Epidemiology and Etiology of In-Hospital Cardiac Arrest at The American University of Beirut Medical Center (AUBMC)

Ahmed Eltarras, MD[1*], Youssef Jalloul, MD[1*], Ola Assaad, MD[1], Michael Bejjani, MD[3], Yara Yammine, MD[3], Nina Khatib, MSN[4], Abdallah Rebeiz, MD[1], Mazen El Sayed, MD[2], Marwan Refaat, MD[1], *These authors contributed equally

[1]Department of Internal Medicine, American University of Beirut Medical Center, Beirut, Lebanon

[2]Department of Emergency Medicine, American University of Beirut Medical Center, Beirut, Lebanon

[3]Faculty of Medicine, American University of Beirut, Beirut, Lebanon

[4]School of Nursing, American University of Beirut, Beirut, Lebanon,

Correspondence:

Marwan M. Refaat, MD, FACC, FAHA, FHRS, FASE, FESC, FACP, FRCP

Associate Professor of Medicine

Director, Cardiovascular Fellowship Program

Department of Internal Medicine, Cardiovascular Medicine/Cardiac Electrophysiology

Department of Biochemistry and Molecular Genetics

American University of Beirut Faculty of Medicine and Medical Center

PO Box 11-0236, Riad El-Solh 1107 2020- Beirut, Lebanon

Office: +961-1-350000/+961-1-374374 Extension 5353 or Extension 5366 (Direct)

Email: mr48@aub.edu.lb

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Disclosures: None

Abstract

Introduction:

In-hospital cardiac arrest (IHCA) constitutes a significant cause of morbidity and mortality. As data is scarce in the Middle East and Lebanon, we devised this study to shed some light on it to better inform both hospitals and policymakers about the magnitude and quality of IHCA care in Lebanon.

Methods:

We analyzed retrospective data from 680 IHCAs at the American University of Beirut Medical Center between July 1st, 2016, and May 2nd, 2019. Sociodemographic variables included age and sex, in addition to the comorbidities listed in the Charlson Comorbidity Index (CCI). IHCA event variables were the day of the week, time from activation to arrival, the location of the event, initial cardiac rhythm, and the total number of IHCA events. We also looked at the months and years. We considered the return of spontaneous circulation (ROSC) and survival to discharge (StD) to be our outcomes of interest.

Results:

The incidence of IHCA was 6.58 per 1000 hospital admissions (95% CI: 6.09-7.08). Non-shockable rhythms were 90.7 % of IHCAs. Most IHCA cases occurred in the Closed units (87.9 %) (intensive (ICU), respiratory (RCU), neurology (NCU), and cardiology (CCU) care units) and on weekdays (76.5%). ROSC followed more than half the IHCA events (56 %).

However, only 5.4 % achieved StD. Both ROSC and StD were higher in cases with a shockable rhythm (61.9% vs. 55.4%, p-value = 0.32 and 19.7% vs. 4.2%, p-value < 0.001 respectively). Survival outcomes were not significantly different between day shifts, evening shifts, and nightshifts (ROSC reached 60.3%, 53.2%, and 53.1% respectively with p-value =

0.19 while StD reached 7.5%, 4.2%, and 3.7% respectively with p-value = 0.13). Survival of the event was not significantly different between weekdays and weekends (56.1% vs. 55.6%, p-value = 0.92); however, StD was higher in events that happened during weekdays than weekends (6.7% vs. 1.9%, p-value = 0.002). A high Charlson Comorbidity Index (≥ 7 vs. 0-2) was associated with a decreased StD (Odds Ratio = 0.3, 95%CI: 0.12-0.76, p-value = 0.011).

Conclusion:

The incidence of IHCA was high, and its outcomes were lower compared to other developed countries. Survival outcomes were better for patients who had a shockable rhythm and were similar between the time of day and days of the week. These findings may help inform hospitals and policymakers about the magnitude and quality of IHCA care in Lebanon.

Key Words: In-Hospital Cardiac Arrest **(**IHCA), Return of Spontaneous Circulation (ROSC), Survival to Discharge (StD), Lebanon, Epidemiology, Charlson Comorbidity Index (CCI)

1. Introduction:

In-hospital cardiac arrest (IHCA) constitutes a significant cause of morbidity and mortality.[3] Based on the American Heart Association's Get With The Guidelines Resuscitation (GWTG-R) registry data from 2003 to 2007, the approximated incidence of in-hospital cardiac arrests in the United States was 211,000 annually or roughly 6 to 7 cardiac arrests per 1000 admissions.[4,5] Data from 2008 to 2017 showed the incidence increased to 292,000 annually or 9 to 10 in-hospital cardiac arrests per 1000 admissions.[3,6] In contrast, data from the UK national cardiac arrest audit showed an incidence of 1.6 IHCA per 1000 admissions in the UK from 2011 to 2013.[3] Despite progress in resuscitation technology and care, survival outcomes following IHCA remain low at 15%–25% and vary radically between 0% and 42% worldwide.[1,2] Claudio et al. showed that various patient and healthcare-related factors are associated with the survival outcomes of IHCA.[1]

