Review of In-Hospital and Out-of-Hospital Cardiac Arrests at a Tertiary Community Hospital for Potential ECPR Rescue

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Abstract

This was a retrospective study on in and out-of-hospital cardiac arrest (IHCA and OHCA) patients at a tertiary community hospital. The aim of the study was to compare characteristics and outcomes of IHCA versus OHCA and evaluate those patients who might have been good candidates for more aggressive resuscitation like extracorporeal membrane oxygenation cardiopulmonary resuscitation (ECPR). The data suggests a strong correlation between an increased duration of cardiopulmonary resuscitation (CPR) and a decreased survival rate for both IHCA and OHCA. Overall survival to discharge rate for ICHA was found to be 30%, above the national average of 17%, and was 6.8% for OHCA, within the national average of around 5-10% (Peberdy *et al*. 2003; Abrams *et al.* 2013). Using specific inclusion and exclusion criteria suggested by recent research, 44 IHCA patients over 2 years and 133 OHCA patients over 4.5 years would have been potential candidates for ECPR. Though this study included only patients from a single institution, it highlights the possibility of improving patient outcomes by implementing a more aggressive resuscitation protocol for refractory cardiac arrest. It warrants further research into resuscitation protocols, specifically the addition of ECPR into the protocols at the Lehigh Valley Health Network for a specific cohort of patients.

Introduction

Cardiac arrest remains a major cause of death in United States despite changes in resuscitation protocols.[1] Both in-hospital and out-of-hospital cardiac arrests still have very poor survival to discharge prognoses without any significant changes in recent years. In-hospital cardiac arrest (IHCA) survival rates are about 17% nationally while those for out-of-hospital cardiac arrest (OHCA) are even lower at 5-10% (Peberdy *et al.* 2003; Abrams *et al.* 2013). Previous studies have suggested significant differences in survival to discharge rates for those suffering witnessed versus unwitnessed arrests, for different initial cardiac rhythms (Ventricular tachycardia or ventricular fibrillation versus pulseless electrical activity (PEA) versus asystole), and for cardiopulmonary resuscitation (CPR) duration (Avalli *et al.* 2012). Within these categories there are additionally differences for those suffering IHCA versus OHCA (Peberdy *et al.* 2003).

The current standard strategy for intervention of IHCA and OHCA is the advanced cardiac life support (ACLS) protocol. ACLS protocol includes performance of adequate chest compressions, airway management, defibrillation when appropriate, and administration of applicable drugs. The progression of cardiopulmonary resuscitation (CPR) for these arrests can

vary greatly between patients. Many factors including initial cardiac rhythm, duration of CPR, quality of CPR, and cause of the arrest account for these differences and the end prognosis for the patient (Haneya *et al.* 2012).

A more aggressive interventional strategy that is also currently available is extracorporeal membrane oxygenation cardiopulmonary resuscitation (ECPR), sometimes referred to as extracorporeal life support. ECPR is a technique and set of protocols to provide externally circulated blood to support cardiac and pulmonary function. The blood is drained from the patient and oxygenated outside of the body before it is returned to circulation. This temporarily allows for adequate bodily perfusion in patients whose hearts will not pump properly. ECMO is a transitory solution that offers valuable time for the pathologies behind the cardiac arrest to be evaluated and treated (Avalli *et al.* 2012; Haneya *et al.* 2012; Fagnoul *et al.* 2014). It is very resource intensive and invasive, so it is best used for patients in refractory cardiac arrest for which conventional CPR is futile. Survival rate for these patients would otherwise be about 0%. Recent studies have shown ECPR to improve survival rates of those with refractory cardiac arrest for both IHCA and OHCA up to 40-46% and 5-15% respectively (Avalli *et al.* 2012; Haneya *et al.* 2012; Fagnoul *et al.* 2014).

Methods

This was a retrospective study involving 169 patients between in 2011 and 2012 with IHCA and 425 patients in January 2011-May 2015 coming to the Emergency Department with OHCA.

