Impact of the COVID-19 Pandemic on In-Hospital Cardiopulmonary Resuscitation Outcomes of Non-COVID-19 Patients: A Comparative Study.

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Abstract

Background: *COVID-19 pandemic affected all aspects of the health care system. In the coronary care units of the cardiovascular department of Cairo University, we have been conducting a regular survey on the cardiac resuscitation outcomes with the last being conducted during the COVID-19 era. We aimed to evaluate the impact of the COVID-19 pandemic on the characteristics and outcomes of in-hospital cardiac arrest in non- COVID-19 patients as compared to the pre-COVID-19 era.*

Methods: *This is a retrospective analysis of data that were prospectively collected from the cardiovascular department coronary care units in Cairo University both before and during the COVID-19 era. Data about the characteristics and outcomes of the in-hospital cardiac arrest in the 2 groups were collected and compared.*

Results: *The pre-COVID group included 128 patients while the COVID-19 group included 144 patients. The leading causes of hospitalization in the pre-COVID-19 group were ACS and ADHF while in the COVID-19 group; cardiogenic shock was the main cause of hospitalization by far. The achievement of ROSC was significantly lower in the COVID-19 group but there was no difference in the survival to hospital discharge. In the pre-COVID-19 group, a higher dose of epinephrine was the single independent predictor of achievement of ROSC, while in the COVID-19 group, the most powerful independent predictor of achievement of ROSC was ACS as the cause of hospitalization.*

Conclusion: *During the COVID-19 pandemic, achievement of ROSC after in-hospital cardiac arrest was significantly lower than in the pre-COVID-19 era.*

Keywords: *In-hospital cardiac arrest, COVID-19 pandemic, Non-COVID-19 patients.*

Background:

The emergence of the COVID-19 pandemic in December 2019 has affected all aspects of the health care system worldwide. Starting from Wuhan, China, a novel coronavirus (severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)) emerged and spread causing a pandemic that gradually affected all the countries worldwide and led to a global shut down in most of the aspects of life and one of the most aggressive morbidities and mortality waves that the world have ever seen.

This pandemic has forced health care providers to work with different standards in caring for patients even if COVID-19 is not their main diagnosis which affected the criteria of hospitalized patients due to limited availability of beds which are mostly occupied with the COVID-19 patients, and also the way of managing patients including the resuscitation procedures to patients who develop cardiac arrest. This included limiting personnel numbers and dealing with personal protective equipment (PPE). **(1)**

Cardiovascular Diseases (CVDs) are the number one cause of death worldwide. **(2)** An estimated 17.5 million people died from CVDs, representing 46.2% of all global deaths. **(2)** Of these deaths, an estimated 7.3 million were due to coronary artery disease (CAD), 6.2 million were due to stroke, and 9.4 million were attributed to high blood pressure (16.5% of all deaths). **(3)**

In Egypt, deaths due to CVD represent 40 % of mortality related to non-communicable diseases (NCDs). **(4)** Unfortunately, there is no data about cause-specific mortality due to CVD, which raises the need for collecting and establishing such data in our country.

In this study, we evaluated the impact of the COVID-19 pandemic on the characteristics and outcomes of in-hospital cardiac arrest patients to detect the cause-specific cardiac arrest, adherence to CPR guidelines and different variables affecting the return of spontaneous circulation (ROSC) and survival to hospital discharge. We compared the resuscitation outcomes in 2 groups of patients, the first group was in the pre-COVID-19 era and the second group was during the COVID-19 era.

Methods:

This is a retrospective analysis of data that were prospectively collected from the cardiovascular department intensive care units in Cairo University hospitals both before and during the COVID-19 era including Kasr Alainy teaching hospital coronary care unit (CCU), Elmanial specialized hospital CCU and New Kasr Alainy teaching hospital CCU).

The patients were divided into 2 groups, the first group was the pre-COVID-19 group that included patients who developed in-hospital cardiac arrest before the COVID-19 era and the second group was the COVID-19 group that included patients who developed in-hospital cardiac arrest during the COVID-19 era.

The pre-COVID-19 group included 128 patients who developed cardiac arrest during admission to one of the 3 cardiac intensive care units of the cardiovascular department of Cairo University in the period from May 15th, 2014 to February 28th, 2015, while the COVID-19 group included 144 patients who developed cardiac arrest during their admission to the same units in the period from October 2020 to May 2021.

As per hospital protocol, COVID-19 was excluded in all the admitted patients in the second group based on the absence of symptoms and signs suggestive of COVID-19 including the history of fever, cough, bony aches, loss of taste and smell in the past few days and CT chest (done to all patients) showing no signs suggestive of COVID-19 according to the CO-RADS classification (only patients with CO-RADS score 1 and 2 were admitted) as patients with suspected COVID-19 were transferred to the specialized COVID-19 isolation sectors of the hospital.