The main patient-related factors are age, sex, initial cardiac rhythm, underlying medical condition, comorbidities, and the time of the IHCA event. In contrast, major healthcare-related factors are the protocols for IHCA care, duration and method of resuscitation, skills of healthcare professionals, time from code activation and the arrival of the code response team, and the location of the IHCA event.[1,7] The study by Chen LM et al. suggests that improving the quality of resuscitation care and minimizing other healthcare-related risk factors can markedly increase survival outcomes from IHCAs.[2,8,9]

Consistent and updated estimates of the magnitude and outcomes of IHCA are fundamental for monitoring and improving the delivery and quality of IHCA care in any healthcare setting. In Lebanon, studies have shown low survival rates (5.5%) from out-of-hospital cardiac arrest.[10]

The reported incidence of IHCA in the UAE was 11.7 per 1000 hospital admissions[2], and in Saudi Arabia was 7.76 per 1000 hospital admissions.[13] The reported survival to hospital discharge in the United States was only (10.4%)[11], and in the UK, it was only (7.9%)[12]. However, unlike European countries and the USA, the epidemiology of IHCA is unknown in Lebanon, suggesting the need for research in this area. Therefore, this study aimed to produce the first estimates of the incidence, characteristics, and outcomes of IHCA at a tertiary-care hospital in Lebanon.

2. Methods:

2.1 Study Design

Retrospective data analysis was performed on 680 IHCA events between July 1, 2016 and May 2, 2019. The Institutional Review Board (IRB) of the American University of Beirut approved this study.

2.2 Study Setting

This retrospective chart review study was conducted at the American University of Beirut Medical Center (AUBMC), which is the largest academic tertiary care center in Lebanon, and a major referral center in Lebanon and the region with over 350 beds. Each hospital unit is equipped with an emergency crash cart that contains all necessary equipment, medications, and defibrillators for resuscitating patients with cardiac arrest. The American Heart Association (AHA) guidelines are applied in the hospital resuscitation policy. The hospital has a medical emergency response team (Code team) that provides resuscitation care. The Code team consisted of an internal medicine resident, an intensive care unit (ICU) nurse, a respiratory therapist, a nurse supervisor. All members of the Code team are certified in Basic Life Support and Advanced Cardiovascular Life Support for adults. The Code team is only called for medical

emergencies that include cardiac arrest or respiratory failure. The Code team is called when a patient is found unresponsive, with no pulse, not breathing, or gasping for air. Any healthcare provider can activate the Code Blue in the hospital.

2.3 Inclusion/Exclusion criteria

All patients who are ≥ 18 years old, experienced an IHCA event, and underwent resuscitation between July 1, 2016 and May 2, 2019 were included in the analysis.

Patients who are < 18 years, patients who presented to the Emergency Department in cardiac arrest, and patients who have missing vital information in their charts were excluded.

2.4 Study Variables

Sociodemographic variables we included are the age and sex of patients who experienced an IHCA. We defined an IHCA according to the AHA Consensus Statement definition as a cardiac arrest that occurs in a hospital and for which resuscitation was attempted with chest compressions, defibrillation, or both.[5] To know if there is a relationship between the overall prognosis of patients before IHCA and the survival outcomes following the IHCA event, the Charlson Comorbidity Index (CCI) (Predicts 10-year survival in patients with multiple comorbidities) was calculated for every patient who experienced an IHCA event.[14]

Variables related to the IHCA event included the time (day (07:00–17:00) vs. evening (17:01-23:00) vs. night (23:01–06:59)), the day of the week (weekdays (Monday to Friday) vs. weekends (Saturday and Sunday)), the location of the IHCA event, the time needed for the Code team for arrival at the scene, the initial cardiac rhythm that caused the cardiac arrest, and the total number of IHCA events. The outcome variables were the return of spontaneous circulation (ROSC) and survival to discharge (StD) from the hospital. (Table 2)

2.5 Data collection

We extracted data from the electronic health records for the corresponding patients who experienced an IHCA at the American University of Beirut Medical Center (AUBMC).