Data was examined for each patient from their medical charts, electronic medical records, and resuscitation records. The overall exclusion criterion was an age greater than 70 or less than 18 or an existing Do Not Resuscitate (DNR). All patients admitted to the hospital at the time of their first arrest were classified as IHCA while those with an arrest taking place prior to admittance were classified as OHCA.

A database was made to compile to condense relevant information for the patients. The information looked at for this study included: demographics, medical history, if the arrest was witnessed, initial cardiac rhythm, duration of CPR, time from arrest to hospital (if OHCA), if there was a return of circulation (>20minutes), and if the patient survived to discharger following the arrest. For OHCA this information included:

When evaluating patients who may have benefited from ECPR, the inclusion criteria were: Patients with witnessed and non-traumatic arrests, CPR initiated within 5 minutes, no terminal malignancies, time from arrest to hospital less than 60 minutes or arrest in hospital. Exclusion criteria were survival or sustained ROSC from conventional CPR.

Fischer's Exact tests and t-tests were used to evaluate significance and p-values.

Results

A comparison of baseline characteristics, CPR variables, and outcomes of the IHCA versus OHCA patients is shown in Table 1 of Appendix 1. The IHCA cohort consisted of 169 patients (98 male, 71 female) with an average age of 55 (21-70) and the OHCA cohort consisted of 425 patients (305 male, 120 female) also with an average age of 55

(18-70). About 89.3% of IHCA patients suffered witnessed cardiac arrests while about 62.4% of OHCA were witnessed. The initial cardiac rhythm was ventricular fibrillation/tachycardia for about 25% of both IHCA and OHCA patients while it was pulseless electrical activity (PEA) for 49% and 26% and asystole 25% and 49% for IHCA and OHCA respectively. Additionally, about 59.2% of IHCA and 16.5% of OHCA patients had a return of spontaneous circulation greater than 20 minutes. Figure 1 shows the overall survival to discharge rates for IHCA to be 30.8% and 6.8% for OHCA.

A statistically significant difference in mean total duration of CPR for index event was found. Mean duration for IHCA was 19.4±18.2 minutes with a range of 1-126 minutes and for OHCA was 47.3±25.7 minutes with a range of 1-330 minutes (p-value <.0001). Figure 2 of Appendix 1 shows that the mean total duration of CPR for survivors to discharge was 12 minutes and 42.6 minutes for non-survivors. In Figure 3, a comparison of survival rate to discharge and total duration of CPR for first arrest of IHCA and OHCA is shown. For both groups those with a total CPR duration of 0-5 minutes have the highest rate of survival at around 60% for IHCA and 80% for OHCA. For the subsequent CPR duration intervals survival rates for IHCA and OHCA were as follows: 44.8% and 28.6% for a duration of 6-10 minutes, 23.3% and 16.7% for 11-20 minutes, 17.2% and 10.8% for 21-30 minutes, 7.7% and 2.4% for 31-40 minutes, 7.1% and 2.2% for 41-50 minutes, and 12.5% and 0% for greater than 51 minutes.

Based upon the inclusion and exclusion criteria for ECPR outlined in the methods, 44 of the 117 IHCA patients who did not survive could have potentially been candidates for ECPR. Additionally, 133 of the 396 OHCA patients who did not survive could have potentially been candidates for ECPR. Figure 4 illustrates the inclusion criteria and that when using ECPR survival rates given by recent studies, 17-20 additional IHCA patients could have potentially survived in 2 years and 13-26 additional OHCA patients could have potentially survived in 4.5 years.

Conclusions

A large correlation was found between decreasing survival rates with increasing total duration of CPR for both IHCA and OHCA, as shown in Figure 3. This finding is consistent with other research (Haneya *et al.* 2012). The small increase in survival rate for IHCA with a CPR duration of greater than 51 minutes is likely due to a small sample size. While the overall survival to discharge rate for IHCA is much greater than for OHCA, the survival rate for a CPR duration of 0-5 minutes is actually greater for OHCA as seen in Figure 3. This could again be due to a small sample size and/or because of the additional health issues present for many IHCA patients.

