Factors Associated with Survival from In-Hospital Cardiac Arrest in the Service Wards and Intensive Care Units of a Tertiary Hospital

Bab E. Pangan, MD,[1] Sheryll Anne R. Manalili, MD,[1]
Jose Donato A. Magno, MD[2] and Felix Eduardo R. Punzalan, MD[2]

[1]*Division of Nephrology, Department of Medicine, Philippine General Hospital, University of the Philippines Manila*
[2]*Division of Cardiology, Department of Medicine, Philippine General Hospital, University of the Philippines Manila*

ABSTRACT

Background. Despite the recent advances in advanced cardiac life support (ACLS), there has been no significant improvement in survival among patients who undergo cardiac arrest. To date, there are no local guidelines on the requirements or standards of in-hospital cardiac arrest teams in the Philippines. In addition, there are still no studies on the outcomes of cardiac arrests among adult patients in a tertiary hospital in the Philippines.

Objectives. The objective of this study is to investigate patient-, event-, and hospital-related factors associated with survival among adult patients who underwent in-hospital cardiac arrest in the service wards and intensive care units of a tertiary hospital.

Methods. This is a prospective cross-sectional study conducted over three months in 2018. Patient-, event- and hospital-related data were collected from each patient with a cardiac arrest event who was referred to the cardiac arrest teams based on the modified Utstein form of reporting cardiac arrests. Survival to discharge from cardiac arrest was the main outcome.

Results. The study included 119 patients, 47.9% male, with a mean age of 50.1 years (SD 16.7). Survival rate was 6.7%. The mean response time did not differ between survival group (1.46 minutes) and mortality group (1.82 minutes) (p value = 0.26). The presence of a shockable initial rhythm (3.6% vs 3/8; p value = 0.01), shorter lag time to initiation of electrical therapy (6.0 vs 9.3 ± 5.6 min; p value = 0.02), shorter time to establishment of an airway (2.75 ± 1.6 vs. 6.98 ± 5.2 min; p value = 0.01), and shorter duration of resuscitation (7 ± 4.6 vs. 13.0 ± 7.9 min; p value = 0.01) were significantly associated with survival. The presence of underlying illnesses is associated with higher mortality. The most common hospital-related problems identified were the need to cover long distances, delay in the call, and the lack of elevators.

Conclusion. The survival rate of patients who underwent cardiac arrest and resuscitation by a cardiac arrest team is low. The initial presenting rhythm, lag time to initiation of electrical therapy, time to establishment of airway, duration of resuscitation, as well as the underlying disease can significantly affect survival. Streamlining the resources of the hospital to address these matters can have an impact on survival.

Key Words: Cardiac arrest, survival, advanced cardiac life support

1st Place Original study category, PGH Resident's Research Forum, October 9, 2018, Human Resource and Development Division, Philippine General Hospital.

Corresponding author: Bab E. Pangan, MD
Department of Medicine
Philippine General Hospital
University of the Philippines Manila
Taft Avenue, Manila 1000, Philippines
Email: babpangan@yahoo.com

INTRODUCTION

In-hospital cardiac arrest teams (CAT) need to be equipped with the skills and knowledge on advanced cardiac life support (ACLS) to respond to patient undergoing cardiac arrests anywhere in the hospital.[1] Majority of these CATs are stationed at the critical areas or intensive care units (ICU) of hospitals. Despite the recent advances in ACLS, there has been no significant improvement in survival among patients

who undergo cardiac arrest. More than 200,000 people are treated for in-hospital cardiac arrest (IHCA) in the United States each year.[2] The UK National Cardiac Arrest Audit database reported an incidence of 1.6 IHCA's per 1000 hospital admissions in the years 2011–2013 with overall adjusted survival rate at 18.4%.[3] No more than 20 to 30% of these patients survive to discharge.[3,4] Factors associated with patient outcomes after a cardiac arrest could be subdivided into the following: patient variables, hospital variables, and event or arrest variables.[5] Some factors associated with a poor survival post arrest are older age, asystole or pulseless electrical activity, unwitnessed arrest and multiple patient co-morbidities.[6] Tirkkonen and colleagues described CATs across various hospitals in Finland as to areas of operation, CAT leader specialty, on-board equipment, presence of dedicated post-resuscitation debriefing, and documentation of resuscitative efforts.[1] Other studies focused on technical aspects of the resuscitative team and the resuscitative efforts, including: time from detection of cardiac arrest to the arrival of the cardiac arrest team or the "response time," presenting initial cardiac rhythm, time to first defibrillation, and duration of cardiopulmonary resuscitation (CPR).[7,8] The most important predictors of survival in cardiac arrest include the response time of CATs; with the observation that no one survived when response time was equal to or longer than 6 minutes.[9] Huang and colleagues noted a response time of approximately 2 minutes in a large hospital in Taiwan.[8] Similar results were noted in a study by Sandroni et al. in 2004 which associated a response time of 1.3 ± 1.7 minutes with return of spontaneous circulation.[9] Studies have been performed in institutions abroad that characterized the response of their cardiac arrest teams.[10,11] The most commonly identified areas that need improvement in CAT's are the lack of training of personnel, the lack of personnel, and the lack of equipment.[10]

