Survival of In-Hospital Cardiac Arrest in COVID-19 Infected Patients

Mohammad Aldabagh *, Sneha Wagle, Marie Cesa, Arlene Yu, Muhammad Farooq and Ythan Goldberg

Montefiore Medical Center, New York, NY 10467, USA; swagle@montefiore.org (S.W.); marie.cesa2019@gmail.com (M.C.); rleneyu@gmail.com (A.Y.); mfarooq@montefiore.org (M.F.); ygolber@montefiore.org (Y.G.)
* Correspondence: aldagahb87md@gmail.com; Tel.: +1-914-563-777

Abstract: Background: There are limited data regarding the outcome of in-hospital cardiopulmonary resuscitation (CPR) in COVID-19 patients. In this study, we compared the outcomes of in-hospital cardiac arrests (IHCA) before and at the peak of the COVID-19 pandemic at Montefiore Medical Center in the Bronx, New York, United States. We also identified the most common comorbidities associated with poor outcomes in our community. Methods: This was a multi-site, single-center, retrospective, observational study. Inclusion criteria for COVID patients were all confirmed positive cases who had in-hospital cardiac arrest (IHCA) between 1 March 2020 and 30 June 2020. The non-COVID cohort included all cardiac arrest cases who had IHCA in 2019. We excluded all out-of-hospital cardiac arrest (OHCA). We compared actual survival to that predicted by the GO-FAR score, a validated prediction model for determining survival following IHCA. Results: There were 334 cases in 2019 compared to 450 cases during the specified period in 2020. Patients who initially survived cardiac arrest but then had their code statuses changed to do not resuscitate (DNR) were excluded. Groups were similar in terms of sex distribution, and both had an average age of about 66 years. Seventy percent of COVID patients were of Black or Hispanic ethnicity. A shockable rhythm was present in 7% of COVID patients and 17% of non-COVID patients (p < 0.05). COVID patients had higher BMI (30.7 vs. 28.4, p < 0.05), higher prevalence of diabetes mellitus (58% vs. 38%, p < 0.05), and lower incidence of coronary artery disease (22% vs. 35%, p < 0.05). Both groups had almost similar predicted average survival rates based on the GO-FAR score, but only 1.5% of COVID patients survived to discharge compared to 7% of non-COVID patients (p < 0.05). Conclusion: The rate of survival to hospital discharge in COVID-19 patients who suffer IHCA is worse than in non-COVID patients, and lower than that predicted by the GO-FAR score. This finding may help inform our patient population about risk factors associated with high mortality in COVID-19 infection, as well as educate hospitalized patients and healthcare proxies in the setting of code status designation.

Keywords: COVID; pandemic; cardiac arrest

1. Introduction

Since the initial detection of COVID-19 cases in the United States in February 2020, more than 40 million cases have been confirmed, with over 656,000 deaths to date [1]. Recent studies estimate that 12–19% of COVID-19 positive patients may require hospitalization, with 3–6% becoming critically ill [2]. Among critically ill patients, hypoxic respiratory failure secondary to acute respiratory distress syndrome (ARDS), myocardial injury, ventricular arrhythmias, and shock are common and predispose them to cardiac arrest [3].

Patients with COVID-19 requiring mechanical ventilation have poor survival rates [3,4]. Furthermore, survival after cardiac arrest is likely substantially lower. The incidence
of out-of-hospital cardiac arrest (OHCA) and death during the COVID-19 pandemic significantly increased compared with the same period the previous year [5]. However, there are limited data regarding the outcome of in-patient cardiac arrest (IHCA) in COVID-19 patients [6,7].

The first study to report outcomes of in-hospital cardiac arrest (IHCA) in COVID-19 was from Wuhan, China, where the survival rate of patients with severe COVID-19 pneumonia and in-hospital cardiac arrest was very poor, with a return of spontaneous circulation (ROSC) rate of 13.2% and a 30-day survival rate of 2.9% [6].

