Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies ***NLM ID:*** *101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Index Copernicus value = 85.10

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Incidence and outcomes of cardiac arrest during COVID-19: an observational study

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ABSTRACT

Aim: The aim of this study to determine the incidence and outcomes of cardiac arrest during COVID-19. **Methods:** This retrospective observational study conducted in the Department of Emergency Medicine. In our institution code blue could be activated through the Automated Code Blue Alert and Activation (ACBAA) system or by pressing the code blue button installed on every patient's bed. The HCBT consisted of an intensive care unit (ICU) consultant, an ICU registrar, an ICU nurse, a medical registrar and a respiratory therapist. Each team member carried an internet proxy phone where the location of the code blue activation would be shown upon activation. The precautionary protocols for HCBT response were formally implemented in our institution. Patients who had code blue activation during their inpatient stay were included in this study. **Results:** The Acute Physiology and Chronic Health Evaluation (APACHE) II score calculated within 24 h of ICU admission was similar between two periods. In the COVID-19 period, the average HCBT response time was 3.60 min, which was significantly longer as compared to pre-COVID-19 period of average 2.55 min. There were a total of 10 code blue activations in the isolation and surveillance wards and 40 code blue activation in wards without COVID-19 positive or suspect case. For the pre-COVID-19 period, no code blue activation happened in the isolation ward which was mainly for tuberculosis cases or other air- borne precaution cases in our institution. In terms of primary outcome, the rate of survival to hospital discharge for IHCA was 6.67% in the COVID-19 period as compared to 12% in the pre- COVID-19 period [odds ratio (OR), 0.62; 95% confidence interval (CI), 0.27-1.85]. For secondary outcomes, there were more total code blue activations per 1000 hospital admissions in the COVID-19 period (OR, 1.41; 95% CI, 0.89-2.52); more code blue activations for periarrest per 1000 hospital admissions in the COVID-19 period (OR, 1.31; 95% CI, 0.68-2.29); as well as more code blue activations for IHCA per 1000 hospital admissions in the COVID-19 period (OR, 1.77; 95% CI, 0.71-4.21). ROSC rate of IHCA in the COVID-19 period was 62.5%, lower as compared to 85% in the pre-COVID-19 period (OR, 0.39; 95% CI, 0.03-2.86). The rates of survival to hospital discharge for all code blue activations and peri-arrest code blue activation were also lower in the COVID- 19 period (all code blue activations: OR, 0.62; 95% CI, 0.27-1.85; peri-arrest code blue activation: OR, 0.75; 95% CI, 0.24-2.84). **Conclusions:** Author concluded that the higher incidence and lower rate of survival to hospital discharge for IHCA during COVID-19 pandemic.

Keywords: Cardiac arrest, COVID-19, intensive care unit, emergency medicine.

Received: August 12, 2021 Accepted: September 22, 2021

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This article may be cited as: TH Anjanappa. Incidence and outcomes of cardiac arrest during COVID-19: an observational study. J Adv Med Dent Scie Res 2021;9(10):5-9.

INTRODUCTION

Since December 2019, several cases of atypical pneumonia caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) were reported in Wuhan, China.[1] This novel coronavirus is currently responsible for the coronavirus disease 2019 (COVID-19) pandemic that rapidly spread in Europe and worldwide. As of November 4, 2020, SARS-CoV-2 infected more than 47 million individuals globally, causing more than 1 million deaths.[2] The COVID-19 pandemic may also be responsible for excess deaths in individuals not directly affected by SARS-CoV-2 infection. An increase in indirect mortality may arise from altered access to healthcare services secondary to the profound reorganization of hospitals[3] and the effects of lockdown on physical, psychological, and social wellbeing. Moreover, lockdown and the fear of contracting the infection in hospitals could have prevented patients from calling emergency medical services (EMS) or presenting to

