surprising. However, the rates of ROSC for PEA and asystole are encouraging. These data suggest that these patients may remain viable if treated early and aggressively.

In the traumatic arrest analysis, the ROSC rates reported here are similar to those in the literature. [1,2,6] A low diastolic blood pressure should be considered an ominous sign and increase the index of suspicion for the transport crew. Unlike earlier reports, we did not note a difference in ROSC associated with ECG rhythms. [7] While not statistically significant, we do note that 2 of 13 patients (15%) receiving needle thoracostomy experienced ROSC. In those patients whose clinical presentation is concerning for thoracic trauma, this intervention may be life-saving.

This study has several limitations. First, this is a retrospective review of self-reported prehospital data. Our sample size, although larger than previous reports, is too small to create a predictive model for in-flight cardiac arrest. Finally, detailed outcome data beyond the hospital disposition were not available.

5. Conclusions

Cardiac arrest during aeromedical transport is infrequent. Twenty-five percent of medical patients who suffer cardiac arrest in the care of aeromedical providers respond to countershock alone. However, medical patients requiring central line placement before aeromedical arrival at the referral facility are less likely to experience ROSC should they experience a cardiac arrest. Patients with traumatic injury and diastolic hypotension may be less likely to survive cardiac arrest during transport.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Drs. Rittenberger, Hostler and Callaway are supported by the Clinical Research Skills Development Core of the Resuscitation Outcomes Consortium through the National Heart, Lung and Blood Institute 5U01 HL077871-02.

We are indebted to the medical directors of STAT MedEVAC, Drs. John Cole, Francis Guyette and TJ Doyle along with Mr. Jeffrey Sayers, for providing access to the data used in this study.

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Table 1

Transports by Nature of Illness

Nature of Illness	Transports
Cardiac	2,881
Medical	1,124
Neurological	1,302
Respiratory	367
Surgical	256
Trauma	3,311
Burns	121
Transplant	146
OBGYN	135
Pediatrics	2,497
Organ Procurement/Other	137
Total	**12,277**

Table 2

Arrival Vital Signs of In-Flight Medical Patients with Cardiac Arrest

	Transport- ROSC (95% CI)	Transport- No ROSC (95% CI)
Pulse	93 (83, 103)	106 (82, 131)
Systolic BP (mmHg)	102 (90, 113)	93 (73, 112)
Diastolic BP (mmHg)	60 (52, 68)	57 (39, 75)

Table 3

Presenting Physiology Predictors of ROSC in Medical Cardiac Arrest Cohort

	Odds Ratio	95% CI	P value
ROSC anytime			
No peripheral IV	0.022	0.0006; 0.78	0.04
Initial heart rate	1.04	1.0; 1.1	0.04
Pulses at destination			
No peripheral IV	0.013	0.002; 0.73	0.04
Initial heart rate	1.04	1.0; 1.1	0.06

Table 4

Intervention Predictors of ROSC in Medical Cardiac Arrest Cohort

	Odds Ratio	95% CI	P value
ROSC anytime			
Initial rhythm	8.1	1.8; 37.1	0.01
Pulses at destination			
Initial rhythm	4.4	1.2; 17.0	0.03

Table 5

Initial Rhythm of Arrest and ROSC for Medical Cardiac Arrest Cohort

Rhythm (# cases)	ROSC anytime	Pulses at destination
VF/VT (24)	96%	90%
PEA (19)	58%	50%
Asystole (5)	40%	33%

Table 6

Arrival Vital Signs of In-Flight Trauma Cardiac Arrest Patients

	Transport- ROSC (95% CI)	Transport- No ROSC (95% CI)
Pulse	93 (80, 106)	96 (83, 109)
Systolic BP (mmHg)	128 (99, 156)	109 (95, 123)
Diastolic BP (mmHg)	83 (63, 103) *	63 (54, 72)

* $p<0.05$