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COVID-19 IN INTENSIVE CARE

The impact of COVID-19 on the epidemiology, outcome and management of cardiac arrest

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Cardiac arrest is one of the major causes of death worldwide [1]. The recent coronavirus disease 2019 (COVID-19) pandemic is impacting both its epidemiology and outcome, further increasing the burden of cardiac arrest. We here review the evidence about the impact of COVID-19 on out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA), as well as the outcomes for cardiac arrest in COVID-19 patients.

A before-and-after comparison from a large United States (U.S.) registry including 19,303 adult patients showed a significant increase in the incidence of OHCA during the COVID-19 pandemic (March 16 through April 30, 2020) compared with the same period in 2019 (mean 88.5 vs. 69.7 per million residents; adjusted mean difference 14.8) [2]. However, the rates of return of spontaneous circulation (ROSC) and survival to hospital discharge were significantly lower during the pandemic (23.0 vs. 29.8% and 6.6 vs. 9.8%, respectively). A recent systematic review summarising 35,379 OHCAs from ten studies showed similar findings [3]. Both studies also report that during the pandemic there was an increase in the number and proportion of arrests from non-shockable rhythm and occurring at home, two features associated with a poor outcome. The rates of ROSC and survival to hospital discharge were both lower even after adjustment for these differences [2]. On the other hand, despite the increase in cardiac arrests occurring at home, the proportion of witnessed arrests and bystander cardiopulmonary resuscitation (CPR) did not differ [2, 3], possibly reflecting more family members staying at home during the lockdown.

Another potential cause of increased OHCA rates and worse outcomes during the COVID-19 pandemic may have been restricted or delayed access to emergency care. Most studies in the systematic review reported longer response intervals by the emergency medical services (EMS) [3], which may reflect an increased workload. In contrast, hospitalisation for the acute coronary syndrome (ACS) and heart failure has decreased during the pandemic peaks in both Europe and in the U.S. [4, 5]. This is probably because patients fear contracting COVID-19 from hospitals and delay seeking medical care. This may have resulted in an increase in the severity of ACS and heart failure and an increase in the likelihood of cardiac arrest.

Evidence shows that the COVID-19 pandemic was associated with a higher incidence of arrests with worse survival rates for IHCA as well. A single-centre study conducted during the first peak of the pandemic in New York reported 125 IHCAs (79% COVID-19 positive) in 2.5 months (March 1–May 15 2020) compared with 117 IHCAs during the whole of the previous year, equivalent to an almost five-fold incidence increase (2.8% vs. 0.6%) [6]. Survival to hospital discharge occurred in only four (3%) vs. 15 (13%) patients, respectively ($p=0.007$). In that study, a greater proportion of IHCAs occurred in general wards than in the intensive care unit (ICU) during the pandemic (46% vs. 33%) compared with the year before (19% vs. 60%). The authors report that because of a shortage of ICU beds, many COVID-19 patients were admitted to general wards, which lacked continuous vital signs monitoring, especially pulse oximetry, therefore

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potentially exposing patients to unrecognised clinical deterioration. A similar scenario has been described in the report of the first wave of the pandemic in Wuhan, China [7]. Lack of ICU beds may influence the outcome from severe COVID-19 as evidenced by a report from 14 European countries showing an inverse relationship between accessibility to ICU and case fatality from COVID-19 [8].

In a report of 401 COVID-19 patients with cardiac arrest occurring in ICUs at 68 hospitals across the USA [9] (Table 1), IHCA was more common in hospitals with fewer ICU beds. In this study, only 48/401 (12%) patients were discharged alive, of whom 28 (7%) had a favourable neurological outcome. In three smaller studies where 77% [10] and > 80% [11, 12] of IHCAs occurred in ICUs, no patient survived hospital discharge. In two of these studies [11, 12], most patients were obese (33% morbidly in one study [12]). At the time of the arrest, one third of patients were undergoing renal replacement therapy and 80% were mechanically ventilated. In one study [11], the PaO_2 to FiO_2 (P/F) ratio within 24 h of arrest was below 100 in two-thirds of patients. In another study [10], the median P/F ratio in patients at the time of cardiac arrest in ICU was 72 (59–114) and the median Sequential Organ Failure Assessment (SOFA) score was 12 (5.5–14).

Overall, these data suggest that the COVID-19 pandemic may have affected the epidemiology of cardiac arrest in two ways: out-of-hospital, by disrupting the access to care for patients needing treatment for cardiac arrest or other life-threatening acute conditions, often not related to COVID-19 [13]; and in-hospital, by the large influx of severely ill COVID-19 patients overcoming the capability of the hospital system. Furthermore, providing an efficient emergency response in the current pandemic is particularly challenging. The international guidelines for the management of cardiac arrest in COVID-19 suggest limiting the number of team members during the initial response, not starting chest compressions until wearing airborne precaution personal protection equipment (PPE), interrupting chest compressions during potentially aerosolising manoeuvres such as tracheal intubation [14], avoiding or limiting bag-mask ventilation unless a viral filter is available, and withholding continuous chest compressions until the trachea is intubated [15]. All these recommendations are aimed at reducing the risk for the rescuers but may reduce the effectiveness of CPR. Even when the airway is secured in a mechanically ventilated COVID-19 patient in ICU, the provision of chest compressions may be delayed by the need for donning PPE or may be compromised by prone positioning. For IHCA, especially in the ICU setting, the risk to the rescuers must be balanced against the benefit of attempting to resuscitate a patient with a high risk of death. Although no specific scores have been developed for prognosticating the outcome from resuscitation of COVID-19 patients, the evaluation of risk factors for unfavourable outcome, such as age [9] and the degree of organ dysfunction and ongoing treatment may provide guidance.

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Compliance with ethical standards

Conflicts of interest
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Table 1 Studies on In-hospital cardiac arrest among patients with COVID-19

	Wuhan, China	US ICUs	New York City, USA	Georgia, USA	Michigan, USA
Author [Reference]	Shao et al. [7]	Hayek et al. [9]	Sheth et al. [10]	Shah et al. [11]	Thapa et al. [12]
COVID-19 Patients	761	5019	N/A	1094	1309
CPR for cardiac arrest *n* (%)	136 (17.9)	400 (8.0)	31	63 (5.8)	54 (4.6)
Location, ICU (%)	17	100	77	84	> 80?
Shockable rhythm (%)	6.0	12.1	13	7.9	3.7
ROSC (%)	13.2	N/A	42	29	54
Survival to discharge (%)	2.9	12.0	0	0	0
Good neurological outcome (%)[1]	0.7	7.0	0	0	0

COVID-19 Coronavirus Disease 2019; *CPR* Cardiopulmonary Resuscitation; *ICU* Intensive Care Unit; *N/A* not available; *ROSC* Return of spontaneous circulation

[1] defined as Cerebral Performance Category 1 or 2, i.e., neurological disability from absent to moderate

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