



Treatment of adult, child and newborn cardiac arrest victims with COVID-19.

Recommendations from the
Interamerican Society of Cardiology /
Sociedad Interamericana de Cardiología (SIAC), National Association of
Cardiologists of Mexico /
Asociación Nacional de Cardiólogos de México (ANCAM) and
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Tratamiento del paro cardiaco en adultos, niños y neonatos con COVID-19. Recomendaciones de la Sociedad Interamericana de Cardiología (SIAC), Asociación Nacional de Cardiólogos de México (ANCAM) y Sociedad Mexicana de Cardiología (SMC)

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ABSTRACT

The COVID-19 pandemic presents a large impact on the general population, but it has taken a specially high toll on healthcare personnel. Resuscitation efforts require potential modifications of the present Cardiopulmonary Resuscitation (CPR) International Guidelines because of the infection rate of the new SARS-CoV-2 virus. It has been seen that up to 15% of COVID-19 patients have a severe disease, 5% have a critical form of infection and the mean death rate is 3%, although there are significant differences according to the country that reports it and patients' baseline conditions that include age, presence of arterial hypertension, obesity, diabetes and cardiovascular disease. In these high risk subjects, mortality might go up to 24%. There are also reports of a recent increase in out-of-hospital cardiac arrest (OHCA) victims. Cardiac arrest (CA) in these subjects might be related to many causes, but apparently, that phenomenon is related to respiratory diseases rather than cardiac issues. In this context, the decision to start or continue CPR maneuvers has to be carefully assessed, because of the low survival rate reported so far and the high contagion risk among healthcare personnel.

RESUMEN

La pandemia COVID-19 presenta un gran impacto en la población general, pero ha cobrado un número especialmente alto de víctimas entre el personal sanitario. Los esfuerzos de reanimación requieren posibles modificaciones de las actuales directrices internacionales sobre reanimación cardiopulmonar (RCP) debido a la tasa de infección del nuevo virus del SARS-CoV-2. Se ha visto que hasta el 15% de los pacientes de COVID-19 tienen una enfermedad grave, el 5% tiene una forma crítica de infección y la tasa media de mortalidad es del 3%, aunque hay diferencias significativas según el país que lo informe y las condiciones de base de los pacientes que incluyen la edad, la presencia de hipertensión arterial, la obesidad, la diabetes y las enfermedades cardiovasculares. En estos sujetos de alto riesgo, la mortalidad puede llegar al 24%. También hay informes de un reciente aumento de víctimas de paro cardiaco fuera del hospital. El paro cardiaco (PC) en estos sujetos podría estar relacionado con muchas causas, pero aparentemente, ese fenómeno se relaciona con enfermedades respiratorias más que con problemas cardiacos. En este contexto, la decisión de iniciar o continuar las maniobras de reanimación cardiopulmonar debe evaluarse cuidadosamente, debido a la baja tasa de supervivencia registrada hasta ahora y al alto riesgo de contagio entre el personal sanitario.

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Abbreviations:

CPR = Cardiopulmonary resuscitation.
CA = Cardiac arrest.
OHCA = Out-of-hospital cardiac arrest.
PPE = Personal protection equipment.
AED = Automated external defibrillator.
N95 Face mask = Face mask with the ability to filter 95% of the inspired air.
SARS = Severe acute respiratory syndrome.
MERS = Middle-east respiratory syndrome.
HEPA filter = High efficiency particulate air filter.
IV = Intravenous.
IO = Intraosseous.
PECO₂ = Carbon dioxide expired pressure.
VF = Ventricular fibrillation.
VT = Ventricular tachycardia.
TdP = Torsades de pointes.

INTRODUCTION

The COVID-19 pandemic is a serious challenge for the general population but mainly for healthcare personnel. Resuscitation efforts will potentially require several modifications to the present cardio-pulmonary resuscitation (CPR) International Guidelines because of the high transmissibility rate of the SARS-CoV-2 virus.^{1,2} According to recent data from the World Health Organization (WHO), 40% of the infected subjects experience light symptoms, another 40% have a moderate intensity disease, 15% might have a severe form and 5% will have a critical condition.³ The mean global mortality rate is 3%, but there are important variations according to the country of origin of the report, the age of the patients and presence of other comorbidities such as arterial hypertension, cardiovascular disease, diabetes, or obesity, that might increase mortality up to 24%.³

Italy and the US have acknowledged a recent increase in OHCA victims.^{4,5} There are several possible mechanisms to explain that a COVID-19 patient presents with a CA. These include a progressive respiratory failure due to SARS, septic shock, pulmonary embolism, myocardial damage and malignant arrhythmias due to either direct myocardial injury^{1,6} or to the use of medications that can prolong the corrected QT interval (QTc) and thus induce ventricular tachycardia (VT) or polymorphic VT-torsade de pointes (TdP) such as hydroxichloroquine and azithromycin.^{7,8} Other drugs

as ritonavir and comorbidities as hypokalemia, hypomagnesemia, fever and severe inflammatory response might as well prolong the QTc interval.⁹

In most subjects, CA will be the consequence of a respiratory problem rather than a cardiac one.⁶ Ideally, it is important to clarify if there is a do not Resuscitate (DNR) order issued by an informed decision from the patient or her/his family. It is likely that the pandemic will induce a global increase in CA victims related to COVID-19 infections. The present work offers some recommendations for healthcare personnel in order to provide the best possible care standards for patients while reducing the exposure and contagion risk among healthcare professionals, a phenomenon that has serious implications. Adequate precautions might reduce the number of cases and slow the COVID-19 infection spread.