Overall survival to discharge rates were found to be above the national average of 17% for IHCA at 30% and within the national average of 5-10% for OHCA at 6.8% (Peberdy *et al.* 2003; Abrams *et al.* 2013). The higher than average survival rate for IHCA is likely because those over the age of 70 were not included in this study.

If ECPR protocols had been in place with the specific inclusion and exclusion criteria outlined, a cohort of IHCA and OHCA patients would have been good

candidates and could have potentially survived. This study warrants further research into resuscitation protocols for those with prolonged or refractory cardiac arrests and into the implementation of and ECPR protocol in the LVHN. However, this study cannot be generalized to any population because it includes data from only one institution and a relatively small sample of patients.

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References

1 Avalli, L., Maggioni, E., Formica, F., Redaelli, G., Migliari, M., Scanziani, M., … Fumagalli, R. (2012). Favorable survival of in-hospital compared to out-of-hospital refractory cardiac arrest patients treated with extracorporeal membrane oxygenation: An Italian tertiary care centre experience. *Reuscitation, 83,* 579-583.

2 Fagnoul, D., Combes, A., & De Backer, D. (2014). Extracorporeal cardiopulmonary resuscitation. *Current Opinion Critical Care, 20,* 259-265.

3 Haneya, A., Philipp, A., Diez, C., Schopka, S., Bein, T., Zimmermann, M., … Muller, T. (2012). A 5-year experience with cardiopulmonary resuscitation using extracorporeal life support in non-postcardiotomy patients with cardiac arrest. *Resuscitation, 83,* 1331-1337.

4 Peberdy, M., Kaye, W., Ornato, J.P., Larkin, V.N., Mancini, M.E., Berg, R.A., … Lane-Trultt, T. (2003). Cardiopulmonary resuscitation of adults in the hospital: A report of 14720 cardiac arrests from the National Registry of Cardiopulmonary Resuscitation. *Resuscitation, 58,* 297-308.

5 Abrams, H, McNally, B., Ong, M., Moyer, P.H., & Dyer, KS. (2013). A composite model of survival from out-of-hospital cardiac arrest using the Cardiac Arrest Registry to Enhance Survival (CARES). *Resuscitation, 84,* 1093-1098.

Appendix 1

Table 1

	All patients (n=594)	In-Hospital (n=169)	Out-of-Hospital (n=425)	p Value
Age, years (range)	54.9 (18-70)	55.3 (21-70)	54.8 (18-70)	
Male, n (%)	403(67.8)	98 (58.0)	305 (71.8)	.002
Medical history, n (%)				
Hypertension	308 (51.9)	87 (51.5)	221 (52.0)	
Diabetes mellitus	191 (32.1)	64 (37.8)	127 (29.9)	
Myocardial infarction	78 (13.1)	20 (11.8)	58 (13.6)	
Chronic heart failure	75 (12.6)	16 (9.5)	59 (13.9)	
Renal failure on dialysis	57 (9.6)	22 (13.0)	35 (8.2)	
Cancer	59 (9.9)	27 (16.0)	32 (7.5)	
Witnessed Arrest, n (%)	416 (70.0)	151 (89.3)	265 (62.4)	<.0001
Initial cardiac rhythm				
Ventricular fibrillation/Tachycardia	140 (23.6)	42 (24.9)	98 (24.8)	0.91
Pulseless Electrical Activity	185 (31.1)	82 (48.5)	103 (26.1)	<.0001
Asystole	206 (34.7)	42 (24.9)	194 (49.1)	<.0001
CPR Duration, min	39.4	19.4±18.2	47.3±25.7	<.0001
Outcome, n (%)				
Return of Circulation >20min	170 (28.6)	100 (59.2)	70 (16.5)	<.0001
Survival to Discharge	81 (13.6)	52 (30.8)	29 (6.8)	<.0001