The study aimed at comparing the characteristics of patients admitted to Cairo University hospitals CCUs in the pre-COVID 19 era with non-COVID 19 patients admitted to the same units during the COVID 19 era, and relating this to resuscitation outcomes (ROSC and survival to hospital discharge). Factors associated with successful ROSC in the 2 groups were also assessed.

Results:

As shown in table 1, patients in the COVID-19 group were older. Regarding comorbidities, there was no statistically significant difference regarding the prevalence of hypertension and diabetes mellitus. CKD and chest problems including bronchial asthma and COPD were more prevalent in the pre-COVID -19 group.

In the pre-COVID-19 group, the most common primary diagnosis was ACS and the leading causes of hospitalization were ACS and ADHF. On the other hand, among the COVID-19 era group, the most prevalent primary diagnosis was CHF and the main driving cause of hospitalization was by far cardiogenic shock.

There was no significant difference between the 2 groups regarding the vital signs before the cardiac arrest event including systolic and diastolic blood pressure and heart rate.

Regarding the resuscitation procedure, doctors were the ones who started the resuscitation process in most of the patients in both groups.

Shockable rhythms including ventricular tachycardia and fibrillation were more common in the pre-covid-19 group and accordingly, the use of a defibrillator was more common in the pre-COVID-19 group. The use of adrenaline and atropine was more common in the pre-COVID-19 group while the use of $NaHCO_3$ was more in the COVID-19 group.

There was no significant difference in the CPR duration between the 2 groups.

The achievement of ROSC was significantly lower in the COVID-19 group (Figure 1) but there was no difference in the survival to hospital discharge between the 2 groups.

Table 1: Patient's characteristics:

Variables		Pre-COVID-19	COVID-19	P value
Gender	Male	58.7%	44.4%	0.01
	Female	41.3%	55.6%	
Age		57.4 ± 16.9	68.7 ± 12.8	0.0001
Primary diagnosis	CAD	38.1%	19.4%	0.0001
	CHF	14.3%	65.3%	
	RHD	11.1%	2%	
	IE	4.8%	8.3%	

	DVT-PE	3.2%	1.4%	
	Arrhythmia	2.4%	0.7%	
	CKD	10.3%	2.1%	
Cause of admission	ACS	22.2%	11.8%	0.0001
	Cardiogenic shock	11.9%	55.6%	
	IE	12.7%	8.3%	
	Arrhythmia	1.6%	0.7%	
	DVT-PE	3.2%	1.4%	
	CHF	24.6%	11.1%	
	Non-cardiogenic shock	2.4%	5.6%	
Comorbidities	HTN	50.8%	50%	0.9
	DM	41.3%	36.1%	0.4
	Dyslipidemia	33.3%	44.4%	0.06
	CKD	54.8%	25.7%	0.0001
	COPD	11.9%	3.5%	0.003
	Asthma	4.85	0.7%	0.001
	Smoking	34.1%	35.4%	0.8
Witnessed arrest		100%	100%	
SBP before arrest		87.5±47	91.8±15	0.3
DBP before arrest		56.5±30	56.4±11.7	0.9
HR before arrest		106.4±22	104.9±14	0.5
Serum Cr before the event		2.8±3.2	1.5±1.3	0.0001
Who started CPR	Doctor	90.5%	98.6%	0.003
	Nurse	9.5%	1.4%	
Initial rhythm	Non-shockable	84.1%	93.7%	0.0001
	Shockable	15.9%	6.3%	
Airway	Invasive	95.2%	98.6%	0.1
	Non- invasive	4.8%	1.4%	

Defibrillator use		34.1%	9.7%	0.0001
Defibrillator No. of shocks		3±4.3	2±1.3	0.4
Defibrillator energy of shocks		214.7±42.8	194.3±30.3	0.1
Medication	Adrenaline	100%	95.8%	0.02
	No of Adrenaline doses	7.9±5	6.5±3.6	0.6
	Atropine	78.6%	2.1%	0.0001
	No of atropine doses	1.94±1.3	0.03±0.2	0.001
	NaHco3	37.3%	52.1%	0.01
Survival to hospital discharge		16(12.7%)	10(6.9%)	0.1
Time interval from collapse to 1st dose of epinephrine/min		2.07±1.28	1.95±1.7	0.5
Time interval from collapse to 1st defibrillation shock/min		5.4±5.0	7.6±5.5	0.2
Time interval from collapse to air way securing/min		3.2±3.1	2.6±1.3	0.04
Duration of CPR		26.8±14.6	27.3±14.5	0.8
ROSC		60 (47.6%)	16 (11.1%)	0.0001

Table 2: Multivariate regression analysis of the independent predictors of achievement of ROSC in the 2 groups.