HEALTHCARE PERSONNEL CONTAGION

The main COVID-19 transmission mechanism is from person to person. Microscopic drops of respiratory secretions («fluge») produced by the infected person while talking, coughing or sneezing contain the virus. When in close distances, those droplets might get to the conjunctival, nasal or oral mucosa, and from there, the virus reaches the lungs.^{1,2} Most of the infected subjects have no symptoms, thus contributing to spread the virus in the general population and in medical professionals.^{10,11} Healthcare personnel can develop a more severe disease because there might be a larger viral inoculum when exposed to spray directly from the patients' airway. Worldwide, it is estimated that 10% of the infected people are healthcare providers. The main risk factor is lack of PPE.^{11,12} A recent survey in Latin America among 936 health system workers (95.1% of them physicians) showed that 56.1% had N95 facemasks, and only 32.6% had a face shield. The authors concluded that the health personnel in this region has limited access to essential PPE during the present COVID-19 pandemic.¹³

In this regard, China reported a 4.4% incidence of infected health personnel at the beginning of the epidemic, mainly due to the

lack of protective equipment and measures. After the implementation of special hospitals to treat COVID-19 patients, and the mandatory use of complete PPE, the contagion rate among healthcare workers has apparently been reduced in a significant proportion.¹⁴ In Wuhan, it was considered that 41% of the initial cases had been infected through hospital-related transmission.^{14,15}

In Italy, by April 17th there were 17,000 people infected among healthcare providers. One hundred and twenty five (125) physicians died as well as 34 nurses.¹⁶ Spain has reported that 14% of its healthcare professionals have been infected.¹⁷ England has found that 14% of their caregivers are infected. Among them, 81% are professionals directly treating COVID-19 patients, but 8% are persons working in the same hospital, without direct contact with infected patients, and 11% are administration workers.¹⁸

In the US, there were 9282 cases of healthcare personnel infected by April 9th.¹⁹ In Latin America we do not have any readily available information. Mexico has reported that up to 23% of the infected persons are healthcare workers, although there are more reports building up.²⁰

SPECIAL HOSPITALS TO TREAT COVID-19 INFECTED PATIENTS

All COVID-19 patients should be treated in specially designed or at least reconfigured hospitals that must be able to control airborne infections and where strict risk reduction policies directed towards healthcare personnel are implemented. It is possible that an abrupt increase in the number of infected patients in Latin-American countries stresses the health system as happened in Spain, forcing to treat patients in any hospital, not only the ones with special facilities.

1. Patients should be placed in individual rooms with a closed door.⁹
2. Every patient should wear a face mask or face shield to control secretion emission while talking, coughing or sneezing.⁹
3. It is advised that every health care and cleaning personnel that has direct contact

with suspected or infected patients wears a complete PPE all the time. The equipment required for exploration (electrocardiogram, echocardiograph, etc.) that are used directly on the patients must be carefully protected and disinfected after each use.^{1,2,9}

4. The healthcare personnel that has no direct contact with suspected or infected patients but works in the same institution should wear at least partial protection equipment such as face-masks, goggles and even face-shields, aside from the usual hygiene and isolation measures recommended by the pertinent authorities to reduce the risk of contagion.^{1,9}

CPR GENERATES SPRAYS

Cardiopulmonary resuscitation (CPR) is a coordinated effort of healthcare professionals working in collaboration and in close proximity to the patient and between them, thus giving favorable conditions for contagion.^{1,2,9} CPR efforts generate sprays, especially when administering chest compressions, ventilating the patient or when trying to establish an advanced airway.¹ The N-95 facemasks might not provide enough protection while administering CPR: the intense and dynamic movements of the CPR providers, as well as a defective seal of the mask imply a higher transmission risk of airborne diseases such as COVID-19. This phenomenon was also observed in the 2010 SARS and in the 2015 MERS epidemics.²¹ *Table 1* shows general recommendations for CPR in patients with suspected or confirmed COVID-19 infection.

RECOMMENDATIONS BEFORE INITIATING CPR

1. All personnel participating in the CPR maneuvers must have his/her own complete PPE.^{1,2,9} A complete hermetic seal mask that will not preclude adequate communication and mobility during CPR is to be used.²¹
2. The patient must have a facemask or a facial tent to control the secretions or sprays emission during CPR.^{1,9}

Table 1: Main adjustments to the cardiopulmonary resuscitation algorithms in patients with confirmed or suspected COVID-19 infection, prior to initiating CPR maneuvers.