The Philippine General Hospital (PGH) is a tertiary, state-owned university hospital that caters to a wide spectrum of patients with various medical conditions from different socio-economic strata. Its main driving mandate coincides with that of its teaching institutional counterpart, the University of the Philippines College of Medicine. Thus, a large part of the services is dedicated to the indigent sector, or the so-called "service patients." There are sixteen wards under the service division of the hospital, two of which are pediatric wards. There are two cardiac arrest teams available for 24 hours. One is the Medical ICU (MICU) CAT which is located at the first floor, while the other is the Central ICU (CENICU) CAT located at the second floor. The MICU CAT responds to calls for the adult service wards located in the first floor as well as separate buildings located outside the main hospital complex, namely: the Cancer Institute, Spine Unit, Sentro Oftalmologico Jose Rizal, and the out-patient department. The Emergency Room Complex and the Obstetrics Admitting Section (OBAS) are the exceptions, having their separate cardiac arrest team located at the ER complex. The CENICU CAT is in charge of the wards located on the second floor. An unpublished study by Lim, Lasco, Isip-Tan in 2008 showed that of 258 patients who underwent CPR in the IM wards, 92.8% died while the rest went home against advice (4.2%) or were transferred to MICU (1.6%).[12] According to the 2016 MICU cardiac arrest census, 184 cardiac arrests were called within the MICU while 485 were called outside the MICU.[13]

There is no cardiac arrest team in the wards that is solely dedicated to respond to calls of cardiac arrests. The usual initial responders are the medical clerks and interns who are tasked to monitor select patients. In some cases, the watcher or relative of the patient are the ones who alert the medical team for any patient concerns especially among patients who are deemed stable enough not to be monitored intensively. The person who initially detects the cardiac arrest calls the code and begins chest compressions. The current system of ACLS response in non-ICU service wards is that a nurse in a certain ward where a cardiac arrest is called has the responsibility to call the CAT designated for that area. The team consists of the internal medicine senior resident on-duty who serves as the team captain, one medical or central ICU nurse, and a hospital utility worker. The members of the team are certified to provide basic life support (BLS) and advanced cardiac life support (ACLS). They proceed to the area bringing the code cart containing the cardiac monitor-defibrillator, medications used in ACLS, and medical equipment necessary to establish an advanced airway.

To date, there are no local guidelines on the requirements or standards of in-hospital CATs in the Philippines. In addition, there are still no studies on the outcomes of cardiac arrests among adult patients in the Philippine General Hospital. By taking a closer look into the system of how a cardiac arrest is addressed and responded to, we can see possible points for improvement, which can possibly open doors to policy changes with regard to CATs in PGH. Furthermore, by correlating the profiles of patients to the outcomes after resuscitation, healthcare providers can have an idea on expected outcomes which can be useful when discussing with the relatives regarding important end-of-life issues such as resuscitation status or the decision to stop the resuscitation attempt.

OBJECTIVES

General Objectives

- To investigate the factors affecting survival from cardiac arrest in the service wards and intensive care units of a tertiary hospital

Specific Objectives

To determine the following:

- Patient-related factors associated with survival from cardiac arrest (age, sex, ward admitted, underlying disease, length of hospital stay at time of arrest)

- Event-related factors associated with survival from cardiac arrest (response time, time to establishment of airway, initial presenting rhythm, time to initiation of electrical therapy, duration of resuscitation)
- Hospital-related factors in the response to cardiac arrests (availability of emergency equipment and medications, infrastructure barriers, locations of CATs, initial responder profile)
- Outcomes of cardiac arrests in the service wards and intensive care units of PGH
- Patient-related and event-related factors associated with return of spontaneous circulation from cardiac arrest to assess the outcome of the resuscitation process alone

METHODS

The study was a cross-sectional study conducted for three months in 2018 at the service wards, intensive care units and selected units of the Philippine General Hospital. The wards included medical wards, neurologic wards, obstetric and gynecologic wards, and the surgical wards, which included general surgery, otorhinolaryngology and orthopedics. The intensive care units include the medical ICU, surgical ICU, neurologic ICU, neurosurgical ICU, intensive maternal unit, burn unit, and the central ICU. Selected units located outside the main PGH building, such as the Cancer Institute, Sentro Oftalmologico Jose Rizal building and Spine Unit, which are also service wards, were also included. Patients were included in the study if they were: 1) adults (>18 years old) with cardiac arrest, 2) admitted at the service wards, intensive care units and other selected units in PGH.

Exclusion criteria included: 1.) patients with cardiac arrests and attended by the cardiac arrest team but were not admitted to the hospital, 2) patients with cardiac arrests in the emergency room, the obstetric admitting section (OBAS), outpatient department (OPD), operating rooms, post-anesthesia care units (PACU), hemodialysis unit, and the private or pay hospital floors. Patients with advance directives of "Do Not Resuscitate" (DNR) were not included since they were not referred to the cardiac arrest team. Those who consequently signed DNR waivers after an initial period of advanced cardiac life support (ACLS), and those who went home against medical advice were also excluded.