In this study, we compared the baseline characteristics and survival rates of COVID and non-COVID patients who experienced IHCA at our institution, with the aim of gaining insight into risk factors associated with poor outcomes and to highlight the importance of goals of care discussions for critically ill COVID-19 patients.

2. Methods

The electronic medical record (EMR) system from three affiliated hospitals in the Bronx, NY, United States, was used for patient selection and data collection. All patients with COVID-19 confirmed by either nasopharyngeal swab or SARS-CoV-2 who were aged 18 and above, had IHCA and underwent cardiac resuscitation (CPR) between 15 March and 30 June 2020 were included in the COVID cohort. The non-COVID cohort consisted of all patients who had in-hospital cardiac arrests and underwent cardiac resuscitation in the period 1 January to 31 December 2019. We used a longer time period for non-COVID patients to increase the size of the comparison group and to reach better matching between the two groups. Patients with OHCA or who arrived to the hospital with ongoing cardiac resuscitation were excluded. Internal transfers within the three hospitals were considered a single hospitalization. Those who were transferred outside the institution or who had cardiac arrest prior to transfer to our institution were excluded. Patients whose code statuses were changed to do not resuscitate (DNR) after initial survival of cardiac arrest were also excluded. This study was approved by the local institutional review board.

All data were obtained from EMRs and cardiac arrest documentation. Patients’ data included age, gender, race, body mass index (BMI), code status as either full code or (DNR), and comorbidities such as hypertension, diabetes mellitus (DM), coronary artery disease, and chronic kidney disease. Other data included location of cardiac arrest, initial electrocardiogram (ECG) rhythm during the cardiac arrest, and length of hospital stay.

The GO-FAR score (Good Outcome Following Attempted Resuscitation) is a clinically validated risk score that utilizes pre-arrest variables to predict the probability of survival to hospital discharge following IHCA [8]. These variables include age, neurologic status on admission, organ status on admission (kidney, liver, cardiac or respiratory failure), and cardiac versus non-cardiac diagnosis on admission. Survival rate categories as defined by the GO-FAR score are shown in Table 1.

| GO-FAR Score | Risk Group | Survival to Discharge with Minimal Neurologic Disability |
|--------------|------------|--------------------------------------------------------|
| ≥24          | Very low survival | <1%                                                   |
| 14 to 23     | Low survival    | 1–3%                                                   |
| −5 to 13     | Average survival | 3–15%                                                  |
| −15 to −6    | Above average survival | >15%                                                   |

**Table 1.** GO-FAR score.

**GO-FAR Score Variables**

| Variables | Yes | No |
|-----------|-----|----|
| Neurologically intact or with minimal deficits at admission | −15 | 0  |
| Major trauma | +10 | 0  |
Injury associated with shock or altered mental status during current admission

| Acute stroke                                      | +8  | 0  |
|---------------------------------------------------|-----|----|
| Ischemic or hemorrhagic stroke during current ad-|     |    |
| mission                                          |     |    |
| Metastatic or hematologic cancer                  | +7  | 0  |
| Septicemia                                        |     |    |
| Documented bloodstream infection with antibiotics |     |    |
| not yet started or ongoing                       | +7  | 0  |
| Medical noncardiac diagnosis on admission         | +7  | 0  |
| Hepatic insufficiency                             |     |    |
| Total bilirubin >2 mg/dL or 34 μmol/L and AST >2× |     |    |
| upper limit of normal, or cirrhosis              | +6  | 0  |
| Admit from skilled nursing facility              | +6  | 0  |
| Hypotension or hypoperfusion within 4 h prior to |     |    |
| arrest                                            |     |    |
| SBP <90, MAP <60, pressors or inotropes other     | +5  | 0  |
| than dopamine ≤3 μmol/kg/min after volume        |     |    |
| expansion, or intra-aortic balloon pump           |     |    |
| Renal insufficiency                               | +4  | 0  |
| Respiratory insufficiency                         |     |    |
| Any of the following: P/F ratio <300, PaO₂ <60,   |     |    |
| SaO₂ <90%; PaCO₂, ETCO₂, or transcutaneous CO₂   |     |    |
| >50, spontaneous RR >40 or <5, or noninvasive or  | +4  | 0  |
| invasive ventilation                             |     |    |
| Pneumonia                                         |     |    |
| Documented active pneumonia with antibiotics not  | +1  | 0  |
| yet started or still ongoing                      |     |    |