1. Reduce health care provider's exposure to the virus
 - a) Use a full PPE before initiating CPR, including a hermetic seal facemask that does not obstruct communications and mobility during CPR
 - b) Limit the number of people involved in CPR
 - c) Initiate the evaluation of the patient 2 meters away
 - d) Place a facemask on the patient to reduce spray generation
 - e) When checking for pulse and respiration, maintain your face away from the patient's
 - f) If available, consider using a mechanical chest compressor for adults and adolescents in order to reduce healthcare personnel exposure
 - g) Inform all of the personnel involved, that the patient is COVID-19 infected
2. The resuscitation team and equipment must be checked and organized prior to any resuscitation attempt. Everyone's role in the team has to be previously assigned and the sequence of procedures discussed to minimize the contagion risk in health personnel
3. Consider if resuscitation is an adequate intervention
 - a) Consider the patient's risk factors such as age, severity of the disease, cause of the CA and the opening heart rhythm to establish if it is adequate or not to start or continue CPR
4. In every patient, the medical team must try to avoid a CA, if it is necessary to treat it, it is mandatory to be well prepared and equipped
5. It is advisable to have a discussion with the patient and family, whenever possible, regarding the presence of «Do Not Resuscitate» orders, wherever the local laws account for that possibility. Those orders must be written and preserved in the patient's file

PPE = personal protection equipment; CPR = cardiopulmonary resuscitation; HEPA filter = high efficiency particulate air filter; CA = Cardiac arrest.

3. Prior to any CPR efforts, and according to the patient's characteristics and evolution, it has to be established if he/she is a suitable candidate for resuscitation that is, if there are serious co-morbidities, what could be the cause of the CA, and the initial heart rhythm. It has to be reminded that asystole is associated with a very poor success rate of the resuscitation efforts. It is important to balance the adequacy of initiating CPR against the risk of healthcare personnel contagion.^{1,6,9} In the light of new information and in a hospital setting, special attention must be paid to inflammatory markers that are associated with a worse prognosis such a D-dimer,

C-Reactive Protein, ferritin or leucocytosis among others.

4. Patients with a cardiac origin CA and with VF/VT as the initial rhythm have higher chances of survival to CPR, although only 5% of the in-hospital CA's correspond to this scenario.⁶
5. It is advisable, when possible, to discuss with the patient and his/her family if there is any preference about resuscitative efforts or under what specific conditions a «Do Not Resuscitate» order might be issued, whenever and wherever the legislation allows such a possibility.

EMERGENCY MEDICAL SYSTEM (EMS)

It is advisable for the EMS dispatchers (911 in several countries) to look for COVID-19 symptoms such as fever, cough and respiratory distress, ask if the patient has had any contact with other suspected or confirmed subjects with COVID-19 infection, and then notify the EMS that the victim is a potential COVID-19 case. When in doubt, all patients should be considered as COVID-19 infected until proven otherwise, and EMS personnel have to take the necessary precautions in every moment. Italy and the US have recently reported an increase in their OHCA cases. In Italy there has been a 58% increase, and among the new cases, 77.4% were suspected COVID-19 patients or had already received an infection diagnosis.⁴

RECOMMENDATIONS FOR FAMILY MEMBERS AND LAY-PERSON RESCUERS

In any case of non-professional rescuers, it is advised to limit the CPR efforts to hands-only CPR, that is, only chest compressions and to use a face mask that covers nose and mouth.¹

1. It is recommended to place a face mask on the victim to reduce transmission risks.^{1,9}
2. In children, chest compressions and ventilation have to be considered, since the incidence of respiratory arrest is higher in the pediatric population.¹ Nonetheless, viral load is usually higher among children, thus forcing more strict transmission reduction measures.

- If there is a EAD available, follow its instructions.

RECOMMENDATIONS FOR HEALTHCARE PROFESSIONALS THAT TREAT OHCA

According to the local prevalence and expansion rate of COVID-19 in a specific community, it has to be considered that every OHCA is COVID-19 related.^{1,4,5} Figures 1 and 2 respectively

show the present recommendations for adult and pediatric basic life support in subjects COVID-19 suspected or confirmed.

- The prehospital EMS personnel will have to have full PPE equipment.¹
- Prior to the arrival at the scene, they must review and organize of the equipment and the team. Assigning specific roles and procedures order will reduce the risk of contagion in the health team.¹