Sample size estimation was not done in the study since all patients who qualified were included. Descriptive analysis was used to be able to answer other parts of the objectives particularly the hospital-related factors.

Demographics and outcomes of patients who underwent cardiac arrest attended by the CATs and the different arrest- and patient-related variables that surrounded cardiac arrest were based on the Utstein style of reporting cardiac arrest.[5] The details of the cardiac arrest event, particularly the time of arrival of the cardiac arrest team, time to establishment of an airway, initial presenting rhythm, time to initiation of electrical therapy, and duration of the resuscitation attempt were recorded in a standardized form by a nurse-on-duty, medical resident-on-duty, or the study research assistant. A digital timer was attached to code carts to accurately record the timing of key events. The nurses, residents, and the research assistant were briefed regarding the study and how to fill up the standardized cardiac arrest form. The principal investigators and research assistant ensured the adequate collection of needed data. We reviewed chart records and noted patient-related factors such as age, sex, ward admitted, main diagnosis, co-morbid conditions, and length of hospital stay at the time of arrest. Every patient who underwent cardiac arrest was followed up to determine the patient's eventual outcome, which may include the following: mortality, survival to discharge, or other outcomes such as home against medical advice (HAMA). The major outcome of the study was survival to discharge, with a subset analysis on patients who had return of spontaneous circulation (ROSC).

To investigate the response to a cardiac arrest event, members of the cardiac arrest team were interviewed weekly. Each member was interviewed only once regardless of the number of times he/she became part of the cardiac arrest team. We developed a questionnaire (Appendix) adapted from the study of Sandroni, et al.[3] The questionnaire included questions about the emergency team, the procedure for the emergency call, the staff and equipment for the cardiac arrest team, and the possible venues for improvement in the response to a cardiac arrest.

Definition of Study Terms

Definition of cardiac arrest and other study outcomes were recorded as per defined in the Utstein style for reporting cardiac arrest published in 1997.[5] Terms used are defined as follows:

- *Cardiac arrest*: Lack of spontaneous circulation or palpable pulse with unresponsiveness and apnea. It is a pulseless cardiopulmonary status requiring chest compressions or defibrillation or both that was attended to by the CAT of the hospital and resulted in an actual hospital record for codes called in the hospital.
- *Cardiac arrest team response time*: Time from when the cardiac arrest was detected and called, until the time of arrival of the cardiac arrest team[7,8]
- *Return of spontaneous circulation* (ROSC): Presence of a palpable carotid pulse signifying resumption of sustained cardiac activity after resuscitation
- *Duration of resuscitation*: Time interval from the moment chest compressions are initiated until the time the resuscitation is terminated for reasons such as return of spontaneous circulation, patient's death, or the decision to discontinue resuscitative attempts as formally expressed by the patient's relative/s
- *Initial responder:* Person who initially assessed the patient and called out the code, and who is usually the one who starts resuscitation through chest compressions. The

initial responder was either a medical intern, medical clerk, nurse, resident, fellow, consultant, nursing aide or a utility worker

- *Length of hospital stay*: Number of days from the day of admission to the hospital, regardless of whether the patient was admitted at the emergency room or at the ward, until the day the cardiac arrest was called
- *Initial presenting rhythm*: The first rhythm noted on the cardiac monitor as interpreted by the leader of the cardiac arrest team
- *Lag time to initiation of electrical therapy*: Time from the onset of the cardiac arrest to the time the first shock is delivered
- *Lag time to establishment of advanced airway:* Time from the onset of the cardiac arrest to the time the endotracheal tube was ensured to be in place
- *Survival to discharge*: Alive by the time the patient was discharged based on the clinical decision of the physician primarily in charge of the patient. This excluded home against medical advice
- *Home against medical advice:* Sent home as decided by the patient, family, or legally authorized representative of the patient, and against the advice of the physician primarily in charge of the patient

Data management and analysis

For the patient-related factors, the age and the length of hospital stay were expressed in mean ± standard deviation, while the sex and the underlying diseases were expressed using percentage. The arrest-related factors, response time, time to establishment of airway, duration of resuscitation attempt, and lag time to initiation of electrical therapy were all expressed in mean ± standard deviation. The Chi-squared test or Fisher's exact test was used, as appropriate, to determine any association between the categorical variables. The Student's t-test or Mann-Whitney-U test was used, as appropriate, to compare the means or medians of continuous variables. A one-tailed test of hypothesis was used to compare the arrest-related factors while a two-tailed test of hypothesis was used for the rest of the factors. A p-value of less than 0.05 was considered significant for all tests.

Ethical considerations

The study protocol was reviewed and approved by the University of the Philippines Manila Research Ethics Board (UPMREB) in March 2018. Informed consent was obtained beforehand from the members of cardiac arrest team interviewed. All information gathered were kept confidential. Access was restricted to the study investigators and research assistant. Data were stored in password-protected computers and locked storage by the authors. There were no direct benefits, risks or hazards to the patients.