Descriptive statistics with simple graphic analysis were performed. Numerical variables are reported as mean, median, or range as appropriate. Categorical variables are reported as the percentage of patients in each category. Proportions were compared using the Wald test. A p-value <0.05 was considered statistically significant. STATA-16 was used for analysis.

3. Results

There were 334 patients who had IHCA in 2019. Of the 6500 COVID-positive patients who were admitted between 15 March and 30 June 2020, we found 450 patients who underwent cardiac resuscitation efforts for IHCA. Age and sex distribution were similar in both groups (Table 2). Seventy-two percent of COVID patients were Black and Hispanic, while sixty-eight percent of non-COVID patients were Black and Hispanic. Seventy percent of COVID patients had shockable rhythms during cardiac arrest compared to seventeen percent of non-COVID patients (p < 0.05). COVID patients had higher BMIs (30.7 vs. 28.4, p < 0.05) and a higher prevalence of diabetes mellitus (58% vs. 38%, p < 0.05). Coronary artery disease was more common in non-COVID patients (35% vs. 22%, p < 0.05). Despite both groups having almost similar predicted average-to-low survival rates based on the GO-FAR score, only 7 (1.5%) COVID patients survived to discharge compared to 23 (7%) non-COVID patients (p <0.05).
Table 2. Characteristics of COVID patients compared to non-COVID patients.

| Demographic Characteristics | Percentage (%) | p-Value |
|-----------------------------|----------------|---------|
|                             | Non-COVID (334) | COVID (450) |
| Male                        | 186 (55.7%)     | 271 (60.2%)     | 0.2 |
| Age (years, mean ± SD)      | 66.8 (15.5)     | 66.4 (13.1)     | 0.72 |
| Race                        |                |                  |    |
| White                       | 49 (14.8%)      | 31 (6.9%)       | <0.001 |
| Black                       | 124 (37.3%)     | 173 (38.4%)     | 0.75 |
| Spanish                     | 92 (27.7%)      | 151 (33.6%)     | 0.07 |
| Asian                       | 5 (1.5%)        | 13 (2.9%)       | 0.18 |
| Unavailable                 | 62 (18.7%)      | 82 (18.2%)      | 0.87 |
| BMI (Kg/m², mean ± SD)      | 28.4 (8.6)      | 30.7 (8.3)      | <0.001 |
| Location                    |                |                  |    |
| General medical unit        | 175 (52.4%)     | 236 (52.4%)     | 0.94 |
| ED                          | 31 (9.3%)       | 60 (13.3%)      | 0.07 |
| ICU                         | 128 (38.3%)     | 154 (34.2%)     | 0.21 |
| Rhythm                      |                |                  |    |
| Non shockable               | 277 (82.9%)     | 370 (82.4%)     | 0.08 |
| Shockable                   | 56 (16.8%)      | 33 (7.3%)       | <0.001 |
| No record                   | 1 (0.3%)        | 46 (10.2%)      | <0.001 |
| HTN                         | 232 (69.5%)     | 340 (75.6%)     | 0.06 |
| DM                          | 128 (38.3%)     | 260 (57.8%)     | <0.001 |
| CAD                         | 116 (34.7%)     | 97 (21.6%)      | <0.001 |
| Dialysis                    | 81 (24.3%)      | 122 (27.1%)     | 0.36 |
| GO-FAR score                | Average survival rate: 139 (41.6%) | 117 (26.1%) | 0.2 |
|                             | Low survival rate: 93 (27.8%) | 123 (27.5%) | 0.59 |
| Length of stay (days, mean ± SD) | 12.6 (15.1) | 9.1 (11.7) | <0.001 |
| Survivors to hospital discharge | 23 (7%) | 7 (1.5%) | <0.001 |