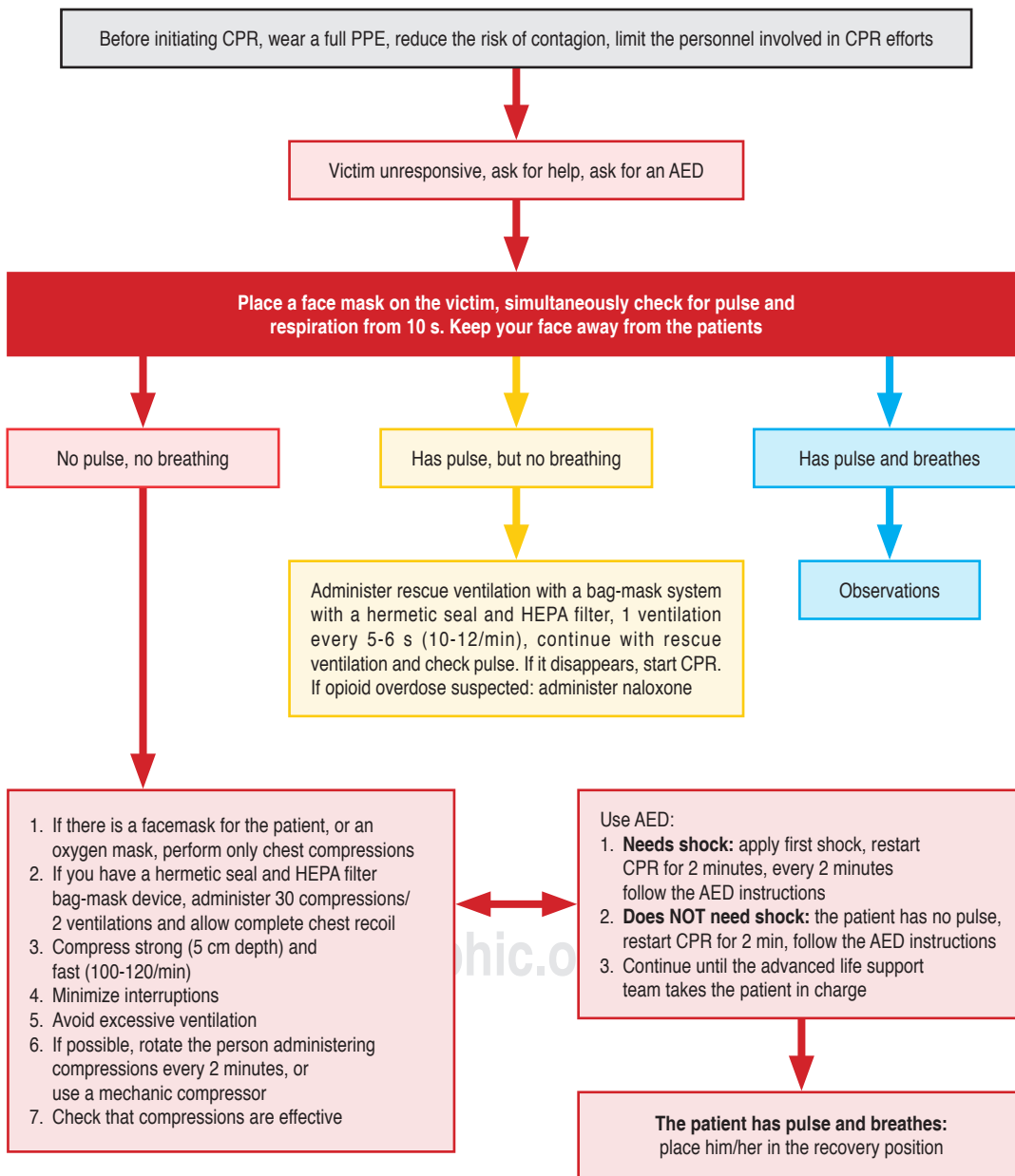


Figure 1:

Adult basic life support algorithms in patients having either suspected or confirmed COVID-19 infection.

PPE = personal protection equipment;
CPR = cardio-pulmonary resuscitation;
AED = automated external defibrillator;
HEPA filter = high efficiency particulate air filter.

3. Whenever responding to any patient with signs or symptoms of a respiratory infection, the evaluation must be initiated at a 2 meter distance from the patient.
4. Any contact with the patient has to be reduced until she / he has a face mask placed.
5. It is possible that every person in the victim's home has already been exposed to COVID-19.
6. The health team has to consider the presence of co-morbidities to evaluate the need to initiate or continue CPR efforts.
7. They will only perform chest compressions.
8. The team member in charge of the airway will place a supra-glottic device. Tracheal intubation is not recommended since the procedure's complexity substantially increases the contagion risk. Recommendations in *Table 2* must be followed at every moment to reduce spray generation.
9. The prehospital caregivers must take the patient only to hospitals prepared for COVID-19 patients' treatment. Emergency medical per-