RESULTS

The study included 119 patients who underwent advanced cardiac life support and were attended to by the cardiac arrest teams (Table 1). The study population was 47.9% male with a mean age of 50.1 years (SD 16.7). The most common underlying diseases of the included patients were cancer (19.3%), cardiovascular-related (17.6%), and sepsis (15.1%). The most common primary causes of death were septic shock (27.0%) and acute respiratory failure (21.6%). Most of the included patients were from the medical wards (54.6%) with only 21% of patients from the intensive care units.

Patient- and event-related factors and survival

Underlying illness was associated with mortality among patients who underwent cardiac arrest (p = 0.00) as shown in Table 2. Asystole was the most frequent initial rhythm in both the mortality (82.0%) and survival groups (50.0%). Presence of a shockable initial rhythm, shorter time to establishment of an airway, shorter duration of resuscitation attempt, and shorter lag time to initiation of electrical therapy were associated with survival (Table 2). Mean response time was not found to be significantly related to survival or mortality.

Patient- and arrest-related factors and ROSC

The most common reason for discontinuing advanced cardiac life support was ROSC (77/111 patients, 64.7%) while the rest were never revived (42 patients or 35.3%) (Table 3). Of those with a ROSC, 8 (10.4 %) survived and 69 (89.6%) eventually died.

Hospital-related variables: CAT member interviews

Members of the cardiac arrest teams were interviewed to determine commonly encountered problems. Twenty persons were interviewed: 9 nurses, 8 residents and 3 utility workers.

The most common problems encountered by the cardiac arrest teams were long distances (80%), delay in the call (45%), and lack of elevators (40%). Other identified problems were the weight of the equipment, need to go out of the hospital building, and closed doors. The most common issues identified during emergencies were inadequate personnel training and lack of personnel, both nurses and utility workers. This was most applicable to the wards that do not usually encounter cardiac arrests, as well as during night shifts when there were fewer personnel; hence, less people who could perform chest compressions. Another problem identified was the lack of instruments such as ECG pads, ECG paper, defibrillator, and special medications, such as adenosine and amiodarone. There were instances when a shockable rhythm was identified but the lack of an easily accessible defibrillator near certain wards caused a delay in that aspect of resuscitation.

Table 1. Baseline characteristics of patients

Patient- characteristics	Frequency (N=119) N, %
Sex	
Male	57 (47.9)
Female	62 (52.1)
Age (years), Mean ± SD	50.1 ± 16.7
Underlying disease	
Cancer[1]	23 (19.3)
Cardiac[2]	21 (17.6)
Sepsis[3]	18 (15.1)
Surgical[4]	11 (9.2)
Neurologic[5]	10 (8.4)
Hematologic[6]	9 (7.5)
Pulmonary[7]	8 (6.7)
Trauma[8]	7 (5.9)
Gastrointestinal[9]	4 (3.4)
Renal[10]	4 (3.4)
Other[11]	4 (3.4)
Wards	
Medical	65 (54.6)
Intensive care units	25 (21.0)
Surgical	17 (14.3)
Neuropsychiatric	8 (6.7)
Obstetric & gynecologic	4 (3.4)
Length of hospital stay (days)	11 ± 12.7 7.0 (median)
Primary cause of death (N=111)	
Septic shock	30 (27.0)
Acute respiratory failure	24 (21.6)
Cardiogenic shock	18 (16.2)
Fatal arrhythmia	9 (8.1)
Brain herniation	8 (7.2)
Hypovolemic shock	5 (4.5)
Shock, multifactorial	5 (4.5)
Acute coronary syndrome	4 (3.6)
Disseminated intravascular coagulation	3 (2.7)
Others	5 (4.5)

[1] *Colon cancer, ovarian cancer, breast cancer, lung cancer, maxillary squamous cell carcinoma, prostate cancer, cholangiocarcinoma, cervical cancer, lymphoma, nasopharyngeal carcinoma, tongue squamous cell carcinoma, gestational trophoblastic neoplasia, anaplastic thyroid cancer*

[2] *Acute coronary syndrome, acute decompensated heart failure, acute peri-myocarditis*

[3] *Community acquired pneumonia, hospital acquired pneumonia, cellulitis, necrotizing fasciitis, urosepsis, soft tissue infection, bacteremia*

[4] *Post ventriculoperitoneal shunt insertion, post trans-sphenoidal excision of pituitary macroadenoma, post cervical spine laminectomy, post pancreaticoduodenectomy, post meningioma excision, post hemicolectomy, post burn wound debridement, post decompressive hemicraniectomy, post partial hip arthroplasty, post total hysterectomy bilateral salpingo-oophorectomy*

[5] *Tuberculous (TB) meningitis, acute cerebrovascular accident, central nervous system infection, brain tumor, X-linked dystonia Parkinsonism,*

[6] *Acute leukemia (acute lymphoblastic leukemia, acute myelogenous leukemia, acute promyelocytic leukemia), autoimmune myelofibrosis, acquired coagulopathies, aplastic anemia, chronic myeloid leukemia in accelerated phase, primary myelofibrosis*

[7] *Pulmonary mass, pulmonary TB, chronic obstructive pulmonary disease (COPD)*

[8] *Multiple stab wounds, electrical burn, fractures, multiple injuries from vehicular accidents*

[9] *Decompensated chronic liver disease, diaphragmatic hernia, acute pancreatitis,*

[10] *End-stage renal disease,*

[11] *Systemic lupus erythematosus, diabetic ketoacidosis, schizophrenia*

Given that the MICU CAT is in charge of several wards and areas, it has happened that simultaneous or consecutive cardiac arrests occurred needing the assistance of the cardiac arrest team in two different places at once. The CAT would attend to the first call, then once it has resolved, they would move to the next call which could significantly compromise the management of the second cardiac arrest.

