Cureus

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Poster

An Alternative Membrane to Improve Extracorporeal Gas Exchange and Biocompatibility

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Categories: Healthcare Technology
Keywords:

How to cite this poster
Lavelle M (2012) An Alternative Membrane to Improve Extracorporeal Gas Exchange and Biocompatibility. Cureus 4(10): e353.

Abstract

Purpose: Extracorporeal Membrane Oxygenation (ECMO) is used to support patients suffering from severe respiratory or cardiopulmonary failure, but current systems require significant improvements to match the efficiency and biocompatibility of the lung. The gas exchange membrane is a major limitation of this system, which can potentially be improved with new materials. Methods: Poly(ethylene glycol) diacrylate (PEGDA) is a highly biocompatible and customizable hydrogel which can function as an alternative gas exchange membrane. A 20% PEGDA hydrogel was assessed as a gas exchange material by perfusing deoxygenated saline through a thin walled PEGDA tube, surrounded by oxygen gas. Oxygen transfer was measured with a PreSens Oxygen Microsensor. Hemocompatibility was assessed by incubating 5 x 10^6 calcein AM stained platelets with PEGDA membranes, as well as the currently used poly(4-methyl-1-pentene) (PMP) membranes. Adhered platelets were quantified through fluorescent microscopy, and the membranes were statistically compared. Results: In as little as 25 min, the PEGDA tube continuous flow system was capable of attaining half the maximal solubility of oxygen in saline. Using Fick's law, the diffusivity coefficient of oxygen through the membrane was determined to be 1.68 x 10^-5 cm^2/s, very near the diffusion rates of oxygen through water. A Mann-Whitney U test revealed a significant difference (p= 1x10^-4) in platelet adhesion between the PMP and PEGDA membranes. This significant reduction in platelet attachment suggests PEGDA offers improved hemocompatibility over the current PMP membranes. Conclusion: We believe the oxygen saturation level and oxygen diffusivity coefficient reached by this exchange membrane demonstrates its capability of meeting respiratory demands. In addition, the significant reduction in platelet adhesion from current PMP membranes will alleviate many of the current thrombogenic complications of ECMO. The pliable nature of PEGDA also allows for the fabrication of small microfluidic exchange networks, which maintain these enhanced gas transfer and hemocompatible properties at a much smaller size. We plan to work toward scaling these networks to meet physiological demands, providing a foundation for a long-term implantable system or destination therapy.

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Published 10/10/2012

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