

Hypotheses & Ideas

Introducing a Method for Safe Air Evacuation from Oxygenator in Cardiac Surgery Operating Rooms during COVID-19 Pandemic

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Abstract

Covid-19 pandemic provides new perspectives and possibly permanent changes in some existing guidelines and safety principles. Evacuated air from the exhaust reservoir and oxygenator, after close contact with the patient's blood added contaminated secretions, drain into the operating room, a potential source for contamination. There are two air exhaust ways from the oxygenator in cardiopulmonary bypass (CPB) circuit; which might be the potential carrier of the Covid-19 virus and resulting contamination. In the current design, these two exhausts are connected to one antibacterial and antiviral filter and then they will attach to the ventilator's exhaust port with a three-way connector, in such a way that the contaminated air will be vented outside the operating room. It is recommended to use antibacterial and antiviral filters in the passage way of the contaminated air coming from Reservoir and Oxygenator exhaust, to be directly guided outside the operating room. In this article, this design is fully described.

Keywords: Covid-19, Cardiac surgery, Personal protection, Cardio pulmonary bypass

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Introduction

The World Health Organization called Corona virus disease 2019 (Covid-19) a pandemic which can cause severe acute respiratory syndrome corona virus (SARS-CoV-2). Undoubtedly, the effects of the recent Covid-19 pandemic on the world will provide a new perspective on some issues and possibly permanent

changes in some existing approaches (1, 2). Some changes in guidelines may be applied forever as eradication of Covid-19 will not happen soon (2, 3). Although the cardiac surgery team may not be on the front line in this pandemic, they need to intervene in some situations if necessary. Elective cardiac surgeries are best postponed until all aspects of the patient's condition have been assessed, but Emergency and

Urgent surgeries must be performed with safety precautions in mind (2). As these surgeries will also put the operating room staff at risk, staff must be protected by applying some approaches. One of the considerations is with suspect Covid-19 cases. It is approved that patient's blood carries Covid 19 (4, 5) and it can contaminate the oxygenator air when Cardiopulmonary Bypass (CPB) machine is connected to the patient during cardiac surgery. Although, there is not enough studies done to show the degree of transmission through the blood, it is recommended to consider and follow safety precautions for potential contaminants until definitive results are obtained. In cardiac surgery and during CPB, the blood returns to the oxygenator. The air

inside the oxygenator is evacuated through two outlets, Reservoir Exhaust (RE) and Oxygenator Exhaust (OE). The air leaves both the RE and OE can potentially transmit Covid 19 and contaminates the operating room environment and staff specially perfusionists. Patient's blood and secretions enter the reservoir from the operation field and are in contact with the air without any barrier. The air can escape through the RE outlet and enters the operating room environment. Patient's blood that enters the oxygenator is also in contact with the air through millions of Hallow Fibres in order to be oxygenated and its Carbon Dioxide and waste products can be removed. Then, the oxygenated blood will be returned to the patient's body, and the air enters the room