2.6 Statistical Methods

We statistically analyzed our data using Statistical Package for the Social Sciences, SPSS version 23. We tabulated the variables as frequencies and percentages (%) and continuous variables as means ± standard deviation (SD). In line with the AHA Consensus Statement, the incidence of IHCA per 1000 admissions was calculated by dividing the total number of times that patients received chest compressions, defibrillation, or both by the number of patients admitted to the hospital during that period. We cross-tabulated outcome variables with risk factors and characteristics. We performed Pearson Chi-squared and Fisher exact tests to estimate differences in proportions of outcomes. We used the t-test for statistical analysis of continuous variables. Odds Ratios (OR) are calculated using logistic regression. We used the Clopper-Pearson confidence intervals when dealing with beta distributions of binomial data. We considered a p-value < 0.05 to be statistically significant. In our analysis, we considered each IHCA event to be distinct and independent unless otherwise specified.

3. Results

3.1 Participants

A total of 680 IHCAs (68.5% males) occurred during the three years under analysis (2016– 2019). The mean age of our population was 68 years with a SD of 17. IHCA events involved patients with multiple comorbidities. The comorbidities of patients with IHCA events are listed in table 1.

3.2 Descriptive data

The overall incidence of IHCA was 6.58 per 1000 hospital admissions (95% CI: 6.09 - 7.08). Non-shockable rhythm (90.7%) was more common than a shockable rhythm (9.3%). Pulseless electrical activity (PEA) constituted the greatest contributor of the initial cardiac rhythms (48.7%), this was followed by asystole (30.4%), and 11.6% of events were unspecified non-shockable rhythm (PEA/Asystole). 4.6% had Ventricular Tachycardia (VT), 2.1% had Ventricular Fibrillation (VF), and 2.6% had a non-specified shockable rhythm (VT/VF). 87.9% of the IHCA events occurred in the Closed units (ICU, CCU, RCU, and NCU). 44.4% of IHCAs were documented in patients who had only one IHCA event. However, 22.4% of IHCAs occurred in patients who had four or more IHCA events. The incidence was the lowest (5.0%) from Jan-Dec 2018 and the highest (8.0%) from Jan-Dec 2017. Figure 1 shows the annual IHCA incidence and the outcomes rates.180 (27.2%) of IHCAs involved patients with a CCI that is less than four, i.e., only 27.2% of IHCAs involved patients with a 10-year survival probability that is greater than 77%. Furthermore, 228 (34.3%) of IHCAs included patients with a CCI that is greater than six (less than 0.01% 10-year survival chance). These findings are represented in table 2.

3.3 Outcome data

Overall, more than half the IHCA events ended up with ROSC (56%), 5.4% of which involved patients who survived to discharge from the hospital. Both ROSC (p-value = 0.379) and StD (p-value = 0.128) were not significantly different among age groups. IHCA events involving patients who presented with shockable rhythm had a higher ROSC and StD compared to non-shockable rhythms (61.9% vs. 55.4%, p-value = 0.32 and 19.7% vs. 4.2%, p-value < 0.001 respectively). Survival to discharge was significantly higher in non-closed units compared with

closed units (15.4% vs. 4.3%, p-value < 0.001), although achieving ROSC was not statistically different (56.1% vs. 55.9%, p-value = 0.98). Patients who experienced two or more IHCA events had a significantly higher ROSC (p-value < 0.001); however, StD was significantly lower than patients experiencing only one IHCA (p-value < 0.001). The time needed for arrival did not appear to influence much ROSC (55.7% vs. 58.5%, p-value 0.73), but IHCAs involving patients whose Code team needed three or more minutes to arrive were more likely to achieve StD (15.8% vs. 4.6%, p-value 0.011). Weekends did not influence ROSC, but they did influence StD (56.6% vs. 55.1%, p-value 0.92 and 1.9% vs. 6.7%, p-value 0.026). The month's association with ROSC was not statistically significant (p-value = 0.51). However, it's association with StD was statistically significant (p-value = 0.021). These findings are represented in table 2. Changes in the CCI were not associated with a change in ROSC (p-value = 0.35 for CCI ≥ 7 vs. 0-2). However, StD was much lower in IHCAs of patients with a CCI ≥ 7 vs. 0-2 (p-value = 0.011) (table 3).

4. Discussion

4.1 Main Findings

This is the first study reporting the epidemiology of IHCA and its outcomes in Lebanon. In this study, the overall incidence of IHCA between July 1, 2016 and May 2, 2019 was 6.58 per 1000 admission. The non-shockable rhythm was more common than a shockable cardiac rhythm at presentation. Most of the cases occurred in the Closed units and on weekdays. 56% of IHCAs involved patients who achieved ROSC. Only 5.4% survived to discharge from the hospital. Both ROSC and StD were higher in patients who presented with a shockable rhythm (p-value = 0.32 and p-value < 0.001, respectively). Discrepancies within shockable and non-shockable subgroups are in line with CCI associations, as we did a separate analysis of the initial cardiac rhythm's