4. Discussion

A recent systematic review and a meta-analysis that included 40 studies in the period 1985–2018 showed that one-year survival after IHCA was 13.4% on average [9]. Our study demonstrates that the outcome of inpatient cardiac arrest for patients with COVID-19 was much lower, with a survival rate of 1.7%. This is comparable to the 2.9% survival rate reported in Wuhan, China [6]. The low survival rate after in-hospital cardiac arrest in COVID-19 patients raises the question of which factors may influence such poor outcomes [10].

4.1. Factors That Affect the Outcome of IHCA in Patients Infected with COVID-19

Multiple studies during the COVID-19 pandemic have suggested that HTN, DM, and CAD are the most common comorbidities that affect the survival of COVID-19 patients, while coexisting infection, malignancy, immunodeficiency, and cerebrovascular disease are less common [11].

Numerous studies have found that the survival to hospital discharge is approximately 50% for patients who have a shockable rhythm during cardiac arrest. In contrast, the likelihood of survival from an initially non-shockable rhythm is two to three times lower (about 15–20%) [12]. In our study, we found that only 7% of COVID patients had a shockable rhythm compared to 17% of non-COVID patients ($p < 0.05$). The low survival rate among the COVID-19 patients may be attributed to the absence of shockable rhythms during the cardiac arrest event.
Age has been widely associated with reduced survival after cardiac arrest, especially for patients over the age of 60 [10]. Previous studies demonstrated that elderly patients with serious underlying medical conditions are not only at greater risk of COVID-19 infection but also at higher risk of COVID-related death [13]. This has remained consistent throughout the COVID pandemic and is further confirmed by our study. We found that all COVID-19 patients who survived to hospital discharge after a cardiac arrest were under age 65.

The average BMI in COVID patients was higher than in the non-COVID patients. This may contribute to the lower survival rate. The “obesity paradox” is a phenomenon that describes how obesity, as a risk factor for cardiac disease, can lead to improved mortality outcome in severe cardiac illness such as cardiac arrest. One study found high BMI to be associated with lower all-cause mortality in survivors of cardiac arrest [14]. However, obesity increases the risk of severe illness and death from COVID-19 [15].

Besides obesity, coronary artery disease (CAD) has also been associated with improved survival following cardiac arrest [16]. This has been attributed to ischemic preconditioning, as well as other mechanisms, such as the patients’ awareness of CAD symptoms and being on protective cardiac medications. The higher prevalence of CAD in non-COVID patients compared to COVID patients is also a likely contributor to the difference in survival in our study.

Diabetes mellitus (DM) was more common in our COVID cohort than in the non-COVID cohort. DM has been associated with reduced return to spontaneous rhythm and 24-h survival [17]. COVID patients with poorer blood glucose control were also found to have increased overall mortality [18].

Studies investigating the relationship between race and outcomes following in-hospital cardiac arrest found Black and Hispanic patients had lower rates of neurological recovery and survival compared to Caucasians [19]. Unfortunately, Blacks and Hispanics were most affected by COVID-19 infection, with the highest rates of hospitalization and death [20].

4.2. GO-FAR Score as an Estimate of Outcome after Cardiac Arrest

Despite similar predicted average survival rates based on the GO-FAR score, the actual survival for COVID patients was much lower for COVID patients than for non-COVID patients. One reason for this discrepancy may be that clinical features captured by the GO-FAR score may be incomplete or of insufficient magnitude with respect to COVID infection. Black and Hispanic patients, who represented a higher percentage of the COVID than non-COVID cohort, have been shown to have a lower survival following in-hospital cardiac arrest [20]. However, race and ethnicity are not included in the GO-FAR score. Another possibility is that the quality of CPR and other aspects of patient care in general could have suffered during the pandemic, leading to worse survival.

