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LETTER TO EDITOR **EDİTÖRE MEKTUP**

CARDIOPULMONARY RESUSCITATION AND PROGNOSIS IN COVID-19 PANDEMİC

COVID-19 PANDEMİSİ'NDE KARDİYOPULMONER RESÜSİTASYON VE PROGNOZ

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Anahtar Kelimeler: Kardiyopulmoner arrest, prognoz, serebral performans kategorisi, difüzyon ağırlıklı görüntüleme.

Dear Editor,

Severe acute respiratory distress syndrome coronavirus-2 (SARS-CoV-2)-associated coronavirus disease-2019 (COVID-19) is spread by droplets and during medical procedures often causing aerosolization; which is the dispersal of droplets into the air creating a severe risk of contamination. Cardiopulmonary resuscitation (CPR) is the leading procedure associated with high aerosolization (1).

While approximately one-tenth of COVID-19 cases require intensive care, mortality in intensive care can rise up to one out of four (2,3). The risk of cardiopulmonary arrest is high in the disease process of COVID-19. The major causes of this finding include deep and resistant hypoxemia due to secondary acute respiratory distress syndrome (ARDS) directly resulting from viral pneumonia, secondary or direct viral-mediated myocardial injury, secondary severe ventricular arrhythmias, and shock; as well as the QT interval prolongation on ECG due to hydroxychloroquine and azithromycin therapy (4).

The management of in-hospital cardiopulmonary arrest, which is the use of advanced life support algorithms, underwent some changes during the COVID-19 pandemic. Herein, we would like to bring in these changes to the discussion.

If the patient has not already been intubated; CPR, which is associated with several risks of aerosolization, should be considered as a combination of intubation, chest compression, defibrillation, and airway interventions with different risk of aerosolization. While all airway interventions are classified as aerosol-generating procedures; chest compression includes procedures with the potential of generating aerosols, whereas defibrillation is not likely to generate aerosols (5). However, personal protective equipment (PPE) may fail to be effective during chest compression because of several factors including slipping of the surgical mask (6). American Heart Association (AHA) (7) European Resuscitation Council (ERC) (5), and the International Liaison Committee of Resuscitation Councils (ILCOR) (8) published guidelines about CPR during the COVID-19 pandemic (Figure). In the COVID-19 guidance prepared by Republic of Turkey Ministry of Health; although there is not a special section about CPR, the procedure is listed as a factor of intense contact and it is stated that all types of PPEs should be used (1).

General principles of the AHA guideline recommend that; before the procedure, rescuers should put on all types of PPE, the number of staff in the intervention room should be limited, the use of mechanical CPR devices should be considered for compression, and all members of the team should be informed of the patient's COVID-19 status in order to reduce the contact of healthcare workers with the virus and to ensure protection against contamination via the airway or droplets. In order to provide oxygenation and ventilation with the low aerosol generation, the guideline recommends that a HEPA (High-Efficiency Particulate Air) filter is attached to the expiratory