association with CCI. Survival outcomes were not significantly different between day shifts, evening shifts, and nightshifts. The survival of the event was not significantly different between weekdays and weekends; however, StD was higher in IHCA events that happened during weekdays than Weekends (p-value = 0.002). The impact of the medical team's availability post arrest may play a role in this observation. ROSC was not associated with CCI (p-value = 0.32). However, survival to discharge was significantly different in IHCAs of patients with different CCI (10-year survival estimate). IHCAs involving patients with a CCI $\geq$ 7 had a statistically significant decreased risk of survival to discharge as compared to a CCI of 0-2 (Odds Ratio = 0.303, 95% CI: 0.12-0.76, p-value = 0.011) (table 3). Thus, CCI may be used with caution to assess the mortality risk of patients in IHCA. The month's association with ROSC was not statistically significant (p-value = 0.51). However, it's association with StD was statistically significant (p-value = 0.021). The reason behind this is unclear, there may be other hidden variables that contributed to this finding. Figure 2 shows the monthly rates of ROSC and StD.

Our study didn't show any significant difference in ROSC between more and less than three minutes for the code team to arrive (55.7% vs. 58.5%, p-value 0.73). Still, IHCAs involving patients whose Code team needed three or more minutes to arrive were more likely to achieve StD (15.8% vs. 4.6%, p-value 0.011). The high percentage of IHCAs in non-closed units in this group could explain this phenomenon. Our Code team consists mainly of an internal medicine resident rotating in a closed unit and a closed unit nurse. Consequently, the code team usually takes less than three minutes to arrive at the IHCA scene when it occurs in a closed unit and may take more than three minutes when it occurs outside the closed units. Patients who are outside the closed units tend to be less critically ill than those in the closed unit. Thus, IHCAs involving patients who are outside the closed units are expected to achieve higher StD. In this

study, the percentage of IHCAs (in the group in which the code team arrived in < 3 minutes) in closed units was 88.7 % as compared to 11.3% in non-closed units. While the percentage of IHCAs (in the group in which the code team arrived in ≥ 3 minutes) in the closed units compared to non-closed units was 70.7% and 29.3%, respectively. IHCAs of patients who experienced two or more IHCA events had a significantly higher ROSC (p-value < 0.001). However, StD was significantly lower than events involving patients suffering from only one IHCA (p-value < 0.001). This finding may be explained by that patients who had ≥ 2 IHCAs would have developed more complications than those who only had only one IHCA event, thus they would have a lower StD. However, we lack the data needed to support this proposition; further studies are needed to explain it.

4.2 Comparison with Previous Studies

The incidence for Lebanon (6.58 per thousand) reported in our study between July 1, 2016 and May 2, 2019 was noticeably higher than 0.7–1.7 per thousand in Israel from 1995 to 2015,[15] 1.6 per thousand reported in the UK in 2011–2013[16], 1.7 per thousand in Sweden from 2006 to 2015,[17] 1.5 per thousand described in Italy in 2012–2014,[18] and 1.3–6.1 per thousand in population studies and 0.58–4.59 per thousand in cohort studies in Australia and New Zealand between 1987 and 2014.[19] These differences, coupled with the high incidence of IHCA reported in our research, raise a concern and prompt the need for further longitudinal study and the development of a Lebanese national register of cardiopulmonary resuscitation.

Overall, 56% of IHCA achieved ROSC in this study, which was higher than other studies done in Canada (46.9%)[6], Israel (12.8%–14.2%)[15], Italy (52.8%)[18], UAE (38.3%)[2] and UK (45.0%)[16]. Yet Iran (61.0% in non-diabetic patients)[20], South Korea (54.1%–69.5%)[21], and Thailand (58.9%)[22] have described better ROSC. G. Fennessy et al. conducted a systematic

review of 30 studies in Australia and New Zealand, including more than 11 million hospital admissions between 1987 and 2014. They reported that ROSC was achieved in 46.0% of patients and that ROSC improved "from 31.8%–43.8% between 1987 and 2007 to 54.1%–58.3% between 2009 and 2014."[19]

In our study, males represented 68.5% of cases of IHCA; the mean age of our population was 68 ± 17. No statistically significant difference in ROSC (p-value = 0.641), and StD (p-value = 0.773) was found between males and females. This was similar to other studies in Canada[6], Italy[18], Isreal[15], South Korea[21], Thailand[22], and the UAE (ROSC (p-value = 0.269), and StD (p-value = 0.733)).[2] However, females had a decreased 30-day survival in Sweden.[17]