DISCUSSION

The main objective of the study was to investigate the patient-related, arrest-related and hospital-related factors affecting survival from cardiac arrest in the service wards and intensive care units of a tertiary hospital, with survival being defined as survival to discharge.

The overall survival rate in our study was 6.7%. This is close to the survival rates of other studies both done in Iran such as 7.2%[15] and 4.8%[16], the latter of which was done in a university hospital. These two studies have a larger sample size of 250 patients, while the observational study of Silva done in a university institution in Brazil, which is also a developing country, had a survival rate of 9% but with a smaller sample size.[17] Our study is limited by the length of the study period. The differences in the populations studied and the settings may also have affected the varying survival rates across studies.

The results of the study show that patient-related factors such as age, sex, ward admitted, and length of hospital stay at time of arrest are not significantly related to survival. This is in contrast to the larger U.S. study of Nadkarni, et al which showed that intensive care unit location of arrest is significantly related to survival.[18] This can be due to the better ICU facilities in the USA as compared to our institution. Danciu, et al conducted a study in a teaching hospital in Illinois, USA, and noted that cardiac arrest after a prolonged duration of hospitalization is associated with decreased survival.[6] The underlying disease in relation to survival had a p-value of <0.00 in this study, but it is difficult to interpret given the low number of cases in the survival group.

Majority of cardiac arrests are still located in the wards, areas which are deemed to be less monitored than the ICU's. This is similar to other studies as well.[8,9] Medical wards are equipped with certain special detail beds that can handle intubated patients. Peculiar to the set-up of PGH, a tertiary hospital and referral center, is that there are patients in the wards, particularly the medical wards, who need ICU-level care but are accommodated in the wards due to the lack of vacancy in the intensive care units. It might be possible that some of these patients who have arrested in the wards are supposedly for ICU admission but cannot be admitted due to lack of vacancy in the ICUs. This can explain why there is a greater number of arrests in the wards than in the ICUs apart from the greater capacity of wards to accommodate patients.

The time to establishment of an airway was found to be significantly related to survival (p-value = 0.01). However,

Table 2. Patient- and arrest-related factors in relation to survival (N=119)

Patient-related factors	Mortality (N=111, 93.3%) N, %	Survival (N=8, 6.7%) N, %	p-value
Sex			0.13
Male	55 (49.5)	2 (25)	
Female	56 (50.4)	6 (75)	
Age (years), Mean ± SD	49.67 ± 16.7	56.25 ± 16.8	0.34
Underlying disease			**0.00**
Cancer	20 (18.0)	3 (37.5)	
Sepsis	20 (18.0)	1 (12.5)	
Cardiac	16 (14.4)	2 (25.0)	
Surgical	10 (9.0)	1 (12.5)	
Neurologic	10 (9.0)	0	
Hematologic	9 (8.1)	0	
Pulmonary	8 (7.2)	0	
Trauma	7 (6.3)	0	
Renal	4 (3.6)	0	
Gastrointestinal	3 (2.7)	1 (12.5)	
Other	4 (3.6)	0	
Wards			0.15
Medical	60 (54.1)	5 (62.5)	
Non-medical	29 (26.1)	0	
Intensive care units			0.15
Medical	11 (9.9)	3 (37.5)	
Non-medical	11 (9.9)	0	

Arrest-related factors	Mortality (N=111, 93.3%) N, %	Median values	Survival (N=8, 6.7%) N, %	Median values	p-value
Response time (minutes) (Mean ± SD)	1.82 ± 1.5	1.5	1.46 ± 1.4	1.35	0.26
Time to establishment of airway (minutes) (Mean ± SD)	6.98 ± 5.2	6.0	2.75 ± 1.6	3.5	**0.01**
Duration of resuscitation attempt (minutes) (Mean ± SD)	13.0 ± 7.9	11.0	7 ± 4.6	5.5	**0.01**
Lag time to initiation of electrical therapy (minutes) (Mean ± SD)	9.3 ± 5.6	10.0	6.00 (n=1)*		**0.02**
Initial rhythm					**0.01**
Shockable (VF, VT, SVT)	4 (3.6)		3 (37.5)		
Non-shockable	107		5		
Asystole	91 (82.0)		4 (50.0)		
PEA/Bradycardia/Other	16 (14.4)		1 (12.5)		

**The two other survivors with shockable rhythms were not given electrical therapy after the rhythm spontaneously converted to sinus*
VF, Ventricular fibrillation; VT, Ventricular tachycardia; SVT, Supraventricular tachycardia; PEA, Pulseless electrical activity

this parameter is only measured in less than half of the population studied since more than half of the patients were already intubated at the time of arrest. The limitation in drawing conclusion from this is the presence of bias, and that the result may not be reflective of the whole population. In contrast to our study, Miranzadeh, et al, in their study done in Iran, noted that the time to establishment of airway was not significantly related to survival.[16]