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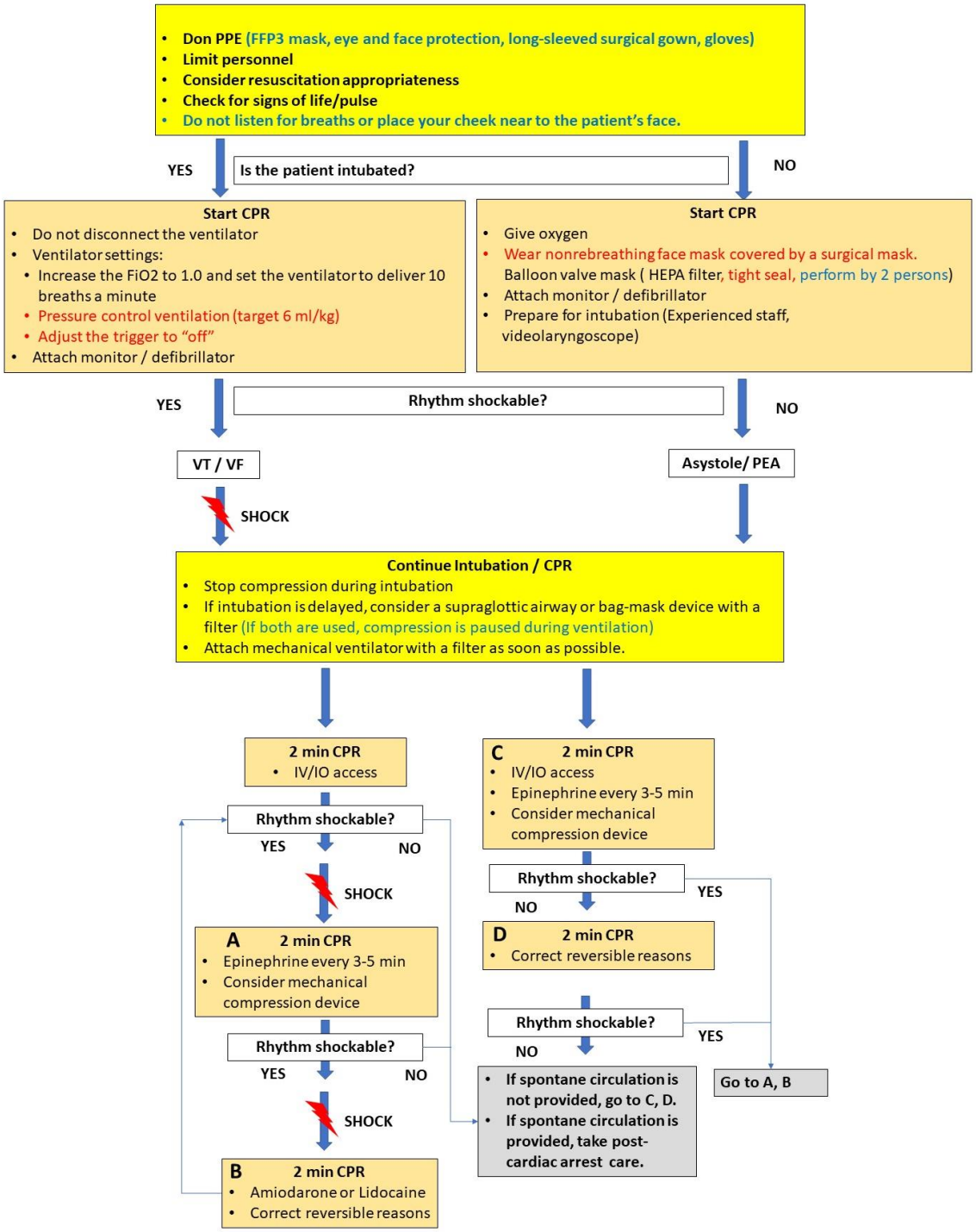

Figure: Advanced life support algorithm in COVID-19.
Footnote: AHA, ERC, and ILCOR in-hospital advanced cardiovascular life support guidelines are presented in a diagram. The recommendations written in red are only included in the AHA guideline; the ones written in blue are included in the ERC guideline, and the recommendations written in black are included in both guidelines.
Abbreviations: PPE: Personal Protective Equipment, CPR: Cardiopulmonary Resuscitation, VT: Ventricular tachycardia, VF: Ventricular fibrillation, PEA: Pulseless electrical activity, IV: intravenous, IO: intraosseous.

arm of the manual or the mechanical ventilation device, chest compressions should be interrupted during intubation to reduce intubation failures, a video laryngoscope should be used if possible, and separation after closed-circuit ventilation should be minimalized (7). It was added that optimal criteria should be established regarding the initiation and continuation of CPR.

In the ERC guidelines and ILCOR guidelines compatible with the ERC guidelines, the importance of using early warning systems has been emphasized in order not to be caught unprepared for a cardiac arrest case. This guideline emphasizes the importance of using PPE although it may potentially delay CPR and states that chest compressions and airway interventions should be performed by wearing at least an FFP3 mask (or N95 or FFP2 if not available), protecting the eyes and the face, putting on long-sleeved surgical gowns, and wearing surgical gloves (5,8). Unlike the AHA guidelines, it was stated that defibrillation can be performed by wearing surgical masks, eye-protecting equipment, short-sleeved gowns, and wearing gloves. Thereby, it is emphasized that 2 shocks can be delivered before chest compression when delays occur in putting on PPE. If a balloon-valve mask is to be used as per the guideline; its duration of use should be kept at a minimum, a virus filter should be used, the procedure should be performed by 2 persons, and compression should be interrupted during ventilation. Interrupting the compressions during ventilation is also recommended for the use of a supraglottic airway (5).