Both ROSC (p-value = 0.379) and StD (p-value = 0.128) were not significantly different among age groups in this study, as well. Kimia et al. conducted a study in three Canadian tertiary-care centers that did not show an association between patient age and StD.[6] In contrast, a systematic review of thirty studies done in Australia and New Zealand reported a negative association between age and survival in three studies.[19] Moreover, a study in the UAE found that the ROSC differed significantly with age (p-value = 0.047). However, The StD was not significantly different among age groups (p-value = 0.063).[2]

Survival to discharge was 5.4% in this study. This is lower than the StD reported in Canada (13.1%)[6], Taiwan (14.1%)[23], Italy (14.8%)[18], the Get With The Guidelines–Resuscitation database in the USA (12.7% for recurrent IHCA and 22.1% for non-recurrent IHCA)[24], the UK (18.4%)[16], UAE (7.7%)[2] and in the Swedish Register of Cardiopulmonary Resuscitation (28.5%).[17] However, it is challenging to discover the reasons behind these differences without precise and consistent data on pre-arrest, intra-arrest, and post-arrest factors.

Approximately 90.7% of IHCAs in our study had a non-shockable initial cardiac rhythm. This was higher than the other studies in Australia and New Zealand (68.6%)[19], "Thailand (71.8%),[22] the UK (72.3%)"[2,18], and the study of recurrent IHCA (89.0%) and non-recurrent IHCA (79.9%) in the USA,[24] yet lower than the data reported from Canada (91.9%)[6] and UAE (91.1%).[2] Multiple studies have shown that the survival outcomes are better when the first monitored rhythm is shockable rather than non-shockable.[1,15–17,19] Similar to earlier studies, the ROSC in our study was 61.9% in IHCA involving patients with a shockable rhythm compared to 55.4% in a non-shockable rhythm.[16]

In our study, the most common location of the IHCA event was the closed units. These results are expected as patients admitted to closed units are normally in a more serious condition compared with non-closed units.[1,2,19,25] The response time to an IHCA event can affect the outcome and the patient's survival. Sandroni et al., in their study, reported that no patient survived if the response time was larger than 6 min since the beginning of the IHCA to the beginning of the resuscitation.[25]

The survival of IHCA by ROSC and StD was similar during the day shift (07:00–14:59) (60% and 7.5% respectively) versus the evening shift (15:01-22:59) (53.2% and 4.2% respectively) versus the night shift (23:00–06:59) (53.1% and 3.7% respectively) in our study, which is contradicting some existing studies showing that ROSC and StD are higher when IHCAs occur during the day time.[16,19,25–27] The Get With the Guidelines–Resuscitation Registry in the USA conducted a study to examine the temporal relationship in survival differences between on-hours (i.e., 07:00-22:59 Monday to Friday) and off-hours (23:00-06:59 Monday to Friday or anytime on weekends) IHCAs using data from 151,071 adults at 470 US hospitals during 2000 to 2014.[2,28] The study showed that StD was significantly lower in patients who

experienced an IHCA during off-hours (16.8%) compared with on-hours (20.6%; $p < 0.001$).[28] A systematic review of IHCA in Australia and New Zealand, four studies found that daytime cardiac arrests were associated with better outcome with two reporting greater ROSC (41.4% vs. 17.0%, p-value < 0.001[29] and 58.9% vs. 41.0%, p-value = 0.04[27]).The lack of a survival difference in our study might indicate a homogeneous quality of care provided both during daytime and night-time. Of course, our study could be underpowered to detect a clinically relevant difference.

In our study, the proportion of IHCA events during the weekend was 23.5%, and this was similar to the study by Giulio et al. in Italy, which showed that the weekend accounted for 28.5% of the IHCA events.[18] Also, our study showed that weekends were not associated with ROSC. Still, they were associated with a decreased StD (56.6% vs. 55.1%, p-value = 0.92 and 1.9% vs. 6.7%, p-value = 0.026) which is similar to the study conducted in the UK in which crude hospital survival to discharge suggested worse outcomes for arrests occurred at weekends (16.1%) than weekdays (19.3%).[16]

4.3 Strengths and Limitations

We believe this to be the first study that has estimated the incidence of IHCA along with its consequences in Lebanon. It also assessed its various associated factors. However, the study has some limitations: (1) data were collected from only one medical center in Beirut. AUBMC is, however, the largest tertiary care center in Beirut. The patients it serves are mainly representative of the population in Beirut, thus limiting the generalizability of the study findings to other hospitals in Lebanon. (2) Furthermore, our database did not collect information on the factors such as ethnicity, nationality, education status, or quality of care. (3) Neurological deficits are common in patients who had an IHCA; however, this study could not assess the rate

of neurological deficits due to the unavailability of data. (4) 11.6% of our sample lacked data on the initial cardiac rhythm during IHCA.