This study shows that non-shockable rhythms are related to more mortalities versus rhythms that can be addressed with electrical therapy; a finding similar to other studies.[14,15] The AHA resuscitation guidelines emphasize early CPR and rapid defibrillation.[19] Timely and proper initiation of shock depends on trained personnel to recognize the rhythm and to give the corresponding electrical therapy. In our study, majority of the identified initial rhythms were asystole. This might have been an overestimation because not all patients were attached to cardiac monitors prior to the onset of arrest, particularly among patients in the wards. Rhythms prior to asystole could have been shockable but since no cardiac monitors were attached prior to some arrests, these shockable rhythms were not recorded and recognized.

The duration of resuscitation was significantly related to survival in this study, similar to the findings of previous studies which found a significant correlation after using logistic regression.[15,16] The study of Adib-Hajbaghery, et al done in Iran noted that the duration of CPR is reflective of the severity of the disease and the effectiveness of the resuscitation being performed.[20] However, logistic regression was not performed in our study.

The response time of 1.82 minutes among non-survivors versus 1.46 minutes among survivors is similar to other studies which were 2 minutes in Huang, et al. done in Taiwan[8], and 1.3 ± 1.7 minutes in Sandroni, et al done in Italy.[9] However, in our study, response time as a variable is not found to be statistically related to survival, contrary to

Table 3. Patient- and arrest-related factors in relation to return of spontaneous circulation (ROSC) (N=119)

Patient-related factors	Non-ROSC (N=42, 35.3%) N, %	ROSC (N=77, 64.7%) N, %	P value
Sex			0.14
Male	19 (45.2)	38 (49.4)	
Female	23 (54.8)	39 (50.6)	
Age (years), Mean ± SD	47.5 ± 14	51.5 ± 18	0.18
Underlying disease			0.86
Cancer	7 (16.7)	16 (20.8)	
Cardiac	7 (16.7)	14 (18.2)	
Sepsis	6 (14.3)	12 (15.6)	
Hematologic	4 (9.5)	5 (6.5)	
Surgical	5 (11.9)	6 (7.8)	
Neurologic	4 (9.5)	6 (7.8)	
Pulmonary	1 (2.4)	7 (9.1)	
Trauma	4 (9.5)	3 (3.9)	
Renal	2 (4.8)	2 (2.6)	
Gastrointestinal	1 (2.4)	3 (3.9)	
Other	1 (2.4)	3 (3.9)	
Wards			**0.01**
Medical	19 (45.2)	46 (59.7)	
Non-medical	16 (38.1)	13 (16.9)	
Intensive care units			0.34
Medical	4 (9.5)	10 (13.0)	
Non-medical	3 (7.1)	8 (10.4)	
Immediate cause of arrest			0.42
Hypotension/shock	19 (45.2)	37 (48.1)	
Respiratory depression/distress	10 (23.8)	26 (33.8)	
Myocardial infarction or ischemia	3 (7.1)	1 (1.3)	
Lethal arrhythmia	3 (7.1)	5 (6.5)	
Brain herniation	3 (7.1)	4 (5.2)	
Disseminated intravascular coagulation	2 (4.8)	1 (1.3)	
Others	2 (4.8)	3 (3.9)	
Arrest-related factors	**Non-ROSC (N=42, 35.3%) N, %**	**ROSC (N=77, 64.7%) N, %**	**P value**
Response time (minutes) (Mean ± SD)	2.30 ± 1.7 (Median 2.0)	1.52 ± 1.2 (Median 1.0)	**0.01**
Time to establishment of airway (minutes) (Mean ± SD)	9.01 ± 5.8 (Median 9.0) N=17	4.41 ± 3.0 (Median 4.0) N=21	0.004
Duration of resuscitation attempt (minutes) (Mean ± SD)	21.18 ± 4.8 (Median 20.0)	7.9 ± 4.5 (Median 6.5)	**0.00**
Lag time to initiation of electrical therapy (minutes) (Mean ± SD)	10.29 ± 7.7 (Median 10.0) N=7	8.50 ± 3.5 N=12	0.24
Initial rhythm			0.30
Shockable (VF, VT, SVT)	2 (4.8)	5 (6.5)	
Non-shockable	40	72	
Asystole	34 (81.0)	61 (79.2)	
PEA/Bradycardia/Others	6 (14.2)	11 (14.3)	

VF, Ventricular fibrillation; VT, Ventricular tachycardia; SVT, Supraventricular tachycardia; PEA, Pulseless electrical activity

the findings of previous studies which found a significant correlation.[15,16] Aside from the distance that the cardiac arrest team has to travel, another reason for this could be the delay in calling for the cardiac arrest team on the part of the initial responders. As for the Cancer Institute, an area outside the main hospital building, the response time was 3 to 5 minutes.