Figure 1

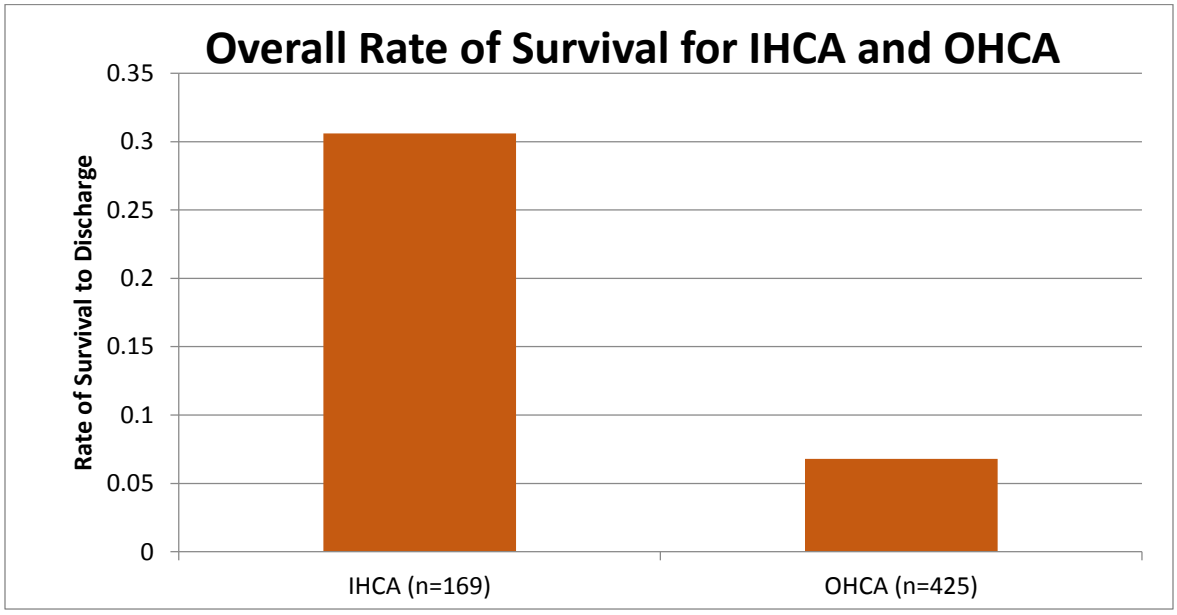


Figure 2

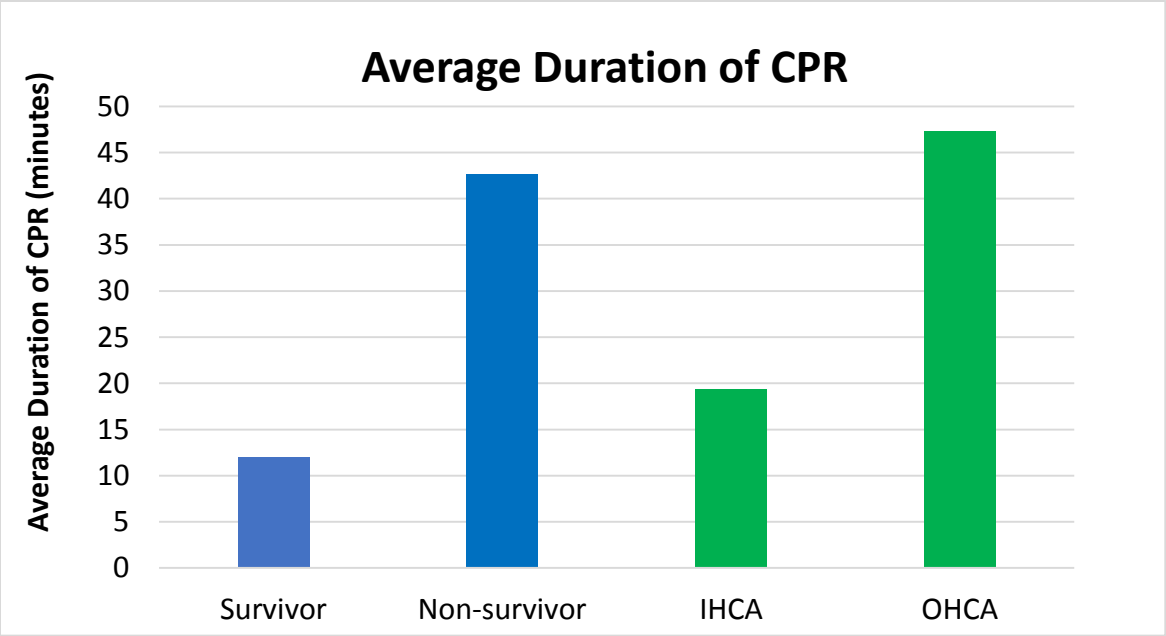


Figure 3

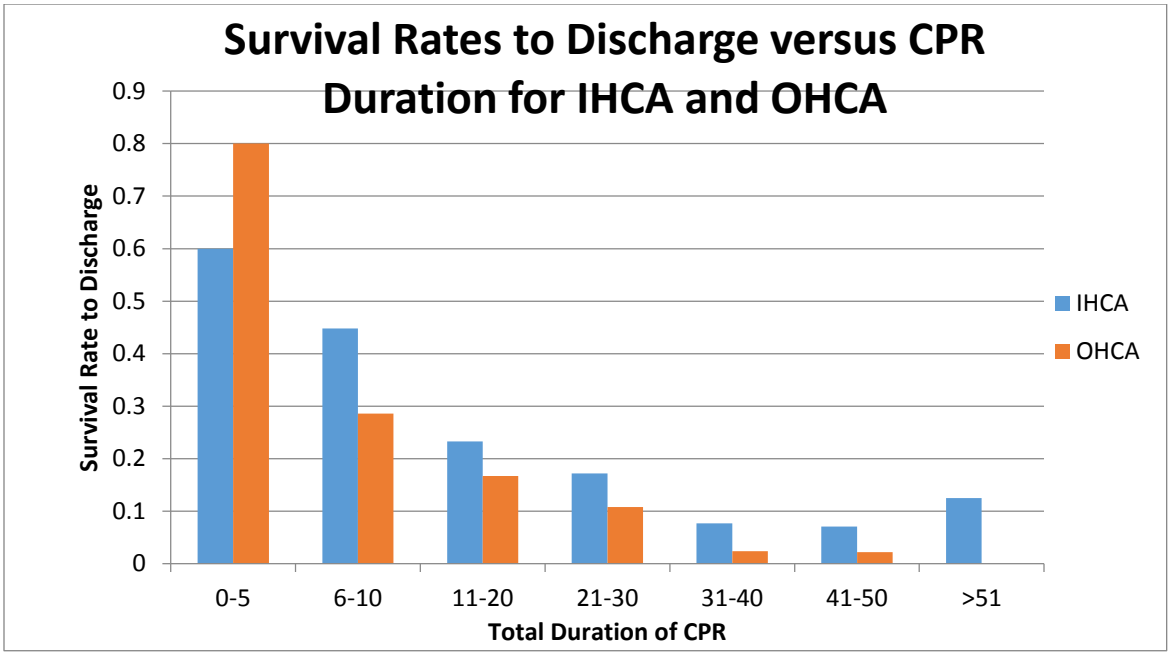
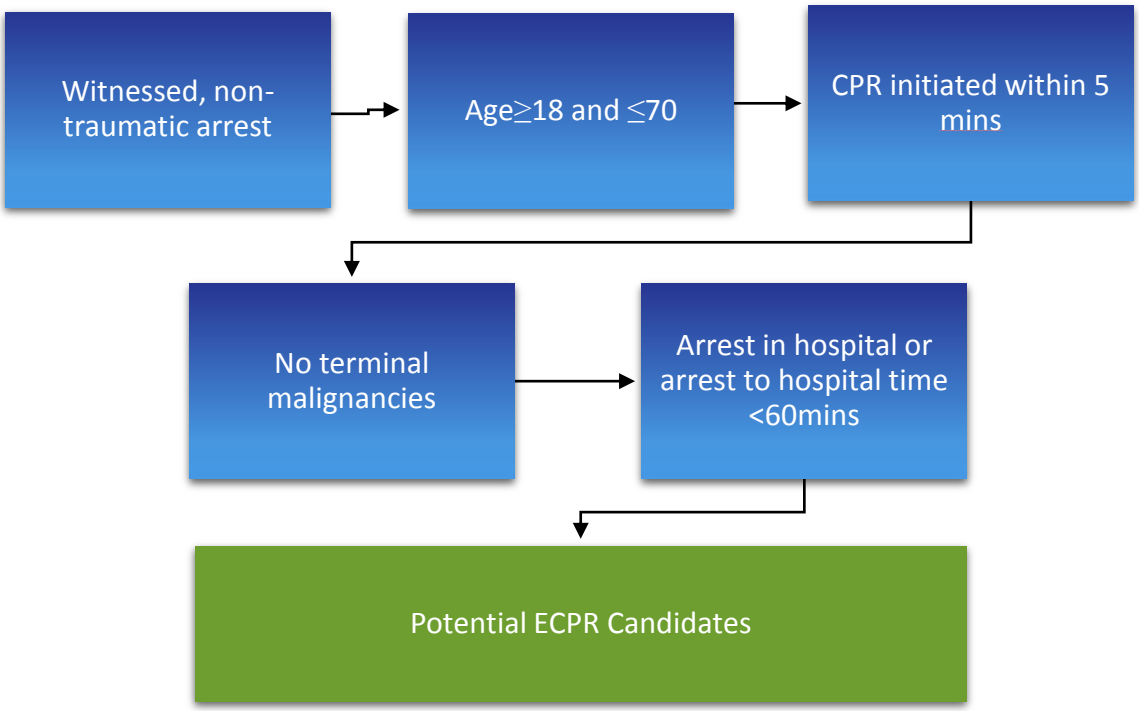