4.4 Insinuations for Clinicians and Future Research

The incidence of IHCA was relatively high, and StD was lower than other developed countries, and this may signify the need for improvements in patient care and monitoring during admission to prevent IHCA as well as post-resuscitation care. Also, the higher incidence of IHCA may be related to other factors such as low health literacy among the Lebanese population leading to late presentation and admission of patients with underlying severe acute or chronic health conditions that may lead to IHCA.[5] However, we lack the data needed to support this proposal.

In this study, the non-shockable rhythm was more common than a shockable cardiac rhythm at presentation (90.7%). Survival outcomes (ROSC & StD) following IHCA events involving patients who presented with non-shockable rhythm were markedly lower than those of patients with shockable rhythm at presentation (55.4% vs. 61.9%, p-value = 0.32 and 4.2% vs. 19.7%, p-value < 0.001 respectively). This highlights the need to develop protocols for post-resuscitation care of patients with non-shockable rhythm IHCAs. Non-shockable rhythms may indicate a severe underlying illness that predicts a poor overall prognosis. This warrants discussing with the patient and family the expected outcomes and the patient's code status to achieve desirable prudent outcomes.

Currently, there is a deficiency of data on post-discharge survival and longitudinal studies. Nationwide registries should collect longer-term follow-up survival statistics after discharge. Post-discharge factors are essential for long-term prediction of morbidity and

mortality. Future studies can implement follow-up methods such as telephone or new web-based data collection tools during the post-discharge follow-up period.

Finally, policymakers need to develop a Lebanese national register of cardiopulmonary resuscitation that collects detailed information on all IHCAs to better describe the situation in Lebanon.

5. Conclusion:

This is the first study that has estimated the incidence and outcomes of IHCA and evaluated its factors in Lebanon. The incidence of IHCA was high, and its consequences were lower compared with other developed countries. Survival outcomes were better for IHCAs involving patients with a shockable rhythm. They were similar between the time of day and the days of the week. Furthermore, the CCI may be used with caution as a predictor of survival to discharge following IHCAs. We believe these findings provide hospitals and policymakers with the data needed to assess the magnitude and quality of IHCA care in Lebanon.

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Table 1: Demographics and comorbidities

Comorbidity		Percentage (Count)
Sex		
	Male	68.5 (446)
	Female	31.5 (214)
Age Group		
	< 50 years	15.9 (108)
	50-59 years	9 (61)
	60-69 years	18 (122)
	70-79 years	30.2 (205)
	≥ 80 years	27 (183)
Myocardial Infarction		16.6 (111)
Congestive Heart Failure		31.9 (213)
Peripheral Vascular Disease		8.4 (56)
Cerebrovascular Accident or Transient Ischemic Attack		7.3 (49)
Dementia		1.7 (11)
Chronic Obstructive Pulmonary Disease		13 (87)
Connective Tissue Disease		0.4 (3)
Peptic Ulcer Disease		1.2 (8)
Liver Disease		
	Mild	2.5 (17)
	Moderate-Severe	1.3 (9)
Diabetes Mellitus II		
	Uncomplicated	21.4 (143)
	End-Organ Damage	13.6 (91)
Hemiplegia		0.3 (2)
Moderate-Severe Chronic Kidney Disease		26.5 (177)
Solid Tumor		
	Localized	15.7 (105)
	Metastatic	8.5 (57)
Leukemia		5.7 (38)
Lymphoma		5.8 (39)
AIDS		0.1 (1)

AIDS = Acquired immunodeficiency syndrome

Table 2: Characteristics and outcomes of patients who experienced an IHCA at the American University of Beirut Medical Center, Beirut, Lebanon, July 1, 2016- May 2, 2019

Variables	Sub-variable	Sub-Subvariable	IHCA- n (%)	ROSC- n (%)	p-value	StD- n (%)	p-value
All			680	380 (56)		37 (5.6)	
Sex							
	Male		466 (68.5)	258 (55.4)	0.641	25 (5.4)	0.773
	Female		214 (31.5)	122 (57.3)		12 (6)	
Age			68 ± 17	69 ± 18	0.36	64 ± 20	0.13
	18-39 years		66 (9.7)	38 (58.5)	0.575	7 (11.1)	0.108
	40-59 years		104 (15.3)	50 (48.5)		6 (6.1)	
	60-69 years		122 (17.9)	69 (56.6)		3 (2.5)	
	70-79 years		205 (30.1)	119 (58.0)		14 (7.0)	
	> 80 years		183 (26.9)	104 (56.8)		7 (3.9)	
Initial Cardiac Rhythm					0.001		< 0.001
	Shockable Rhythm		63 (9.3)	39 (61.9)		12 (19.7)	
		Ventricular Fibrillation	14 (2.1)	9 (64.3)		3 (21.4)	
		Ventricular Tachycardia	31 (4.6)	24 (77.4)		9 (31.0)	
		VF/VT	18 (2.6)	6 (33.3)		0 (0)	
	Non-shockable Rhythm		617 (90.7)	341 (55.4)		25 (4.2)	
		Asystole	207 (30.4)	92 (44.4)		2 (1.0)	
		Pulseless Electrical Activity	331 (48.7)	190 (57.6)		10 (3.1)	
		PEA/Asystole	79 (11.6)	59 (74.7)		13 (17.3)	
Location							
	Closed Units		598 (87.9)	334 (55.9)	0.979	25 (4.3)	< 0.001
	Non-closed Units		82 (12.1)	46 (56.1)		12 (15.4)	
Number of IHCA Events							
	1		302 (44.4)	99 (32.9)	< 0.001	31 (10.5)	< 0.001
	2		142 (20.9)	92 (64.8)		2 (1.5)	