	Pre-COVID-19 group	COVID-19 group
Independent predictor	Mean dose of epinephrine	ACS as a cause of hospitalization
R^2	0.9	1.0
Standardized B coefficient	-1.057	-1.0
p-value	0.004	0.0001

Figures:

COVID-19 era

11 %

89%

ROSC
No ROSC

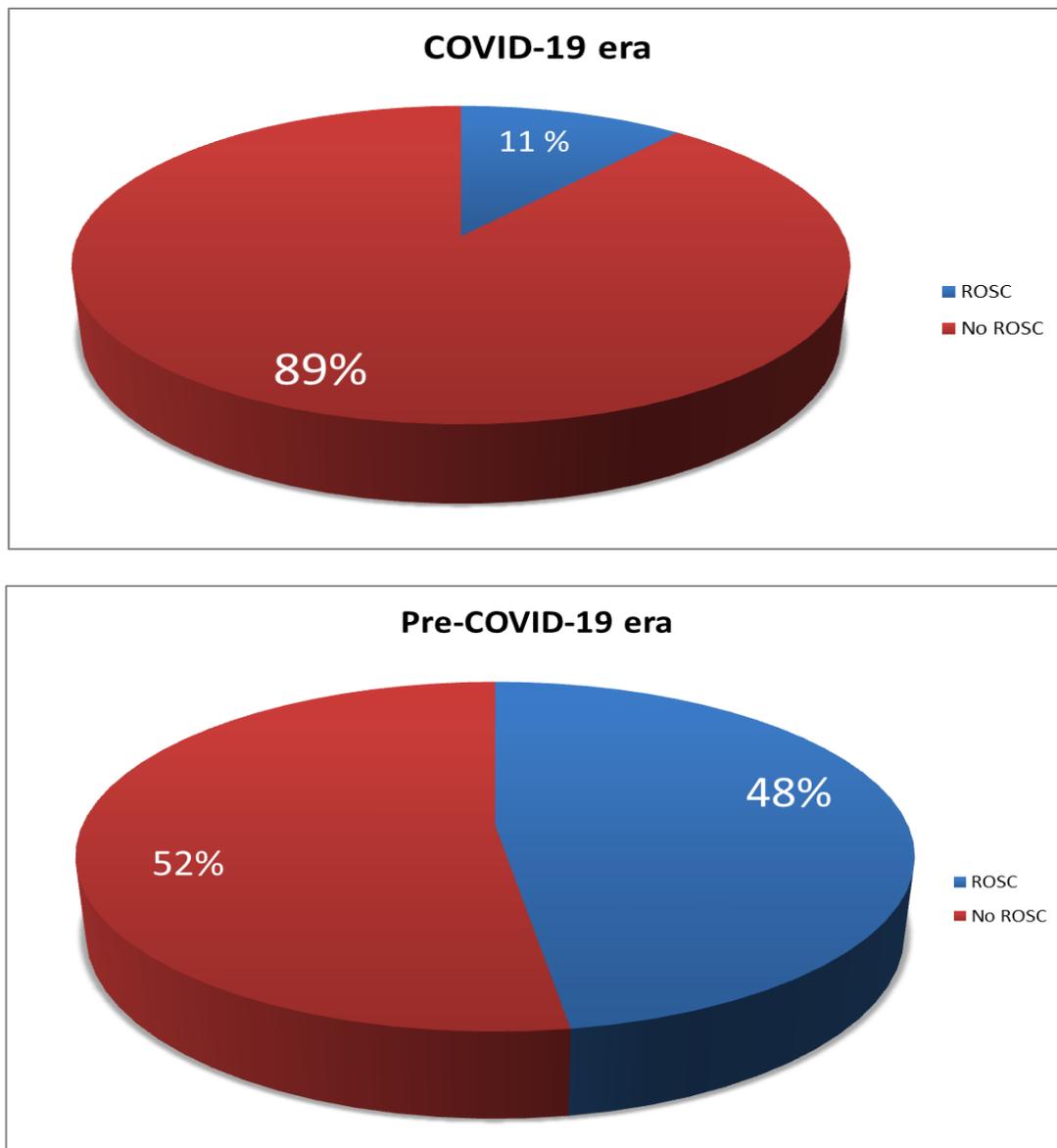## Pre-COVID-19 era

48%

52%

ROSC
No ROSC

Figure 1: percentage of achievement of ROSC in the 2 groups.

Predictors of ROSC:

To identify the factors that could predict ROSC in each group, the patients who achieved ROSC were compared to those who did not achieve ROSC in both groups by univariate analysis.