emergency departments.[4] Recent studies from communities severely affected by the novel coronavirus 2019 (COVID-19) pandemic have reported lower rates of successful resuscitation for outof-hospital cardiac arrest (OHCA).[5-7] Unadjusted rates of sustained return of spontaneous circulation (ROSC) decreased by an absolute 14.6% (from 25.2% in 2019 to 10.6% in 2020) in New York, New York,[5] and by 8.5% (from 13.5% in 2019 to 5.0% in 2020) in northern Italy.[6] Investigators have speculated that lower rates were because of higher patient illness severity and overwhelmed emergency medical service (EMS) agencies during the COVID-19 pandemic. However, it is unknown if lower rates of sustained ROSC for OHCA are generalizable to geographic regions less severely affected by the COVID-19 pandemic and/or accompanied by lower rates of survival to discharge. For several reasons, it is possible that the impact of the COVID-19 pandemic on rates of sustained ROSC after OHCA has not been limited to just regions with high COVID-19 disease burden. Policy changes that were instituted among EMS agencies during the pandemicmay have been implemented broadly, even in areas with low to moderate COVID-19 incidence. These changes may affect rates of sustained ROSC, including slower response because of a need to don personal protective equipment, shorter treatment duration on EMS arrival, or higher rates of termination of resuscitation in the field in patients without ROSC. It is also unclear if prior reports of lower rates of sustained ROSC during the pandemic actually resulted in lower rates of survival to discharge, because sustained ROSC is an intermediate outcome and can be influenced by multiple factors (eg, high-dose epinephrine) without improving overall survival.

MATERIAL AND METHODS

This retrospective observational study conducted in the Department of Emergency Medicine after taking the approval of the protocol review committee and institutional ethics committee.

In our institution code blue could be activated through the Automated Code Blue Alert and Activation (ACBAA) system or by pressing the code blue button installed on every patient's bed. The HCBT consisted of an intensive care unit (ICU) consultant, an ICU registrar, an ICU nurse, a medical registrar and a respiratory therapist. Each team member carried an internet proxy phone where the location of the code blue activation would be shown upon activation.

The precautionary protocols for HCBT response were formally implemented in our institution.

Inclusion criteria

Patients who had code blue activation during their inpatient stay

Exclusion criteria

- Patients who were younger than 20 years old
- All false code blue activations
- Accidentally pressing on the code blue button
- Wrongly validated vital signs by staff which triggered the AABCA system.

The study retrospectively collected data of all the patients included in the study. The HCBT response time for code blue activation in our institution was calculated as the time from code blue phone alert to time of arrival of HCBT at patient's bedside.

The primary outcome was IHCA survival rate to hospital discharge. The secondary outcomes included incidence of code blue activation as per hospital admissions, incidence of periarrest code blue activation as per hospital admissions, incidence of IHCA as per hospital admissions; the rate of return of spontaneous circulation (ROSC) for IHCA and the rate of survival to hospital discharge of all code blue activation and peri-arrest code blue activation. ROSC was defined as the onset of an organised rhythm with a palpable pulse and a measurable blood pressure for at least 30s.[8]

STATISTICAL ANALYSIS

Continuous data was reported as means and 95% confidence intervals. Categorical variables were reported as numbers and percentages of patients in each category. Proportions were compared using Chi-square or Fisher exact tests and continuous variables were compared using the t test. For outcome analysis, the odds ratio (OR) and 95% confidence interval were calculated. Data was analysed using SPSS statistical software version 21.0. Two-tailed *P* values < 0.05 were considered significant.

RESULTS

There were 4000 hospital admissions in the COVID-19 study period and 5000 hospital admissions in the pre- COVID-19 control period (Table.1). Despite a 20% decrease in hospital admissions during COVID-19 study periods as compared to the pre-COVID-19 control period, the number of code blue activations increased by (30 cases increased to 50 cases) (Table.1). The base- line characteristics of the included patients are shown in Table.2. Patients in the COVID-19 cohort were younger whereas more patients in the pre-COVID-19 cohort had history of malignancy. The other baseline characteristics such as gender, hypertension, diabetes, ischaemic heart disease, chronic liver disease, chronic lung disease and chronic kidney disease were similar between two periods. The Acute Physiology And Chronic Health Evaluation (APACHE) II score calculated within 24 h of ICU admission was similar between two periods. In the COVID-19 period, the average HCBT response time was 3.60 min, which was significantly longer as compared to pre-COVID-19 period of average 2.55 min (Table.2).

