Cardiopulmonary resuscitation in prone position in critically ill patients with SARS-CoV-2 infection

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ABSTRACT

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Coronaviruses are a large family of viruses that cause illnesses ranging from the common cold to more severe diseases. SARS-CoV-2 is a new virus that has not been previously identified in humans. Patients with SARS-CoV-2 commonly develop acute respiratory distress syndrome (ARDS), myocardial injury, ventricular arrhythmias, and shock, all of which increase their risk of cardiac arrest. The main objective of this brief review is to raise the discussion on the possible indication of cardiopulmonary resuscitation in a patient with SARS-CoV-2 in prone position as a way to save time, since the entire process of decubitus change is complex and often slow, due to the number of devices used in these patients, such as catheters, infusion pumps and monitors. In addition to a price of high demand for stressed human resources.

INTRODUCTION

On 30 January 2020, the WHO Director-General declared the novel coronavirus outbreak a public health emergency of international concern[1-2]. For patients with ARDS, the specific characteristics of the syndrome, such as respiratory mechanics, are still under investigation. COVID-19 can rapidly progress to ARDS, an inflammatory process in the lungs that induces non-hydrostatic protein-rich pulmonary oedema. The consequences ARDS associated with COVID-19 infection are profound hypoxemia, decreased lung compliance, and increased intrapulmonary shunt and dead space. In patients with SARS/COVID-19 there is a disproportionality between complacency and

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hypoxemia, this can be attributed to arteriography reports of unpublished study that found pulmonary thromboembolism (PTE).The biological aspects include severe inflammatory injury to the alveolar-capillary barrier with 10-20 times interleukin 6 levels, surfactant depletion, and loss of aerated lung tissue[3-5]. ARDS is a syndrome defined by a numerous physiopathological criteria. It is therefore not surprising that lung-protective ventilatory strategies that are based on underlying physiological principles have been shown to be effective in improving outcome. Lung protection strategy can be provided in patients with ARDS, resulting in better pulmonary function and higher rates of weaning from the ventilator. Therefore, lung-protective strategy should be applied to patients with COVID-19 induced ARDS who are on a mechanical ventilator[6-11]. The patients are placed on low tidal volumes and low FiO_2 to maintain acceptable oxygenation. Some studies demonstrated that female and obese patients are more likely to be placed on high tidal volume ventilation. This pattern is often reported in other studies and likely reflects the calculation of tidal volume based on actual body weight. Patients were ventilated in volume-controlled mode with tidal volume at 6 mL/kg of predicted body weight. Patients with SARS-CoV-2 commonly develop ARDS, myocardial injury, ventricular arrhythmias, and shock, all of which increase their risk of cardiac arrest. The main objective of this brief review is to raise the discussion on the possible indication to prompt start cardiopulmonary resuscitation manoeuvres in a patient with SARS-CoV-2 in prone position.

HISTORY AND EVOLUTION

The first case report of successful CPR in the prone position was described by Sun et al. in 1992. The report consisted of two neurosurgical cases of CPR after acute hypovolemia. Both cases were resuscitated with the technique named by the author as "reverse precordial compression manoeuvre" with one hand placed on the back of the patient, in the mid-thoracic spine, and the other hand placed on the lower third of the sternum serving as counter-pressure to the compression of the back. According to the author, that second hand can be replaced by rigid devices on the same site[12].

There had been also successful return of a spontaneous circulation (ROSC) after defibrillation in prone position, without the necessity of repositioning the patient. Miranda et al. described a case in which electrical defibrillation was successfully performed in the prone position in a patient undergoing complex spinal surgery. They suggested that, if defibrillation were required in ventilated patients positioned prone, defibrillation should be attempted in the prone position, as turning the patient supine would consume valuable minutes and reduce the chances of successful defibrillation[13-14].

Since 2005 the AHA Guidelines for CPR and ECC recommended that CPR in the prone position may be a reasonable choice when the patient cannot be flipped in the supine position without prejudice, particularly in hospitalized patients with an advanced airway in place[15-16].

There was no specific recommendation on the frequency and depth of compressions to the patient in the prone position. Parallel to the recommendation given to patients in supine position, in one case from our hospital, the frequency was maintained above 100 cpm and depth sufficient to produce good perfusion[17].