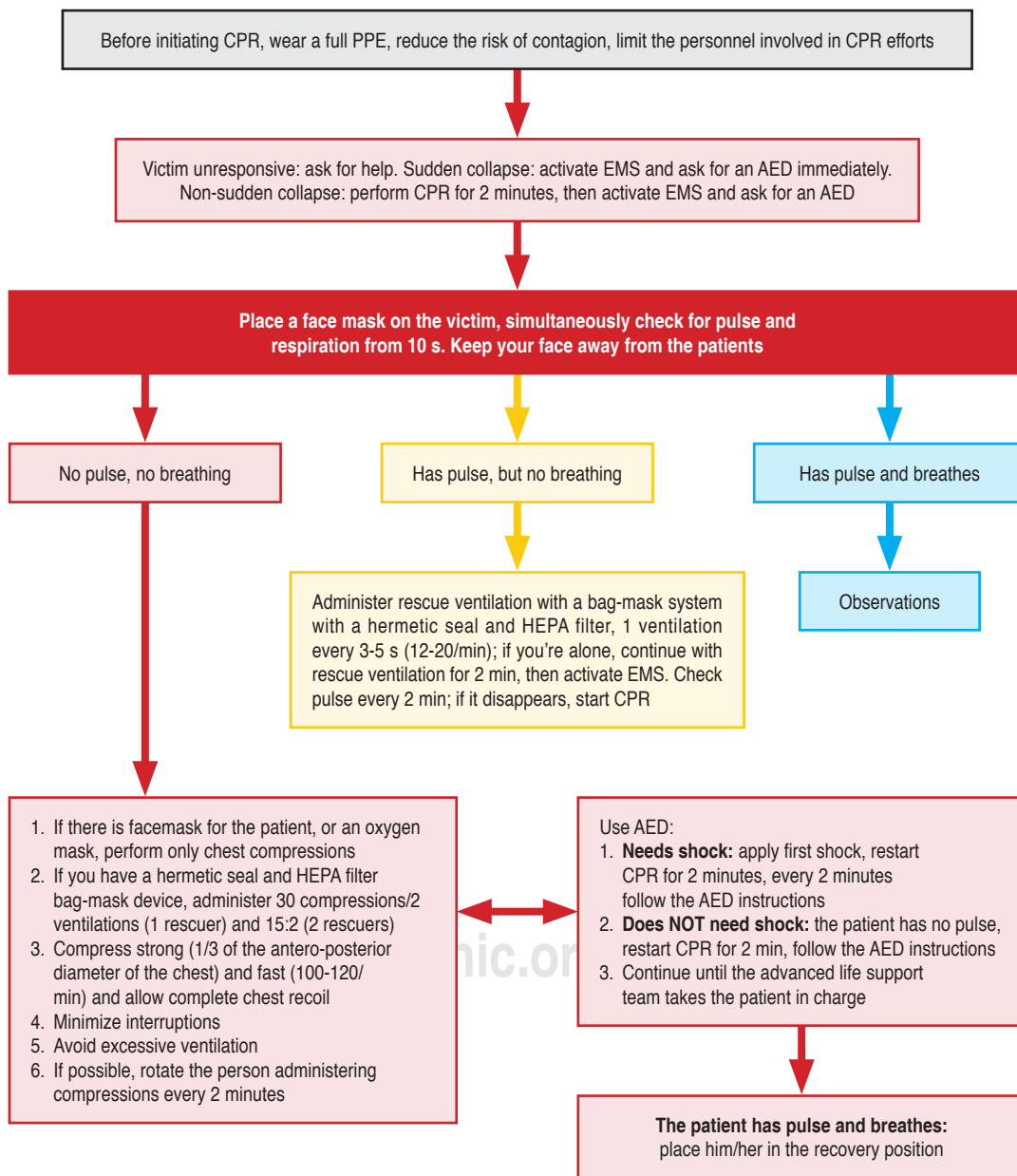


Figure 2:

Pediatric basic life support algorithms with one or two rescuers for patients suspected or confirmed with COVID-19 infection.

PPE = personal protection equipment;
 CPR = cardio-pulmonary resuscitation;
 AED = automated external defibrillator;
 HEPA filter = high efficiency particulate air filter.