4.3. Effect of the Pandemic on the Health Care System, Quality of CPR and, Patient Care

CPR is a complex intervention that includes airway management, ventilation, chest compressions, drug therapy, and defibrillation. In the setting of COVID-19 infection, viral particles can remain in the air with a half-life of approximately 1 hour, increasing the risk of transmission to resuscitation providers. Multiple studies have demonstrated a significant risk of viral transmission due to aerosol and droplet generation during CPR [21–23]. Due to this risk, hospital policies require providers to have full personal protective equipment (PPE) during CPR as per the American Heart Association guideline [24]. At the time of the early pandemic in the United States, efforts to preserve the source supply of PPE may have led to a reduction in the numbers of CPR responders [25].

In addition, during this unprecedented time in New York City, the number of critically ill patients exceeded the capacities of ICUs in most hospitals. Operating rooms, general medical floors, and hallways became sites to treat critically ill COVID-19 patients
Pre- and post-cardiac arrest care may have been adversely impacted due to a combination of limited knowledge in treating COVID-19 infection, as well as the emotional burden on healthcare workers including feelings of fear, fatigue, and despair [28].

4.4. Study Limitations

This was a multi-hospital system study with a predominantly Black and Hispanic population with a high prevalence of significant comorbidities that explains the lower survival rate following IHCA in our community compared to the rate nationwide (7% vs. 13.4%). The two groups were chosen from different years and over different periods of time to avoid false negative results in the non-COVID group in 2020 and to achieve a better match between the two groups. Ten percent of COVID patients’ records regarding the rhythm during the cardiac arrest were missing due to the high volume of patients undergoing cardiac arrest with a limited number of providers. Undocumented details of cardiac arrest procedures included elements such as time of event, medications administered, ventilator setting at time of arrest, oxygen saturation and other vital signs. Additionally, as this study was carried out retrospectively, selection bias could not be completely avoided.

Due to the low number of cardiac arrest survivors at our institution, we could not statistically verify the relation between the risk factors and the outcome of cardiac arrest during the COVID pandemic.

5. Conclusions

The rate of survival to hospital discharge in COVID patients who suffer cardiac arrest is extremely low. The results from this study may inform providers, hospitalized patients, and their relatives when discussing designation of code status. This study also demonstrates the most common risk factors that affect the outcomes of inpatient cardiac arrest in COVID-19 patients. Further research with a larger and more diverse population is needed to better understand survival probability in specific patient subgroups.

Author Contributions: Conceptualization, Y.G.; methodology, M.A. and Y.G.; software, M.A and M.F; validation, M.A. and Y.G.; formal analysis, M.A. and Y.G.; investigation, Y.G.; resources, Y.G.; data curation, M.C., S.W., M.F. and A.Y.; writing—original draft preparation: M.A.; writing-review and editing, Y.G. and M.A.; visualization: Y.G.; supervision: Y.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board at Montefiore Medical Center and Albert Einstein College of Medicine, IRB number: 2020-11485.

Informed Consent Statement: Informed consent waived for retrospective data collection.

Data Availability Statement: Derived data supporting the findings of this study are available from the corresponding author on request

Conflicts of Interest: All authors declare no conflicts of interest in relation to the work presented in this manuscript.