In fact, the vast majority of published successfully resuscitated cases were intraoperative-cardiac arrests, mostly young patients and with compression in the midline, two-thirds of the way up the torso between imaginary scapulae[18].Yet, paediatric, and geriatric reports also exist[19-20]. Even though research data about haemodynamic and respiratory effects of prone CPR are scarce, they suggest that prone CPR can generate higher mean systolic blood pressure (although not at statistical significance level) and higher mean arterial pressure during circulatory arrest than standard CPR, and mean tidal volumes of 400±110 ml [21-22].

American Heart Association (AHA) did not review the guidelines until only in 2015 guidelines[23]. However, the new guidelines increased focus on methods to ensure that high-quality CPR is performed by setting targets for rate and depth of compressions as well as minimum values obtained from the monitoring devices as capnography and continuous arterial line. Cardiopulmonary resuscitation is a high-intensity team effort that diverts rescuer attention away from other patients[24].

In the context of COVID-19 patients, the risk to the clinical team is increased and resources can be profoundly more limited, particularly in regions that are experiencing a high burden of disease. While the outcomes for cardiac arrest in COVID-19 patients are yet unknown, the mortality for critically ill COVID-19 patients is high and rises with increasing age and comorbidities, particularly cardiovascular disease. Therefore, it is reasonable to consider age, comorbidities, and severity of illness in determining the appropriateness of resuscitation and balance the likelihood of success against the risk to rescuers and patients from whom resources are being diverted[25].

In response to the COVID-19 pandemic, Resuscitation Council UK has produced a series of resources for healthcare professionals. Depending on the cause and time point during CPR, CPR can start with the patient in the prone position[25]. However, optimum timing of patient turning is yet to be determined; and, currently, it seems more like a case-specific decision than a guideline question.

More data and research about prone CPR "physiology" is needed in to define better its effects on hemodynamics (systemic and cere-

bral), respiratory system and post –resuscitation course.

An equally important issue is that of the education of prone CPR. This includes education of proper performing of prone CPR technique, as well as "proper" – remains to be clarified- time and way of turning the patient supine. Questions that can rise both in intrahospital – e.g. removing unnecessary monitoring – and out of hospital cardiac arrests that can be treated with prone CPR- e.g. only compressions, underlying surfaces- pose challenges could alter current life support protocols. Increased willingness of bystander action for prone CPR in "hot" COVID 19 area could be only an example for the necessity of this type of CPR. Thus, if in the past there were a doubt whether such training should it be limited only to those how may encounter such conditions (e.g. neurosurgeons, anaesthetists, intensivists); COVID-19 pandemic makes that kind of education essential literally for all; initially medical, nursing, paramedical and EMTs staff and all the others (rescue teams, police staff and fire-fighters, civilians) on future plan.

TECHNICAL DETAILS AND PRACTICAL ISSUES

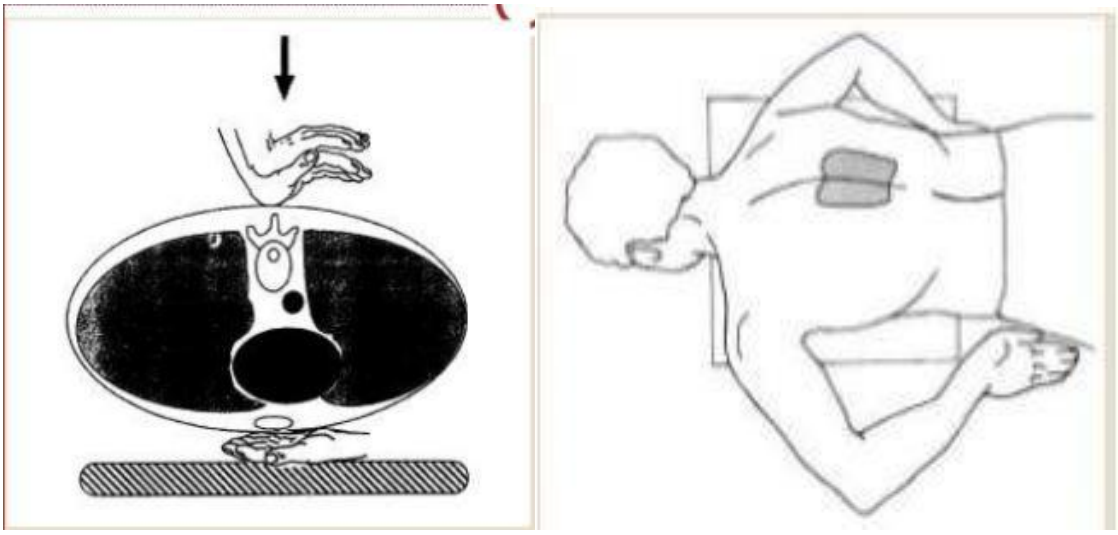
When performing CPR, it is important to secure a high quality CPR in the procedure, defining goals for the rate and depth of compressions, as well as monitoring by recommended monitoring, such as capnography and continuous arterial line (if already in site). It is reported that when the patient is positioned prone, the largest LV cross-sectional area is 0 to 2 vertebral segments below the inferior angle of the scapula in at least 86% of patients[26].Other authors suggest that both hands should be interlocked and placed on the patient's back on the midthoracic spine T7 landmark[27]. Providing sternal counter pressure such as sandbags or 1-litre fluid bags under the patient's chest could improve effectiveness.