	3		84 (12.4)	64 (76.2)		4 (4.8)	
	4		60 (8.8)	47 (78.3)		0 (0)	
	5		50 (7.4)	40 (80.0)		0 (0)	
	≥ 6		42 (6.2)	38 (90.5)		0 (0)	
Time from Activation to Arrival (min)							
	< 3 min		621 (93.8)	346 (55.7)	0.725	28 (4.6)	0.011
	≥ 3 min		41 (6.2)	24 (58.5)		6 (15.8)	
Time of IHCA Event							
	Day (7:00-14:59)		262 (38.8)	158 (60.3)	0.19	19 (7.5)	0.132
	Evening (15:00-22:59)		218 (32.3)	116 (53.2)		9 (4.2)	
	Night (23:00-6:59)		195 (28.9)	103 (53.1)		7 (3.7)	
Days of Week							
	Weekday (Monday-Friday)		520 (76.5)	291 (56.1)	0.921	34 (6.7)	0.026
	Weekend (Saturday-Sunday)		160 (23.5)	89 (55.6)		3 (1.9)	
CCI (10-Year Survival %)					0.317		0.061
	0-2 (90-98%)		93 (14.1)	51 (54.8)		11 (12)	
	3 (77%)		87 (13.1)	51 (59.3)		4 (4.7)	
	4-6 (2.2-53%)		257 (38.6)	135 (52.5)		13 (5.2)	
	≥ 7 (< 0.01%)		228 (34.3)	138 (60.5)		9 (4.1)	

Categorical variables are presented as percentage (count). Pearson Chi-squared and Fisher exact tests were applied to estimate differences in proportions. A p-value < 0.05 was considered for statistical significance.

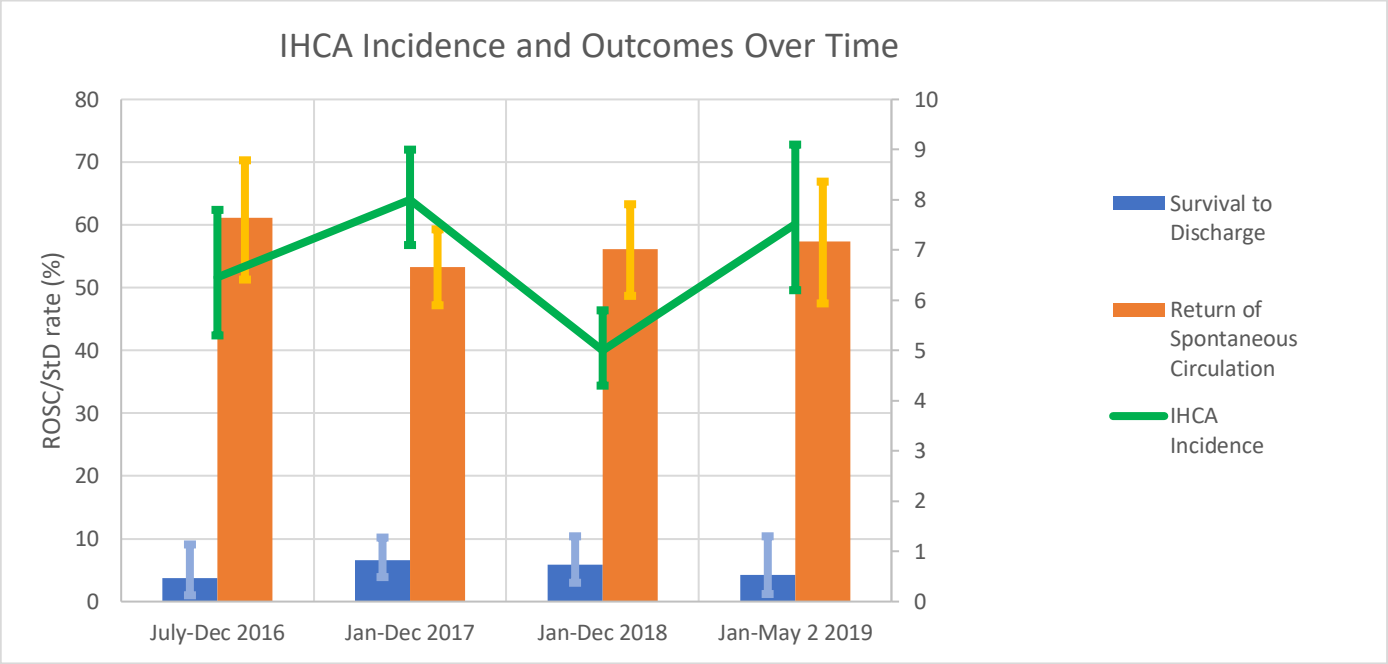
IHCA = in-hospital cardiac arrest; ROSC = return of spontaneous circulation; StD = survival to discharge; CCI = Charlson Comorbidity Index; VF = Ventricular Fibrillation; VT = Ventricular Tachycardia; PEA = Pulseless electrical activity.