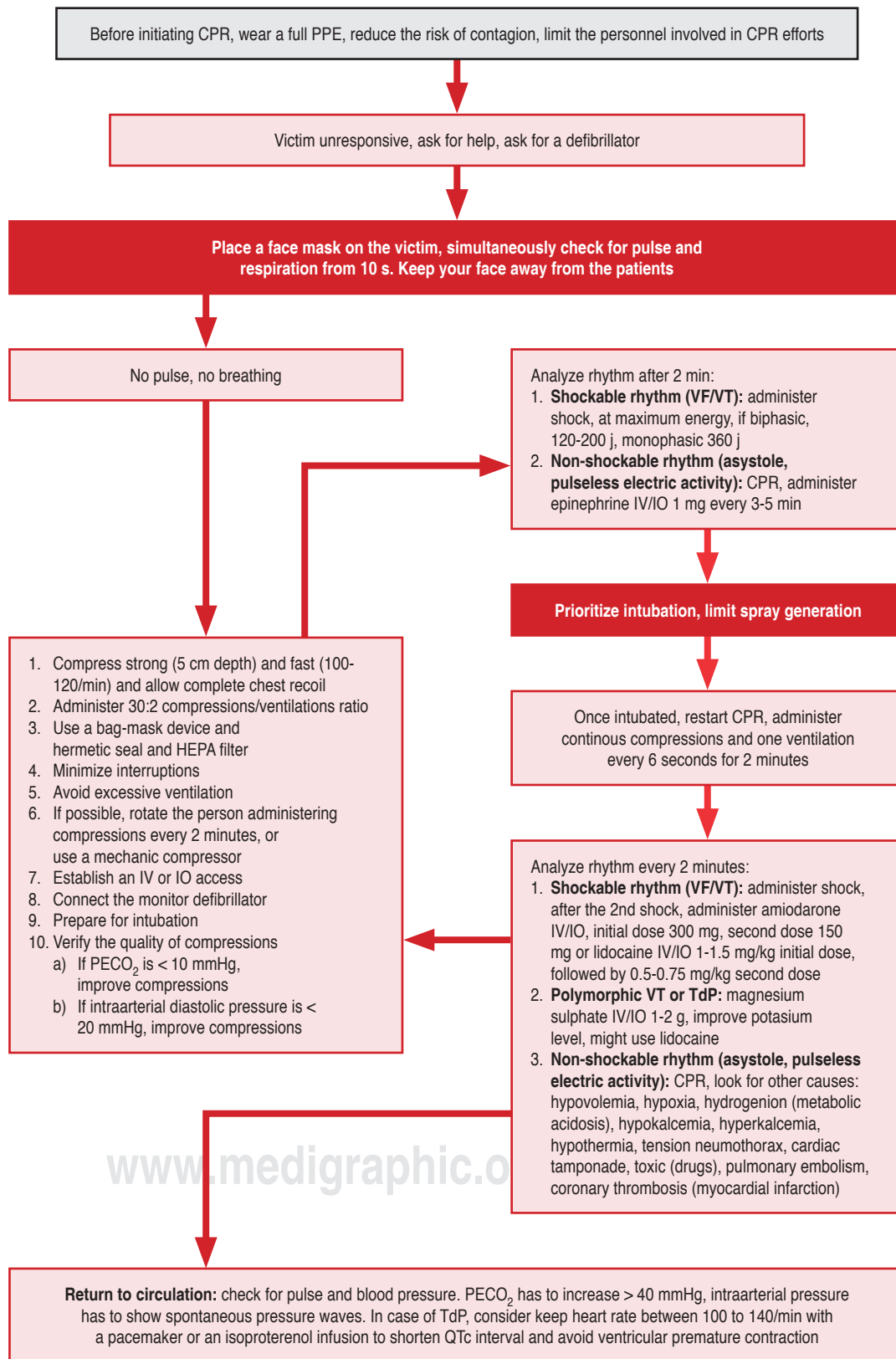


Figure 3:

Adult advanced life support algorithms in patients with a suspected or confirmed COVID-19 infection.

PPE = personal protection equipment;
 CPR = cardio-pulmonary resuscitation;
 IV = intravenous;
 IO = intraosseous;
 PECO₂ = expired carbon dioxide pressure;
 VF = ventricular fibrillation;
 VT = ventricular tachycardia;
 TdP = Torsade de pointes.