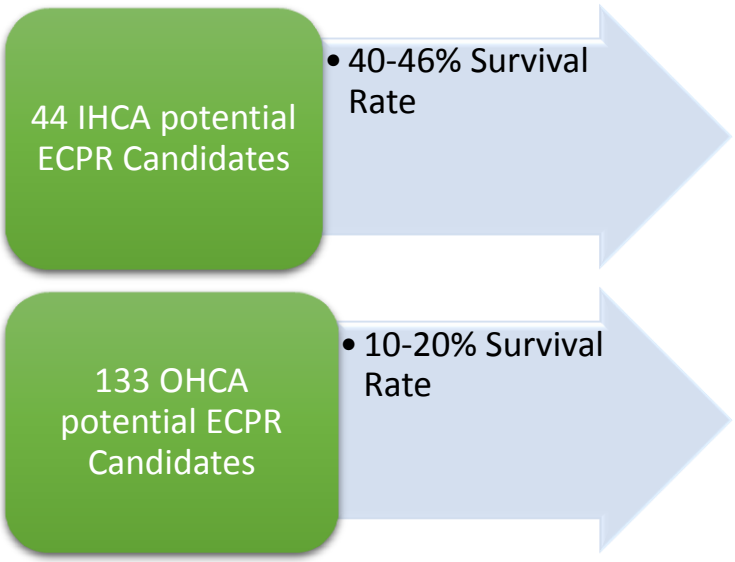


Figure 4


Witnessed, non-traumatic arrest
Age≥18 and ≤70
CPR initiated within 5 mins
No terminal malignancies
Arrest in hospital or arrest to hospital time <60mins
Potential ECPR Candidates


44 IHCA potential ECPR Candidates
• 40-46% Survival Rate
133 OHCA potential ECPR Candidates
• 10-20% Survival Rate