There were a total of 10 code blue activations in the isolation and surveillance wards and 40 code blue activation in wards without COVID-19 positive or suspect case (open wards). For the pre-COVID-19 period, no code blue activation happened in the isolation ward which was mainly for tuberculosis cases or other air- borne precaution cases in our institution.

In terms of primary outcome, the rate of survival to hospital discharge for IHCA was 6.67% in the COVID-19 period as compared to 12% in the pre-COVID-19 period [odds ratio (OR), 0.62; 95% confidence interval (CI), 0.27-1.85] (Table.3). For secondary outcomes, there were more total code blue activations per 1000 hospital admissions in the COVID-19 period (OR, 1.41; 95% CI, 0.89-2.52); more code blue activations for periarrest per 1000 hospital admissions in the COVID-19 period (OR, 1.31; 95% CI, 0.68-2.29); as well as more code blue activations for IHCA per 1000 hospital admissions in the COVID-19 period (OR, 1.77; 95% CI, 0.71-4.21)

(Table 1.). ROSC rate of IHCA in the COVID-19 period was 62.5%, lower as compared to 85% in the pre-COVID-19 period (OR, 0.39; 95% CI, 0.03-2.86) (Table.3). The rates of survival to hospital discharge for all code blue activations and peri-arrest code blue activation were also lower in the COVID-19 period (all code blue activations: OR, 0.62; 95% CI, 0.27-1.85; peri-arrest code blue activation: OR, 0.75; 95% CI, 0.24-2.84) (Table.1). Table.4 lists the reasons of code blue activation for peri- arrest situation.

Table 1 blue code activation

Parameter	Pre-COVID-19 period	COVID-19 period	OR
Total hospital admission	5000	4000	
Total code blue activation	30	50	1.41 (0.89-2.52)
Peri-arrest	10	15	1.31 (0.68-2.29)
In-hospital cardiac arrest	8	12	1.77 (0.71-4.21)

Table 2 Baseline profile of the patients

	Pre-COVID-19 period (n = 30)	COVID-19 period (n = 50)	P value
Age (year)	71.8 ± 11.7	66.0 ± 11.8	0.03
Male gender (%)	19 (63.33)	35 (70)	0.39
DM (%)	21(70)	32 (64)	0.65
Hypertension (%)	15 (50)	25(50)	0.25
IHD (%)	8(26.67)	15 (30)	0.34
CVA (%)	6(20)	8 (16)	0.77
Chronic kidney disease (%)	8 (26.67)	16 (32)	0.87
Chronic lung disease (%)	3 (10)	7 (14)	0.88
Chronic liver disease (%)	2 (6.67)	3 (6)	0.77
Malignancy (%)	5 (16.67)	4 (8)	0.02
APACHE II Score	20.1 ± 9.1	29.3 ± 9.2	0.85
HCBT response time (min)	2.55 ± 1.15	3.60 ± 2.22	0.02

DM diabetes mellitus, IHD ischaemic heart disease, CVA cerebrovascular accident, APACHE II Acute Physiology And Chronic Health Evaluation II, HCBT hospital code blue team

Table 3: Outcome for code blue activation

	Pre-COVID-19 period (n = 30)	COVID-19 period (n = 50)	P value
Initial shockable rhythm	1 (n = 8)	4 (n = 20)	1.82 (0.13-111.3)
ROSC	5 (n = 8)	17 (n = 20)	0.39 (0.03-2.86)
Total survival to hospital discharge	15 (n = 30)	20 (n = 50)	0.62 (0.27-1.85)
Peri-arrest survival to hospital discharge	10 (n = 20)	15 (n = 30)	0.75 (0.24-2.84)
Cardiac arrest survival to discharge	1 (n = 8)	1 (n = 15)	0.55(0.01-47.01)

ROSC return of spontaneous circulation

Table 4: Reason for periarrest code blue activation

Peri-arrest cause	Pre-COVID-19 period (n = 20)	COVID-19 period (n = 30)
Airway obstruction (%)	0 (0)	1* (3.33)
RR (%)	0 (0)	2 (6.67)
SpO_2 (%)	8 (40)	6 (20)
HR (%)	3 (15)	1 (3.33)
SBP (%)	4 (20)	12 (40)
Others (%)	12# (30)	5# (25)