The most common problems encountered by the cardiac arrest teams in attending to cardiac arrests were long distances and lack of elevators, which were most evident in the cardiac arrests in outside buildings such as the Cancer Institute. Another problem is a delay in the call which occurred in wards wherein the medical staff were not experienced in managing cardiac arrests, or wherein the medical personnel

were focused on the initial resuscitation that the activation of the cardiac arrest team was overlooked. These findings were similar to the study in Italy by Sandroni, et al.[10]

Both the medical ICU and the central ICU in which the cardiac arrest teams are situated have only one local telephone line. The limitation is that the phone lines of an ICU may be busy, particularly during the day. In the case of the United Kingdom, a designated internal telephone number for emergencies has been recommended to be used inside the hospital for faster communication.[21] Providing the leader of the cardiac arrest team with a duty phone can also be considered.

Other problems include inadequate personnel training and lack of personnel. The members of the MICU and CENICU cardiac arrest teams have certifications on ACLS, which are being renewed as necessary. Many residents and nurses in non-medical wards and intensive care units are not ACLS-certified, yet they are the initial responders when a cardiac arrest occurred in their respective areas. Resuscitation training of hospital medical personnel has been associated with better survival from in-hospital cardiac arrest.[22] A previous study conducted in Georgia, USA by Dane, et al noted that cardiac arrests discovered by nurses trained in ACLS is significantly associated with higher rates of survival to discharge.[23] A move towards improvement in the response to cardiac arrests was to have healthcare workers, particularly residents and nurses, undergo ACLS certification with regular renewal.

Despite having an ICU in close proximity to some wards, other ICUs do not have the complete equipment needed for advanced cardiac life support, such as a functioning defibrillator or emergency medications. There are instances when a shockable rhythm is identified but lack of easily accessible defibrillator near certain wards causes a delay in that aspect of resuscitation.

Since the initial presenting rhythm and the lag-time to initiation of electrical therapy are significantly related to survival, it can be suggested that placing more defibrillators in strategic areas in the hospital can influence the survival from in-hospital cardiac arrests. A difficulty pointed out from the interviews of the members of the cardiac arrest teams are the long distances and the heavy equipment. However, with the installation of more defibrillators, only the CAT members themselves must go to the site of the cardiac arrest for faster intervention.

With the knowledge of event-related and patient-related factors affecting survival, healthcare providers especially the CAT members can have an idea on expected outcomes. These outcomes can be useful when discussing the status of the patient as well as important end-of-life issues with the relatives.

Further analytic studies with a larger sample size and longer duration can be performed to determine prognostic factors for survival of patients who undergo cardiac arrest in this tertiary hospital. Data collection can be extended such that a cardiac arrest registry can be established similar to those of other countries. These registries can show trends in cardiac arrest response. Another limitation of this study is the lack of follow-up after discharge to check on the functional and neurologic status of the patients who survived cardiac arrest. This can also be an option for future studies.

CONCLUSION

This study found a low survival rate among adult service patients in a tertiary hospital who have undergone cardiac arrest and were referred to the cardiac arrest team. The initial rhythm, the lag time to initiation of electrical therapy, the time to establishment of airway, and the duration of resuscitation are event-related variables that can significantly affect survival. On the other hand, underlying disease is a patient-related variable noted to be significantly associated with mortality. As such, streamlining the resources of the hospital to address these matters can have an impact on survival.

Statement of Authorship

BEP and SARM participated in data collection and analysis.

JDAM and FERP gave advice on the methodology and approved the final version of the manuscript.

Author Disclosure

All authors declared no conflicts of interest.

Funding Source

This study was completed through the support and funding of the PGH Research Grant 2018.

REFERENCES

1. Tirkkonen J, Nurmi J, Olkkola KT, Tenhunen J, Hoppu S. Cardiac arrest teams and medical emergency teams in Finland: a nationwide cross-sectional postal survey. Acta Anaesthesiol Scand. 2014 Apr; 58(4):420-7. doi: 10.1111/aas.12280.
2. Mozaffarian D, Benjamin EJ, Go AS, Arnett DK, Blaha MJ, Cushman M, et al. Executive Summary: Heart disease and stroke statistics-2016 update: a report from the American Heart Association. Circulation. 2016 Jan; 133(4):447-54. doi: 10.1161/CIR.0000000000000366.
3. Nolan JP, Soar J, Smith GB, Gwinnutt C, Parrott F, Power S, et al. Incidence and outcome of in-hospital cardiac arrest in the United Kingdom National Cardiac Arrest Audit. Resuscitation. 2014 Aug; 85(8):987–92. doi: 10.1016/j.resuscitation.2014.04.002.
4. Bajan KB, Raje K, Hegde A, Kapadia F. In-hospital cardiopulmonary resuscitation: a one-year study. J Assoc Physicians India. 1998 Sep; 46(9):793-95.
5. Cummins RO, Chamberlain D, Hazinski MF, Nadkarni V, Kloeck W, Kramer E, et al. Recommended guidelines for reviewing, reporting, and conducting research on in-hospital resuscitation: the in-hospital "Utstein Style.' Circulation. 1997 Apr; 95(8):2213-39. doi: 10.1161/01.cir.95.8.2213.
6. Danciu SC, Klein L, Hosseini MM, Ibrahim L, Coyle BW, Kehoe RF. A predictive model for survival after in-hospital cardiopulmonary arrest. Resuscitation. 2004 Jul; 62(1):35-42. doi: 10.1016/j.resuscitation.2004.01.035.