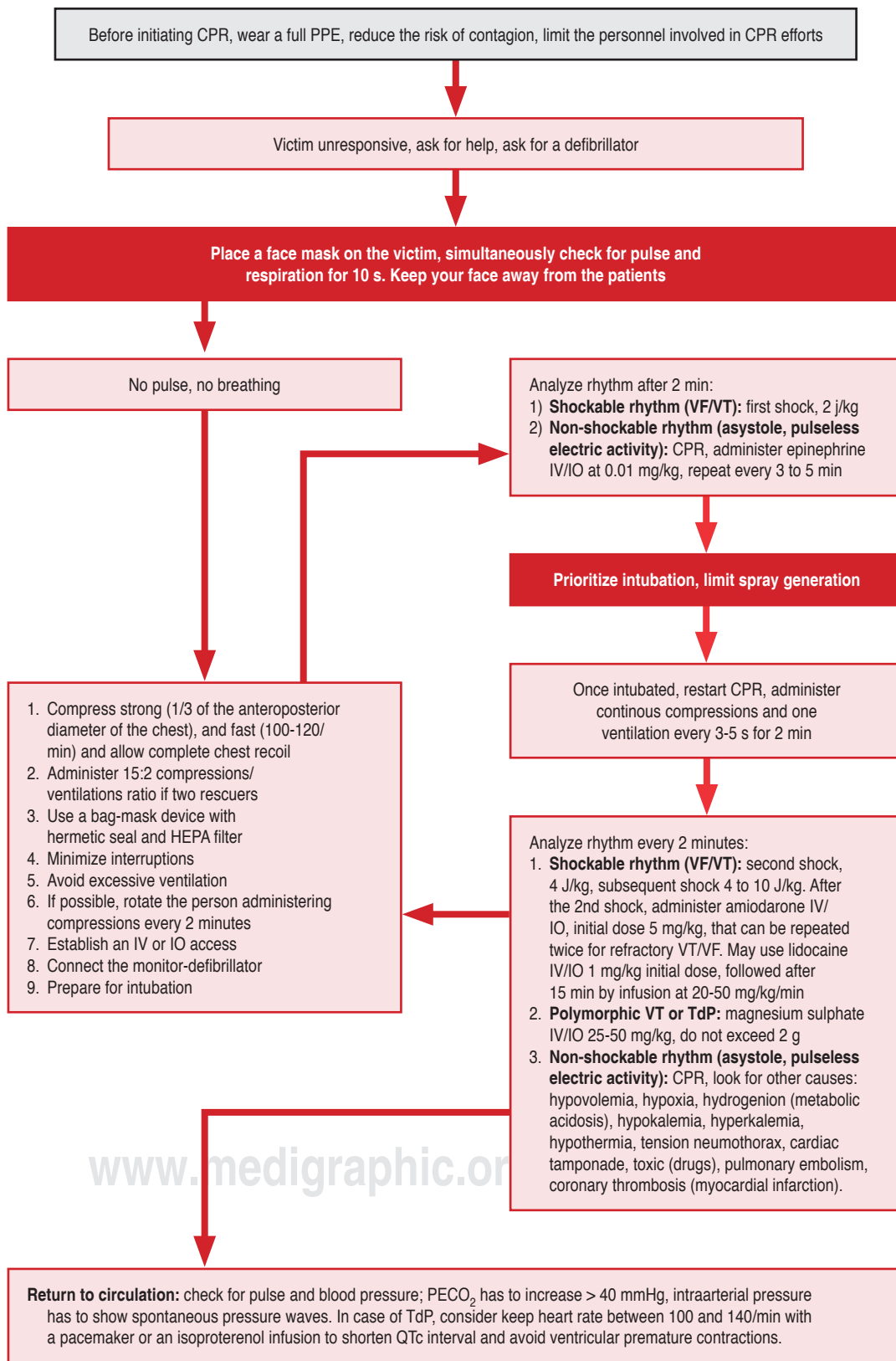


Figure 4:

Pediatric advanced life support algorithms in patients with a suspected or confirmed COVID-19 infection.

PPE = personal protection equipment;
 CPR = cardio-pulmonary resuscitation;
 IV = intravenous;
 IO = intraosseous;
 PECO₂ = expired carbon dioxide pressure;
 VF = ventricular fibrillation;
 VT = ventricular tachycardia;
 TdP = Torsade de pointes.

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Table 2: Strategies to generate low amounts of sprays during CPR.

1. Use a closed system of hermetic seal bag-valve-mask device with HEPA filters
2. Make early intubation and connect a mechanical ventilator
3. To achieve a successful intubation in the first attempt, stop chest compressions and use a videolaryngoscope
4. Place an isolation and protection system for the patient while intubating (Figure 5)
5. If intubation is delayed or does not have properly trained personnel, consider a supraglottic device (laryngeal mask or laryngeal tube)
6. Reduce disconnections from the closed circuit system to the maximum

CPR = cardiopulmonary resuscitation; HEPA filter = high efficiency particulate air filter.

sonnel must announce prior to their arrival to the selected hospital that they are on transit with a COVID-19 case, in order for the hospital to prepare the reception of the patient.

10. Consider using a thoracic compression mechanical device to minimize contagion risk.
11. Family and other possible contacts have to travel in a different vehicle.
12. If there is no return of spontaneous circulation (ROSC) with CPR, consider to not transport the victim to a hospital since the survival rate is even lower.¹
13. To withdraw the full PPE, it is recommended to have supervision in order to avoid contamination.^{22,23}

RECOMMENDATIONS FOR HEALTHCARE PERSONNEL THAT TREAT A CA IN THE HOSPITAL

These recommendations do not apply to patients without COVID-19, who should receive standard CPR,¹ nonetheless, try to reduce the number of persons involved in resuscitation efforts to keep distancing and avoid contagion during the pandemic. Figures 3 and 4 show the recommendations for advanced life support in adult and pediatric patients, respectively with suspected or confirmed COVID-19 infection. Both include the treatment for Polymorphic VT or TdP.^{24,25}

1. It is advised to closely monitor patients in order to detect early signs of deterioration and avoid emergency tracheal intubation

that might pose a higher risk for the patient and the health personnel.

2. If the patient is at high risk of developing a CA, consider his/her transportation to a negative air pressure unit if available, in order to reduce the risk of virus exposure of the health personnel during CPR.^{1,9}
3. Keep the door closed at every moment to avoid contamination of adjacent areas.⁹
4. It is advisable to compose the resuscitation team with the minimum number of persons possible to avoid contagion. Four persons are deemed an appropriate team-size.
5. Intubate the patient at the moment of the CA, following the instructions in Table 2 to minimize spray generation. It is advisable to use a protection and isolation system during the videolaryngoscope tracheal intubation to reduce exposure of the health personnel, as shown in Figure 5.
6. Adjust the mechanical ventilator to the patient's specific needs.
7. If the patient is already intubated that present with CA, increase FiO₂ to 1.0, and start with continuous chest compressions. The mechanical ventilator should be kept in a pressure-control mode with the pressure limited to 6 mL/kg of ideal body weight for adults and 4-6 mL/kg for neonates, set the trigger to Off. Program a ventilator rate of 10/min for adults and 30/min for neonates.