Chest compressions can be started by compressing the spine in between the scapulae (shoulder blades). The same compression rate (100-120/min) and depth of compression (5-6 cm) as conventional chest compression should be used. Aim for a diastolic pressure of 25 mmHg on the arterial line. If initial attempts at resuscitation are unsuccessful, or chest compressions are ineffective turn the patient supine to facilitate resuscitation. (Figure 1)[25].

The compressions in the prone position are delivered to the thoracic spine at the same rate and strength as they were delivered during the supine position.

In case of defibrillation, an analogue to the standard apical and right infraclavicular position should be used; however more research data are needed to define the exact amount current to be delivered. The latter is related to the different anatomical structure and distance from skin to heart.

Figure 1. Patient in prone position and the rescuer providing "Reversed Precordial Compressions"[15].



Another difference with "classical" CPR technique is increased chance of pressure injuries due to poor positioning. Special attention should be given for possible eye injuries. An early examination in cases of ROSC and stable patient would be a good strategy for early detection of any problems.

Airway management and ventilation is also challenging. If already intubated, then attention should be paid in any endotracheal tube dislocation. However, in the patient that is not already intubated, then emergency techniques like intubation in prone position could be of help, if applicable.

Finally, if we attempt to be rational and trust the current literature, we need at least 5 health professionals with proper protection equipment during each serious cardiac arrest with COVID-19[25]. The reality of the USA shows us that, in places where many patients suffer concomitant cardiac arrest, there may be perplexity / irrationality when it comes to acting, leading to a delay in initiating CPR manoeuvres and what -according to some- could lead to passive or unintentional dysthanasia.

CONCLUSIONS

Cardiopulmonary resuscitation in a patient with SARS-CoV-2 in prone position is a feasible option that may save lives.Again, immediate initiation of CPR and decrease of no-flow time to minimum, even in the prone position, is the best choice to these patients. Yet, it seems that techniques that in the past are considered as rescue manoeuvres and used only rare in emergencies, are becoming more and more a routine during this pandemic. This fact could change the practice of medicine in the future.

REFERENCES

1. World Health Organization. Coronavirus disease 2019 (COVID-19): situation report, 67. 2020.
2. Pan, C, Chen L, Lu C, et al. Lung Recruitability in SARS-CoV-2 Associated Acute Respiratory Distress Syndrome: A Single-centre, Observational Study. Am J Respir Crit Care Med. 2020.
3. Tang X, Du R, Wang R, et al. Comparison of Hospitalized Patients With ARDS Caused by COVID-19 and H1N1. Chest. 2020: S0012-3692(20)30558-4.
4. Lai CC, Shih TP, Ko WC, et al. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. Int J Antimicrob Agents. 2020;55(3):105924.
5. Divani AA, Andalib S, Di Napoli M, et al. Coronavirus Disease 2019, and Stroke: Clinical Manifestations and Pathophysiological Insights. J Stroke Cerebrovasc Dis. 2020:104941. doi: 10.1016/j.jstrokecerebrovasdis.2020.104941.
6. Möhlenkamp S, Thiele H. Ventilation of COVID-19 patients in intensive care units. Herz. 2020:1–3.
7. Phua J, Weng L, Ling L, et al. Intensive care management of coronavirus disease 2019 (COVID-19): challenges and recommendations. Lancet Respir Med. 2020 doi: 10.1016/S2213-2600(20)30161-2.
8. Alhazzani W, Møller MH, Arabi YM, et al. Surviving sepsis campaign: guidelines on the management of critically ill adults with coronavirus disease 2019 (COVID-19) Intensive Care Med. 2020 doi: 10.1007/s00134-020-06022-5.
9. Gattinoni L, Coppola S, Cressoni M, et al. Covid-19 does not lead to a "typical" acute respiratory distress syndrome. Am J Respir Crit Care Med. 2020 doi: 10.1164/rccm.202003-0817LE.
10. Gattinoni L, Chiumello D, Caironi P, et al. COVID-19 pneumonia: different respiratory treatment for different phenotypes? Intensive Care Med. 2020 doi: 10.1007/s00134-020-06033-2. [
11. Camporota L, Guerin C (2020). How to ventilate in COVID-19. https://esicm-tv.org/webinar1_live_20-how-to-ventilate-in-covid-9.html (ESICM-webinar on April 2nd). Accessed: 12 April 2020.
12. Sun WZ, Huang FY, Kung KL, et al. Successful Cardiopulmonary Resuscitation of Two Patients in the Prone Position Using Reversed Precordial Compression. Anesthesiology 1992 ;77(1):202-204.