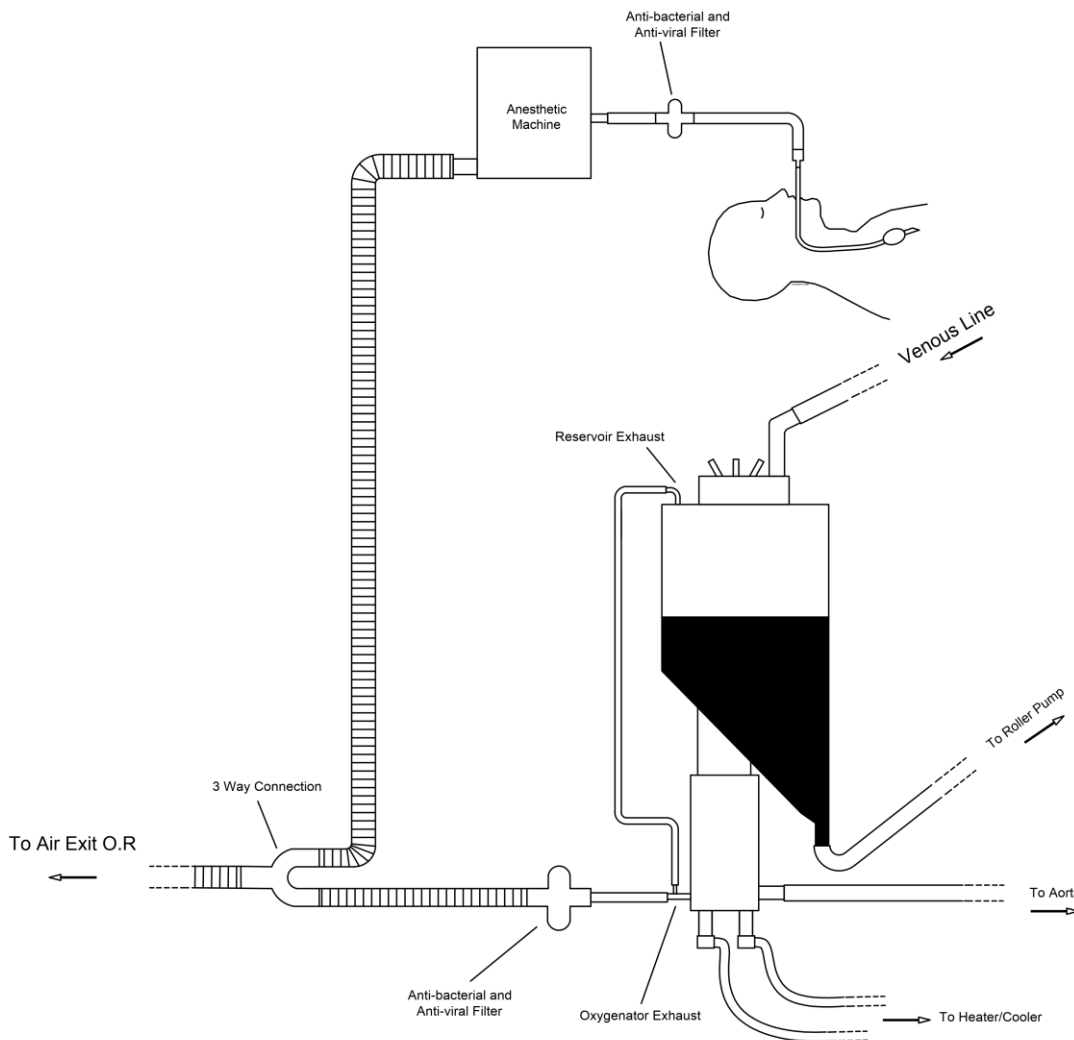


Figure 1. This Schematic diagram shows air safety measures in RE and OE of the Cardio Pulmonary bypass oxygenator.

through the OE. Although theoretically the blood is not in contact with the air inside the oxygenator, practically it is possible for the virus to escape from the patient's blood and enter into the air, depending on the size of the pores, the size of the corona virus and the type of oxygenator. There are also millions of fibres' and elements that blood is able to pass through them. There is a possibility of fibre's damage, which can cause air contamination (Technical defect such as rupture or Leakage), however there is not enough studies available to support this.

To prevent corona virus from entering to the operating room environment, simple steps can be followed (Figure 1). RE and OE outlets would be surrounded by tubes (1/4 inch tube and 3/8 -1/2 inch tube, respectively) and through a three-way connector connect with an Antibacterial Filter which is used in anaesthetic machine. Then join them to the ventilator outlet or the wall suction with regulator through a three-way connector in order to vent the air inside the tube to the outside of the operating room.

The current hypothesis was approved by Institutional Ethics Committee, coded IR.SBMU.RETECH.REC.1399.676, Research Deputy, SBMU, Tehran, Iran.

Discussion

One question is whether the Covid-19 virus can be seen in patients' blood sample or not. Based on the limited studies, the Covid-19 virus has been isolated from patients' blood samples, and this scenario is possible (6, 7). The pore size in Oxygenator's micro pores membranes is 200 Nano meters (8), while the size of the virus is about 140-60 Nano Meters (9). Therefore, theoretically, there is a risk that the virus will pass through the Gas Exchange Membrane. In other words, the virus in the patient's blood can pass through the Gas Fiber and the oxygenator's gas outlet and contaminate the room air.

Findings from the Fragmeni et al (10) study on ECMO Membranes showed that pore size has a different distribution in different parts of the oxygenator (ECMO membranes have better quality and are more expensive than cardiopulmonary bypass

oxygenators). The microscopic images showed that even in an oxygenator, the Hollow Fibers do not have a uniform arrangement, and four different types of Hollow Fibers positions were shown in the studies. The pore sizes are different at the end of surgery, too and they depend on the various factors, such as endogenous factors (e.g lipoproteins or Levels of cholesterol) or exogenous factors (e.g. alcohol or drugs). The Surface Active Specimen factors in the patient's blood also affect membrane hydrophobic character. Therefore, in addition to the initial size of the pores, other factors are also involved (10, 11). Besides Pore Size, plasma leakage is also effective in transmitting the virus to oxygenators. Plasma leakage is also known as Membrane Wetting, Plasma Break Through (10). If plasma leakage occurs in the oxygenator membranes; the virus can cross the oxygenator's Micro Porous Membrane and enters the Gas Side. In theory, plasma leak occurs after 6 hours usage of a conventional oxygenator (8). All the blood returned from the patient and the contents of the suction which are blood and secretions from the operating field enter the reservoir and the adjacent air leaves the RE without any barrier. Corona Virus can be detached from the patient's blood and spread through the gas outlet in the environment. Theoretically, the oxygenator outlet can also contaminate the operating room air. Although there has been no report of air contamination from RE and OE, no study has been conducted, as well. In order to solve this problem, Oxygenator gas outlet can be connected to the operating room air outlet as described above. The operating room airflow (Air Exit Operating Room) must have a proper suction. The suction flow should be greater than Feeding Flow Gas, but should not cause negative pressure on the gas side (8). The staff protection is not new, but when we encounter with a new disease, protocols and guidelines need to be reviewed and permanent changes may be created.

Conclusion

It is recommended that all the exhausted air, which is in contact with the patient's blood, and secretions (including RE and OE air, the patient's exhaled air through the tracheal tube and from the

operating room's suction) are equipped with antibacterial and antiviral filters and attach to the operating room air outlet (Air Exit).

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

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