In the pre-COVID-19 group, a shorter time interval from collapse to the start of CPR and a higher mean dose of epinephrine were significantly associated with successful ROSC.

In the COVID-19 era group, factors associated with successful ROSC were younger age, CAD as a primary diagnosis, ACS as a cause of hospitalization, absence of chest problems at presentation, shockable rhythm at the time of arrest, higher SBP and DBP before the time of arrest, the shorter time interval from collapse to airway securing and from collapse to 1st defibrillator shock and use of adrenaline.

Multivariate stepwise logistic regression analysis among the previous significant variables was used to identify the independent variables that can predict ROSC.

In the pre-COVID-19 group, the mean dose of epinephrine was the single independent predictor of achievement of ROSC, while in the COVID-19 era group, the single most powerful independent predictor of achievement of ROSC was ACS as the cause of hospitalization (Table 2).

Discussion:

The COVID-19 era dictated major changes in patient management strategies. To make hospital beds more available, elective procedures were deferred and only the very sick patients were admitted. Our coronary care units were designated as non-COVID-19 patient units, and the hospital admission protocol included triaging all possible admission cases to exclude Coronavirus infections with pre-admission chest computed tomography done to almost all admissions.

During the COVID-19 era, most of the international societies dealing with the resuscitation process suggested modified guidelines for cardiopulmonary resuscitation including some recommendations aiming to increase the protection of the healthcare workers and limit the spread of infection as multiple steps in the resuscitation process are associated with the significant aerosol generation which may be a strong source of dissemination of COVID-19 infection. These modifications included limiting the number of the personals involved, proper donning and doffing of the personal protective equipment, pausing chest compressions during intubation and considering video laryngoscopy. **(5,6,7)**

Multiple published studies showed an increased incidence of in-hospital cardiac arrest and reduced survival rates during the COVID-19 pandemic compared to the pre-COVISD -19 era. In New York, a study was conducted in the early wave of the COVID-19 pandemic and showed a five-fold increase in the rates of in-hospital cardiac arrest and worse outcomes as compared to the pre-COVID-19 era. **(8)**

Since 2014, we have been conducting regular surveys on our CCU CPR outcomes with the last being during the COVID-19 era. **(9)**

The main findings of our study conducted during the COVID-19 era were:

1- Low rate of ROSC (11.1%) in the patients who experienced cardiac arrest in the COVID-19 era.

2- The independent predictor of ROSC during the COVID-19 era was ACS as the cause of admission unlike in the pre-COVID era as it was the mean dose of epinephrine.

3- Very low rate of survival to hospital discharge (6.9%).

As previously shown, there was a discrepancy in the 2 groups regarding the cause of admission. In the pre-COVID 19 era, ACS and CHF were both the main leading causes of admission in our coronary care units while in the COVID 19 era, cardiogenic shock was the single most common cause of admission. This reflects the worse quality of the admitted patients during the COVID 19 era.

The rates of ROSC were lower during the COVID-19 era. As the COVID-19 patients were excluded from this study, this partly omits the COVID-19 diagnosis as a potential confounder for lowering the rates of ROSC. The possibility, however, that a patient with COVID-19 positive infection was missed, or that the worse outcomes are related, at least in some patients, to a previous SARS Corona VIRUS-II infection, or inefficiency of the health care system in resuscitation cannot be excluded.

The absence of significant difference in most of the components of the resuscitation process reflects that the human factor represented by the resuscitation team did not impact the lower rates of ROSC. This is unlike some published data that shed light on the unpleasant effects of the proposed changes in the resuscitation process of patients with in-hospital cardiac arrest during the COVID-19 pandemic regarding reduced rates of ROSC. **(**10**)**

The lower rates of ROSC can be attributed to many factors including older age of patients, CHF as the most common primary diagnosis, cardiogenic shock as the main cause of admission, and lower rates of shockable rhythm at the time of the arrest. This reflects the fact that during the COVID-19 pandemic, patients refrained from seeking medical advice or hospitalization except if they experience unbearable complaints.

These findings are consistent with data from a large, multicenter study that collected audit data at two public hospitals in Hong Kong comparing the outcomes of in-hospital cardiac arrest before and during the COVID-19 era. This study showed that in-hospital cardiac arrest during the COVID -19 pandemic was independently associated with lower rates of ROSC. **(**10**)**

Conclusion:

Among patients admitted to the cardiovascular intensive care units in Cairo University hospitals, there was a significant decline in the rates of ROSC after cardiac arrest during the COVID-19 pandemic than before it and admission with ACS was the most powerful independent predictor of ROSC.

Conflict of interest: The authors declare that there is no conflict of interest.

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