Figure 5: Patient's protection and isolation system for intubation with video-laryngoscope to reduce healthcare personnel contagion risk.

Fix the endotracheal tube or tracheostomy cannula as well as the ventilation circuit in order to avoid involuntary extubation. If the patient has return of circulation, program the mechanical ventilator device to the actual needs of the person.

8. If the patient is in prone decubitus, and is not intubated, try to place him in a supine position to start CPR. It is not sure if prone CPR is effective, but in patients already with prone advanced respiratory support, any change to a supine position should be avoided because of the high extubation and spray generation risk. CPR must be performed in that position, place the defibrillator patches in the antero-posterior position and perform chest compressions pushing the T7-T10 vertebral bodies.¹ If the compressions are ineffective, as shown by diastolic pressure records, or if there is accidental extubation of the airway or any difficulty to have a prompt reestablishment of spontaneous circulation, a change to the supine position must be considered.
9. It is important to get out of the complete PPE under supervision to avoid contamination.^{22,23}

SPECIAL CONSIDERATIONS CONCERNING MOTHERS AND NEONATES WITH CA

According to unpublished data from the Hospital de Sant Joan de Déu in Barcelona, the outcome data in mothers and children with COVID-19 infection are scarce and show high variability. With this in mind, it is suggested to consider that both the mother and the child are contagious.¹

Neonatal CA

The umbilical cord route is preferred over the endotracheal way to administer medications such as epinephrine to avoid spray generation. Endotracheal intubation procedures must follow the same spray-minimizing techniques suggested in [Table 2](#).¹

Maternal CA

The principles of CA in a mother do not change among patients with suspected or confirmed COVID-19 infection.¹

1. Physiological cardiopulmonary changes during pregnancy might increase the risk of an acute decompensation in COVID-19 infected critically ill pregnant patients.
2. The preparation for a perimortem cesarean section must be done early during the CPR attempts or even better, anticipated, since it has to be performed in the first four minutes of CPR maneuvers. The planning has to allow for the obstetrical and neonatal teams to get fully dressed with PPE, even if afterwards there is a return to spontaneous circulation.

ETHICAL ASPECTS OF CPR DURING THE COVID-19 PANDEMIC

The present health systems' crisis induced by the COVID-19 pandemic has forced institutions and healthcare workers to develop crisis standards that are very different to the established standards of care. Some aspects must be accounted for in order to protect health care personnel from an ethical standpoint.²⁶ Whenever possible, the resuscitation preferences should also be discussed with the patient and his/her family.

1. Start CPR only after the personnel involved in CPR wears whole PPE that must include a face mask for the persons performing endotracheal intubation.
2. Healthcare personnel will only perform interventions in a safe manner, for example, defibrillate and use supplemental oxygen on the patient until the proper equipment and team are available on the scene.
3. Healthcare personnel with proper equipment and training will not refuse to perform CPR because of personal safety reasons except in patients with refractory or irreversible damage.
4. Hospital must establish their own standards of care defining how, when and to whom CPR efforts have to be applied. Those criteria will help physicians to establish clear CPR guidelines and establish the appropriate maneuvers and their duration in each case.

CONCLUSIONS

The COVID-19 pandemic has meant a serious challenge for the general population and for the medical services, especially the healthcare professionals that are exposed to a very contagious virus, with high morbidity and mortality. There are reports of increasing OHCA cases in several countries. It is important to modify the current strategies for the treatment of CA victims, especially when considering that CPR maneuvers generate sprays that increase the contagion risk for healthcare professionals. Every person that assists patients with an active COVID infection, or suspected to have a COVID infection, has to have a full Personal Protection Equipment before initiating CPR. It is fundamental to protect and care for every health professional because they are the ones treating the infected patients and they have become a strategic asset.

Older age associated with comorbidities such as arterial hypertension, diabetes mellitus, obesity, cardiovascular disease and lung disease poses a high risk of mortality among infected patients. Apparently, the main cause for CA is a progressive respiratory failure, and in most cases, the initial rhythm encountered is asystolia, that is associated with very poor response to CPR maneuvers and thus, bad outcomes.

In every case of CA, it is reasonable to consider age, comorbidities, the severity of the underlying illness and the opening heart rhythm to decide if it is appropriate to initiate or continue the resuscitation efforts; at the present time, a balance must be made between the chances of survival and the risk of contagion among the rescuers.

Every health care professional must consider the consequences of having an illness that may go from a temporary disability to serious or even fatal complications that will limit his / her attention capabilities on other patients and might jeopardize their own families.

An important issue about the present recommendations is that they have to be locally adapted and considered by the specific health systems according to the diseases' local behavior and the available resources.

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ETHICAL RESPONSIBILITIES

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The present work has not received any founding.

For the present research, there were no experiments performed on Humans or animals.

The present work does not depict any particular data about any patient.