References
1. Updated Number on the COVID-19 Cases. Available online: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/us-cases-deaths.html (accessed on 24 July 2021).
2. Guan, W.-j.; Ni, Z.-y.; Hu, Y. Liang, W.-h.; Ou, C.-q.; He, J.-x.; Liu, L. Clinical Characteristics of Coronavirus Disease 2019 in China. N. Engl. J. Med. 2020, 382, 1708–1720.
3. Yang, X.; Yu, Y.; Xu, J.; Shu, H.; Xia, J.; Liu, H.; Wu, Y.; Zhang, L.; Yu, Z.; Fang, M.; et al. Clinical courses, and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: A single-centered, retrospective, observational study. LANCET RESPIR. MED. 2020, 8, 475–481.
4. Bhatraju, P.K.; Ghassemieh, B.J.; Nichols, M.; Kim, R.; Jerome, K.R.; Nall, A.K.; Greninger, A.L. Covid-19 in Critically Ill Patients in the Seattle Region—Case Series. N. Engl. J. Med. 2020, 382, 2012–2022.

5. Lai PH, Lancet EA, Weiden MD; et al. Characteristics Associated with Out-of-Hospital Cardiac Arrests and Resuscitations during the Novel Coronavirus Disease 2019 Pandemic in New York City. JAMA Cardiol. 2020, 5, 1154–1163.

6. Shao, F.; Xu, S.; Ma, X.; Xu, Z.; Lyu, J.; Ng, M. In-hospital cardiac arrest outcomes among patients with COVID-19 pneumonia in Wuhan, China. Resuscitation 2020, 151, 18–23.

7. Miles, J.A.; Mejia, M.; Rios, S.; Sokol, S.I.; Langston, M.; Hahn, S. Characteristics and Outcomes of In-Hospital Cardiac Arrest Events during the COVID-19 Pandemic: A Single-Center Experience from a New York City Public Hospital. Circ. Cardiovasc. Qual. Outcomes 2020, 13, e007303.

8. Rubins, J.B.; Kinzie, S.D.; Rubins, D.M. Predicting Outcomes of In-Hospital Cardiac Arrest: Retrospective US Validation of the Good Outcome Following Attempted Resuscitation Score. J. Gen. Intern. Med. 2019, 34, 2530–2535.

9. Schluep, M.; Gravesteijn, B.Y.; Stolker, R.J.; Endeman, H.; Hoeks, S.E. One-year survival after in-hospital cardiac arrest: A systematic review and meta-analysis. Resuscitation 2018, 132, 90–100.

10. Factors That Affect Survival in COVID-19 Infected Patients. Available online: https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-at-higher-risk.html (accessed on 24 July 2021).

11. Yang, J.; Zheng, Y.; Gou, X.; Pu, K.; Chen, Z.; Guo, Q.; Ji, R.; Wang, H.; Wang, Y.; Zhou, Y. Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: A systematic review and meta-analysis. Int. J. Infect. Dis. 2020, 94, 91–95.

12. Merchant, R.M.; Yang, L.; Becker, L.B.; Berg, R.A.; Nadkarni, V.; Nichol, G.; Carr, B.G.; Mitra, N.; Bradley, S.M.; A. et al. American Heart Association Get with the Guidelines-Resuscitation Investigators. Incidence of treated cardiac arrest in hospitalized patients in the United States. Crit. Care Med. 2011, 39, 2401–2406.

13. Liu, K.; Chen, Y.; Lin, R.; Han, K. Clinical features of COVID-19 in elderly patients: A comparison with young and middle-aged patients. J. Infect. 2020, 80, e14–e18.

14. Gupta, T.; Kolte, D.; Mohananey, D.; Khera, S.; Goel, K.; Mondal, P.; Aronow, W.S.; Jain, D.; Cooper, H.A.; Iwai, S.; et al. Relation of Obesity to Survival After In-Hospital Cardiac Arrest. Am. J. Cardiol. 2016, 118, 662–667.

15. Tartoff SY, Qian L, Hong V, Wei R, Nadjafii RF, Fischer H; et al. Obesity and Mortality among Patients Diagnosed With COVID-19: Results from an Integrated Health Care Organization. Ann. Intern. Med. 2020, 173, 773–781.

16. Stecker EC, Teodorescu C, Reinier K, Uy-Evanado A, Mariani R, Chugh H; et al. Ischemic heart disease diagnosed before sudden cardiac arrest is independently associated with improved survival. J. Am. Heart Assoc. 2014, 3, e001160.