In these guidelines, a separate section is allocated for intubated patients or for patients in the prone position during the occurrence of cardiac arrest. In intubated cases, rescuers should wear PPE that will provide protection against airborne transmission. The ventilation circuit should not be opened when starting CPR. FiO_2 should be increased to 1.0, the procedure should be switched to pressure control ventilation, a flow rate of 6 mL/kg (ideal body weight) should be targeted, and the pressure limit should allow for a proper chest elevation. The trigger should be switched off to avoid automatic triggering and hyperventilation due to chest compressions. The respiratory rate should be set to 10 per minute. In patients; whom cardiac arrest occurs in the prone position, CPR can be started directly in this position after putting on PPE if the patient is already intubated. Compression is exerted over the area between the two scapulae (on the corpora of the T7-T10 vertebrae) 2 times per second aiming at a depth of 5-6 cm. In this position, defibrillator pads can be placed at the anterior-posterior or bi-axillary position. If the compressions cannot be performed efficiently, if the circulation does not improve after minutes, and if an intervention is to be performed in the supine position; the patient is placed in the supine position (5,7,8).

Male gender, advanced age, hypertension, diabetes mellitus, coronary artery disease, presence of comorbidities such as cerebrovascular disease, dyspnea, and high levels of procalcitonin (> 0.5 ng / mL) and aspartate aminotransferase (AST) (> 40 U / L) are known to be associated with poor clinical outcomes in COVID-19 pneumonia (9,10). However, information is limited about COVID-19 patient outcomes after in-hospital cardiac arrest and about the associated risk factors.

In a single-center retrospective study conducted in Wuhan, 761 severe COVID-19 patients were evaluated. Of these patients, 136 underwent resuscitation and the patients were evaluated for risk factors and the following endpoints including the return of circulation without chest compression, 30-day survival, and the neurological condition on day 30. To assess the neurological condition, "cerebral performance category scores" have been utilized; which range from 1 to 5. A score of one or two indicates a good neurological outcome, while a score of 5 refers to death. In that study; spontaneous circulation was achieved in 13.2% (n = 18) of the patients, 2.9% (n= 4) of the patients survived at the end of 30 days, and only 1 patient had a good neurological outcome. Of the risk factors assessed; a baseline shockable rhythm as ventricular fibrillation or pulseless ventricular tachycardia confirmed by monitoring and the resuscitation of the patient in the intensive care unit were associated with favorable outcomes (11).

In a study from the United States conducted to compare the prognosis of COVID-19 patients with other patients after CPR and to interpret the results for COVID-19 patients; 5690 patients, who were admitted to the intensive care unit due to pneumonia or sepsis in the period between 2014

and 2018 and who received mechanical ventilation support during the arrest, were evaluated for the investigation of risk factors and outcomes. While the survival rate until discharge was 12.5%, the rate of patients with cerebral performance category scores of 1 and 2 was found to be 9.2%. Advanced age, asystole or pulseless electrical activity at baseline, and vasopressor use were found to be associated with poor survival (12). The causes of poor outcomes identified in COVID-19 patients are of course very diverse; including the necessity to follow up the patients in regular inpatient units instead of ICU despite indications due to a heavy healthcare system load and the occurrence of delays because of putting on PPE.

The untoward effects of COVID-19 are not limited to in-hospital CPR processes. In a recently published analysis from Italy, it was stated that the incidence of out-of-hospital cardiac arrest increased by 58% compared to the previous year and the time to reach the hospital delayed by about 3 minutes (13). As an even more striking finding, the rate of bystander resuscitation at the event scene decreased by 16% and the incidence of out-of-hospital mortality increased by 15%. Given the fact that not all of these cases were COVID-19 patients, the issue of changes in the overall functioning of the healthcare system due to the pandemic is once again revealed.

In conclusion; the pandemic that we experience has made it difficult to perform many routine procedures normally performed during clinical practice. Undoubtedly, one of these procedures is resuscitation. It is very important to ensure the safety and benefits balance during the CPR to be carried out in this period. Anecdotal data and limited study results piling up since the beginning of the pandemic indicate that the outcomes of CPR are unfavorable in COVID-19 patients. It is observed that safety is prioritized in the recent guidelines. It is critical to perform large-scale studies in order to determine CPR outcomes as per the recent guidelines, to identify associated risk factors, and to identify patient subgroups that will benefit from such approaches.

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Ethics

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