Table 3: Charlson comorbidity index (10-year survival predictor in patients with multiple comorbidities)

Variable	Sub-variable	ROSC- OR (95% CI)	p-value	StD- OR (95% CI)	p-value
CCI					
	Score 0-2	-	-	-	-
	Score 3	1.2 (0.66-2.17)	0.55	0.355 (0.11-1.16)	0.087
	Score 4-6	0.91 (0.57-1.47)	0.70	0.391 (0.17-0.91)	0.029
	Score ≥ 7	1.26 (0.78-2.06)	0.35	0.303 (0.12-0.76)	0.011

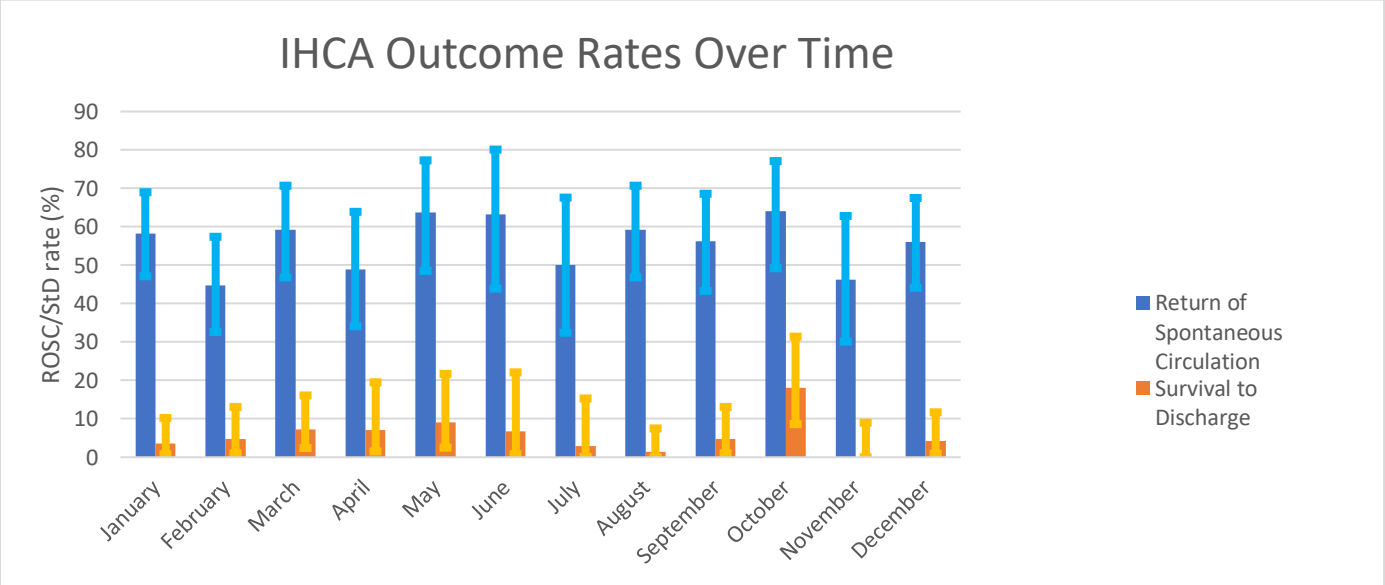
CCI = Charlson Comorbidity Index; ROSC = return of spontaneous circulation; StD = survival to discharge.

Figure 1: Annual IHCA incidence and outcome rates.



Error bars are representative of 95% confidence interval.

Figure 2: Monthly rates of return of spontaneous circulation and survival to discharge.



Error bars are representative of 95% confidence interval.