Vents, Cardiac Events, and Aerosolized Contaminants: Performing CPR on Vented COVID-19 Patients

Kerolos Abadeer, DO and Christopher Perry, MD
Editor: Alex Flaxman, MD MSE – RowanSOM/Jefferson Health/Virtua-Our Lady of Lourdes Medical Critical Care Fellowship Program

A full year has now passed since COVID-19 first hit the U.S., yet we still face many of the same daunting challenges in caring for those affected who are critically ill. Such challenges encompass not only providing the best care for the patient, but also to ensuring the safety of staff members.

Evidence during the first SARS-CoV epidemic suggested a consistent association between pathogen transmission and what was referred to as "aerosol generating procedures."[1] Such procedures allow air current to move across the surface of a film of liquid (mainly respiratory in source) generating aerosolized contaminants, with the particle size inversely proportional to the velocity (smaller viral particles vs larger bacterial cells).[2,3]

> "COVID-19 has dramatically changed the practice of emergency medicine and critical care in many ways, not just in how we deliver care but also in how we ensure our personal safety during acute resuscitation."

Performing cardiopulmonary resuscitation (CPR) represents one such procedure,[1,4] leading to potentially dangerous exposure for physicians and staff when a COVID-19 patient goes into cardiac arrest. This danger is multiplied by the fact that CPR is often performed by a team of practitioners all in close proximity to the patient and under intense emotional stress. Any means, therefore, of minimizing aerosolization during CPR has the potential to reduce risks to staff members.

In the past, performing CPR on ventilated patients generally involved disconnecting the patient from the ventilator and performing bag-mask-ventilation while chest compressions were being performed. In doing so, appropriate minute ventilation could be ensured without concerns of high-pressure limits or false triggers preventing the ventilator from delivering breaths to the patient. Given the concerns of danger to staff members, however, guidelines published by the American Heart Association have now recommended against this practice for COVID-19 patients, urging practitioners instead to "consider leaving the patient on a mechanical ventilator with a HEPA filter to maintain a closed circuit and to reduce aerosolization."[5]

The efficacy of this approach has been supported in a Brazilian study performed during the pandemic.[6] In this study, minute ventilation, airway peak pressures, and tidal volumes (VT) on three modes [volume control (VCV), pressure control (PCV) and pressure-regulated volume control (PRVC)] were evaluated using an intubated and mechanically ventilated CPR manikin. Ventilators were set to mimic recommended parameters for bag valve mask ventilation during CPR: PEEP of zero, respiratory rate of 10 breaths/min, FiO2 100%, and an inspiratory time of one second. During VCV and PRVC modes VT was set to 600 mL, while the PCV mode targeted inspiratory pressure was set to 16 cm H2O (adjusted to achieve 600 mL VT prior to compressions). Importantly, trigger thresholds were set to their least sensitive value (-20 cm H2O) to prevent false triggering and the peak pressure alarm was set to the maximum possible value (120 cm H2O) to maintain VT.

Despite increased peak airway pressures in all three modes and a small reduction in VT in the pressure limited modes, none of the ventilation modes resulted in clinically prohibitive pressures and all delivered volumes acceptable by current standards. The data indicated that maintenance of mechanical ventilation during CPR can be done safely while still delivering appropriate minute ventilation to the patient. Recommended settings appear in table.[1]

Table 1: Recommended ventilation settings during cardiopulmonary resuscitation

Trigger Pressure	-20cm H_2O	*(Least sensible value)*
Peak Pressure alarm	120cm H_2O	*(Max possible value)*
PEEP	0 cm H_2O	*Ventilation settings set to mimic recommended parameters for bag-valve-mask ventilation during CPR*
RR	10 breaths/min	
FiO_2	1.0	
Inspiratory time per cycle	1s	
VCV & PRVC modes	TV = 600mL	
PCV mode	Inspiratory Pressure = 16cm H_2O *(Targeted to achieve TV = 600mL)*	

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COVID-19 has dramatically changed the practice of emergency medicine and critical care in many ways, not just in how we deliver care but also in how we ensure our personal safety during acute resuscitation. Maintaining an intubated patient on the ventilator while performing CPR is one such way in which we have the potential to minimize exposure to aerosolized virus while still ensuring the best possible care for our critically-ill COVID-19 patients. ●

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