17. Movahedi, A.; Mirhafez, S.R.; Behnam-Voshani, H.; Reihani, H.; Ferns, G.A.; Malekzadeh, J. 24-Hour survival after cardiopulmonary resuscitation is reduced in patients with diabetes mellitus. J. Cardiovasc. Thorac. Res. 2017, 9, 175–178.

18. Zhu, L.; She, Z.-G.; Cheng, X.; Qin, J.-J.; Zhang, X.-J. Association of blood glucose control and outcomes in patients with COVID-19 and pre-existing type 2 diabetes. Cell Metab. 2020, 31, 1068–1077.e3.

19. Joseph, L.; Chan, P.S.; Bradley, S.M.; Zhou, Y.; Graham, G.; Jones, P.G.; Sarrazin, M.V.; Girotra, S.; American Heart Association Get with the Guidelines-Resuscitation Investigators. Temporal changes in the racial gap in survival after in-hospital cardiac arrest. JAMA Cardiol. 2017, 2, 976–984.

20. Townsend MJ, Kyle TK, Stanford FC. Outcomes of COVID-19: Disparities in obesity and by ethnicity/race. Int. J. Obes. 2020, 44, 1807–1809.

21. Couper, K; Taylor-Phillips S, Grove A, Freeman K, Osokogu O, Court R, Mehrabian A, Morley PT, Nolan JP, Soar J, Perkins GD. COVID-19 in cardiac arrest and infection risk to resuscuers: A systematic review. Resuscitation. 2020 Jun;151:59-66.

22. Christian, M.D.; Loutfy, M.; McDonald, L.C.; Martinez, K.F.; Ofner, M.; Wong, T.; Wallington, T.; Gold, W.L.; Mederski, B.; Green, K.; Low, D.E.; SARS Investigation Team. Possible SARS coronavirus transmission during cardiopulmonary resuscitation. Emerg. Infect. Dis. 2004, 10, 287–293.

23. Risk of COVID-19 Transmission during Resuscitation. Available online and accessed on: https://www.who.int/news-room/comments/detail_modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations (accessed on 24 July 2021).

24. Edelson, D.P.; Sasson, C.; Chan, P.S.; Atkins, D.L.; Aziz, K.; Becker, L.B.; Berg, R.A.; Bradley, S.M.; Brooks, S.C.; Cheng, A.; et al. Interim Guidance for Basic and Advanced Life Support in Adults, Children, and Neonates with Suspected or Confirmed COVID-19: From the Emergency Cardiovascular Care Committee and Get With The Guidelines-Resuscitation Adult and Pediatric Task Force of the American Heart Association. Circulation 2020, 141, e933–e943.

25. Mahmoud, S.U.; Crimble, F.; Khan, S.; Choudry, E.; Mehwish, S. Strategies for Rational Use of Personal Protective Equipment (PPE) among Healthcare Providers during the COVID-19 Crisis. Currres 2020, 12, e8248.

26. Ranney, M.L.; Griffith, V.; Jha, A.K. Critical Supply Shortages—The Need for Ventilators and Personal Protective Equipment during the Covid-19 Pandemic. N. Engl. J. Med. 2020, 382, e41.

27. Boškoski, I.; Gallo, C.; Wallace, M.B.; Costamagna, G. COVID-19 pandemic and personal protective equipment shortage: Protective efficacy comparing masks and scientific methods for respirator reuse. Gastrointest. Endosc. 2020, 92, 519–523.

28. Korkmaz, S.; Kazgan, A.; Çekić, S.; Tartar, A.S.; Balci, H.N.; Atmaca, M. The anxiety levels, quality of sleep and life and problem-solving skills in healthcare workers employed in COVID-19 services. J. Clin. Neurosci. 2020, 80, 131–136, doi:10.1016/j.jocn.2020.07.