RR respiratory rate, *SpO_2* peripheral capillary oxygen saturation, *HR* heart rate, *SBP* systolic blood pressure*Code blue activated for massive bleeding from tracheostomy site

#Code blue activated for acute drop in Glascow Coma Score with concerns of airway patency

DISCUSSION

The incidence and outcomes of IHCA during COVID-19 pandemic were study. Whilst the recent study about IHCA done by Miles et al. also observed decreased survival rate of IHCA during the COVID-19 pandemic as compared to pre-COVID-19 pandemic, 79% of the IHCA patients in their study were COVID-19 positive, which was a major difference as compared to our study.[9] For all code blue activation during COVID-19 period in our study, only one IHCA case was later confirmed as COVID-19 positive. Hence, the increased incidence and decreased survival rate of IHCA and total code blue activation observed in our institution is unlikely directly caused by COVID-19 disease process. COVID-19 has imposed a strong demand on the public healthcare system with the result of resource redistribution and reprioritisation to minimise COVID-19 transmission risk. A number of rehabilitation wards in our hospital, were converted to acute care wards to admit acute non-COVID patients, a common resource reallocation strategy nationwide in pandemic.[10,11] the staff in our hospital, who usually care for subacute patients now have to care for acute patients. There might be a possibility of unfamiliarity with the acute patient profile resulting in missing a deteriorating patient. Also due to the precautions taken against COVID-19, there would be some inevitable delay in attending to a deteriorating patient. Particularly for patients admitted to surveillance and isolation wards, the deterioration of patients who cannot call for help themselves might not be caught until staff attends to them as they are all in single rooms, by when the patients could have deteriorated into periarrest or cardiac arrest situation. Based on above, we cautiously attribute the increased IHCA incidence during COVID- 19 pandemic in our institution due to diversion of resources and manpower to care for COVID-19 patients as well as prevent COVID-19 transmission.

It is expected the survival of in-hospital cardiac arrest (IHCA) during COVID-19 pandemic will be lower due to precautions taken before initiating resuscitations.[12]

Present study did observe a decreased rate of IHCA survival to home discharge. The response time of HCBT during COVID-19 period is significantly longer than pre- COVID-19 period, which could be associated with the decreased survival rate. Whilst precautions taken have minimized the risk of healthcare providers' exposure to COVID-19, donning PPE could be time consuming and may cause delay in attendance to patients with IHCA. Performance and behavioural change in response to IHCA may have impacted on HCBT response as well.[13] Mask ventilation and tracheal intubation are considered aerosol-generating procedures, however it is still uncertain whether chest compression or defibrillation are aerosol generating procedures due to very limited evidence.[14,15] For IHCA patients with suspected or confirmed COVID-19 disease, European Resuscitation Council (ERC) COVID-19 Guidelines recommends use of airborne-precautions for aerosol-generating procedures (chest compressions, airway and ventilation interventions) during resuscitation.[16] The minimum

airborne-precaution PPE is defined as gloves; long-sleeved gown; filtering face piece 3 (FFP3) or N99 mask/ respirator and eye and face protection (full-face shield safety glasses or equivalent). Alternatively, PAPRs with hoods may be used.[16] The precautionary measure used by our HCBT is in accordance with the ERC COVID-19 guidelines.

Whilst it is imperative for code blue responders to take appropriate precautions during the COVID-19 pandemic, we should also make every effort to reduce the incidence and improve the outcome of IHCA. Our institutional experience has demonstrated that the code blue activation system with periarrest criteria might have a role in reducing IHCA incidence.[17] In our institution the incidence of the rate of survival to hospital discharge for IHCA was 6.67% in the COVID-19 period as compared to 12% in the pre-COVID-19 period [odds ratio (OR), 0.62; 95% confidence interval (CI), 0.27-1.85]. The use of automated physiological monitors to assist in the acquisition of vital signs and identifying deteriorating patients could have a unique advantage in the pandemic situation.[18] With regards to measures to improve IHCA resuscitation outcomes, we propose full PPEs readily available for code blue responders in the emergency trolley and regular simulation of code blue activation with airborne precautions.

CONCLUSION

The higher incidence and lower rate of survival to hospital discharge for IHCA during COVID-19 pandemic.

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