13. Miranda CC; NewtonMC .Successful defibrillation in the prone position. Br J Anaesth, 2000;87 (6):937-938.
14. Beltran SL, Mashour GA. Unsuccessful Cardiopulmonary Resuscitation during Neurosurgery: Is the Supine Position Always Optimal? Anesthesiology2008;108(1):163-164.
15. American Heart Association. 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care, Circulation. 2005 Dec 13;112(24 Suppl): IV1-203.
16. International Liaison committee on Resuscitation. Part 2: Adult basic life support. 2005 International Consensus on Cardiopulmonary Resuscitation on emergency Cardiovascular Care Science with Treatment Recommendation. Circulation 2005; 111 (Suppl):206-2011.
17. De Souza Gomes D, Bersot Alves Darcy C. Cardiopulmonary resuscitation in the prone position. Open J Anesth.2012;2(5):199-201.
18. Aslanidis T. Alternative positions for cardiopulmonary resuscitation. Open Sci J Clin Med.2017; 5(4):21-24.
19. Kelleher A, Mackersie A. Cardiac arrest and resuscitation of a 6-month old achondroplastic baby undergoing neurosurgery in the prone position. Anaesthesia. 1995 ;50(4):348-350.
20. Mazer SP, Weisfeldt M, Bai D, et al. Reverse CPR: a pilot study of CPR in the prone position. Resuscitation 2003;57(3):279-85.
21. Wei J, Tung D, Sue SH, et al. Cardiopulmonary resuscitation in prone position: a simplified method for outpatients. J Chin Med Assoc. 2006;69(5):202- 206.
22. Monsieurs KG, Nolan JP, Bossaert LL, et al. European Guidelines for Resuscitation 2015. Resuscitation 2015; 95:1-80.
23. Volchenboum SL, Mayampurath A, Goksu-Gursoy G, et al. Association Between In-Hospital Critical Illness Events and Outcomes in Patients on the Same Ward. Jama. 2016; 316:2674-2675.
24. Virani SS, Alfonso A, Bejamin EJ, et al. Heart disease and stroke statistics-2020 update: a report from the American Heart Association. Circulation 141.9 (2020): e139-e596.
25. UK Resuscitation Council. Resuscitation council UK statements on COVID 19 Coronovirus CPR and resuscitation. 2020. Available from: https://www.resus.org.uk/media/statements/resuscitation-council-uk-statements-on-covid-19-coronavirus-

cpr-and-resuscitation/ (accessed :05/04/2020)

26. Kwon MJ, Kim EH, Song IK, et al. Optimizing Prone Cardiopulmonary Resuscitation: Identifying the Vertebral Level Correlating with the Largest Left Ventricle Cross-Sectional Area via Computed Tomography Scan. AnesthAnalg. 2017;124(2):520-523.
27. Bhatnagar V, Jinjil K, Dwivedi D, et al. Cardiopulmonary Resuscitation: Unusual Techniques for Unusual Situations. J Emerg Trauma Shock. 2018;11(1):31-37.

Key words: SARS-CoV-2, Critical Care, Prone Position, ARDS, Cardiac Arrest, Pandemic

Author Disclosures:

Authors Authors Bersot C.D.A, Pereira J.E.G and Aslanidis Th have no conflicts of interest or financial ties to disclose.

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