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Challenges of Life Support/Medical Support for Human Missions (8)
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OPTIMIZATION OF VENTILATION AND CHEST COMPRESSION FOR SPACESUIT DESIGN

Abstract

Innovation in spacesuit design over the recent years have focused on enhancing mobility, operational performance and safety. Little research has focused on technology to improve ventilation or chest compressions for astronauts in the case of medical emergencies requiring CPR. We propose a modification to the conventional design to incorporate components which facilitate ventilation and chest compression for resuscitative interventions. Ventilation is of utmost importance when considering CPR. Normally, it is possible to observe the recovery provided adequate ventilation is supplied, even without delivering chest compressions intermittently. We propose the installation of mask ventilator based on a similar design to modern snorkels. This tubing can be connected to a ventilator, which can alter between positive pressure ventilation (PPV) and continuous positive airway pressure (CPAP). Moreover, the mask ends of ventilator devices can be individually customized to 3D print facial features of the astronauts. Not only would this allow ease of positioning for the unconscious astronaut, it would maximize efficiency of ventilation preventing loss of air within the spacesuit by optimized sealing. For this procedure, a reserve amount of air should be made available for CPAP during CPR either in a separate compartment or drawn from the PLSS.

In order to establish simultaneous chest compression with ventilation, it is necessary to consider resources, personnel availability, and compression technique. Under standard conditions, chest compressions are delivered using a 3:1 protocol where 3 chest compressions are provided per one breath or ventilation. The conventional design for spacesuits are akin to inflatable balloons and require the conservation of a higher internal pressure within the suit than the environment. As a result there is a lower feasibility of performing manual chest compressions in space. With compartmentalized units within the spacesuit dedicated for pressure regulation, it may be possible to administer chest compressions by de-pressurizing the space between the astronaut and the spacesuit to not only bring back heart rhythm but also aid with breathing. Particularly, by de-pressurizing space in the diaphragmatic area and pressurizing compartments near the respiratory orifices, it may be possible to reverse conditions resulting in asphyxia. With the limitation that manual chest compressions are more difficult without an adequate amount of force and pressure generation during compressions, another option may be to deliver chest compressions by connecting the spacesuit to an automated chest compression system, which can be controlled by supporting personnel.