7. Singh S, Namrata, Grewal A, Gautam PL, Luthra N, Tanwar G, et al. Evaluation of cardiopulmonary resuscitation (CPR) for patient outcomes and their predictors. J Clin Diagn Res. 2016 Jan; 10(1):UC01-4. doi: 10.7860/JCDR/2016/14773.7012.
8. Huang CH, Chen WJ, Ma MH, Chang WT, Lai CL, Lee YT. Factors influencing the outcomes after in-hospital resuscitation in Taiwan. Resuscitation. 2002 Jun; 53(3):265-70. doi: 10.1016/s0300-9572(02)00024-2.
9. Sandroni C, Ferro G, Santangelo S, Tortora F, Mistura L, Cavallaro F, et al. In-hospital cardiac arrest: survival depends mainly on the effectiveness of the emergency response. Resuscitation. 2004 Sep; 62(3):291-7. doi: 10.1016/j.resuscitation.2004.03.020.
10. Sandroni C, Cavallaro F, Ferro G, Fenici P, Santangelo S, Tortora F, et al. A survey of the in-hospital response to cardiac arrest on general wards in the hospitals of Rome. Resuscitation. 2003 Jan; 56(1):41-7. doi: 10.1016/s0300-9572(02)00283-6.
11. Sandroni C, Nolan J, Cavallaro F, Antonelli M. In-hospital cardiac arrest: incidence, prognosis and possible measures to improve survival. Intensive Care Med. 2007 Feb; 33(2):237-45. doi: 10.1007/s00134-006-0326-z.
12. Lim BAT, Lasco PGD, Isip-Tan IT. Cardiopulmonary resuscitation in the PGH Internal Medicine wards. University of the Philippines Philippine General Hospital, Manila. 2008. Unpublished.
13. Philippine General Hospital Medical Intensive Care Unit (MICU) Census (2016). Cardiac arrest census. Retrieved from the MICU records. 2016
14. Brindley PG, Markland DM, Mayers I, Kutsogiannis DJ. Predictors of survival following in-hospital adult cardiopulmonary resuscitation. CMAJ. 2002 Aug; 167(4):343-8.
15. Salari A, Mohammadnejad E, Vanaki Z, Ahmadi F. Survival rate and outcomes of cardiopulmonary resuscitation. Iran J Crit Care Nurs. 2010; 3(2):45-9.
16. Miranzadeh S, Adib-Hajbaghery M, Hosseinpour N. A prospective study of survival after in-hospital cardiopulmonary resuscitation and its related factors. Trauma Mon. 2016 Feb; 21(1):e31796. doi: 10.5812/traumamon.31796.
17. da Silva RM, Silva BA, Silva FJM, Amaral CFS. Cardiopulmonary resuscitation of adults with in-hospital cardiac arrest using the Utstein style. Rev Bras Ter Intensiva. 2016 Oct-Dec; 28(4):427-35. doi: 10.5935/0103-507X.20160076.
18. Nadkarni VM, Larkin GL, Peberdy MA, Carey SM, Kaye W, Mancini ME, et al. First documented rhythm and clinical outcome from in-hospital cardiac arrest among children and adults. JAMA. 2006 Jan; 295(1):50-7. doi: 10.1001/jama.295.1.50.
19. Hazinski MF, Chameides L, Hemphill R, Samson RA, Sinz E, Schexnayder SM. Highlights of the 2015 American Heart Association Guidelines for CPR and ECC. [Internet]. [cited 2020 Aug 15]. Available from: https://eccguidelines.heart.org/wp-content/uploads/2015/10/2015-AHA-Guidelines-Highlights-English.pdf.
20. Adib-Hajbaghery M, Akbari H, Mousavi SG. Successful operation of CPR in Kashan hospitals. JRMS. 2005; 10(3):193.
21. NHS Estates, Department of Health, and the Welsh Office. Telephone Services. London: DoH, 1989. (Health building note [HBN] 48).
22. Camp BN, Parish DC, Andrews RH. Effect of advanced cardiac life support training on resuscitation efforts and survival in a rural hospital. Ann Emerg Med. 1997 Apr; 29(4):529-33. doi: 10.1016/s0196-0644(97)70228-2.
23. Dane FC, Russell-Lindgren KS, Parish DC, Durham MD, Brown TD. In-hospital resuscitation: association between ACLS training and survival to discharge. Resuscitation. 2000 Sep; 47(1):83-7. doi: 10.1016/s0300-9572(00)00210-0.

Appendix. Interview form for Cardiac Arrest Team members

Form Number: _____	CAT member: __ Nurse __ Medicine resident __ Utility worker	
Problems encountered while the CAT is going to the wards	__ Delay in the call __ Delay in answering the call __ Long distances __ Need to go out of the hospital building	__ Lack of elevators __ Closed doors __ Weight of equipment __ Others: _____
Problems encountered during emergencies	__ Lack of instruments, as follows: _____ __ Lack of personnel, as follows: _____ __ Inadequate personnel training __ Others: _____	