

# THE ARTIFICAL PLACENTA: DEVELOPMENT OF A LUNG AND KIDNEY ASSIST DEVICE FOR CRITICALLY ILL PRETERM NEONATES

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## Introduction

Neonatal mortality declined worldwide in recent years, yet preterm birth is still the leading cause of death among newborns [1]. Many of these cases are caused by immaturity of the lungs, sometimes compounded by kidney failure [2,3].

Currently available therapies including mechanical ventilation, extracorporeal membrane oxygenation (ECMO), and continuous renal replacement therapy (CRRT) do not fully address the needs of extremely preterm infants (>24 weeks gestational age). These technologies are highly invasive, associated with lifelong disability, and require multiple human-machine interfaces that limit family integration [4,5].

The ArtPlac project aims to develop a combined lung-kidney assist device to prevent lifelong disability through a less invasive, infant- and family-centered approach. This abstract describes an initial ArtPlac design.

## Methods

User requirements were defined based on stakeholder analysis and translated into design requirements. Initial concepts for the blood inlet/outlet geometry and device housing were generated and converted into 3D designs.

## Results

The device should be connected through the umbilical vessels, eliminating additional vascular access to the neonate. Furthermore, the system should be pumpless and driven solely by the neonate's heart to minimize the risk of hemolysis. To handle three fluids (blood, gas, dialysate), the fiber bundle is designed in a hexagonal shape with a 60° angle between respective layers of oxygenation and dialysis hollow fiber mats (figure 1). To avoid dead water areas in the fiber bundle, potting will be performed in a round fashion in a single production step.

## Discussion

Incorporating user requirements, a novel hexagonal membrane design combines oxygenation and dialysis in one housing (figure 2). Upcoming design challenges are

to minimize pressure drop and to limit hemodilution by keeping the priming volume as low as possible. With ArtPlac, we envision a revolutionary treatment approach to improve survival and quality of life in neonatal intensive care.

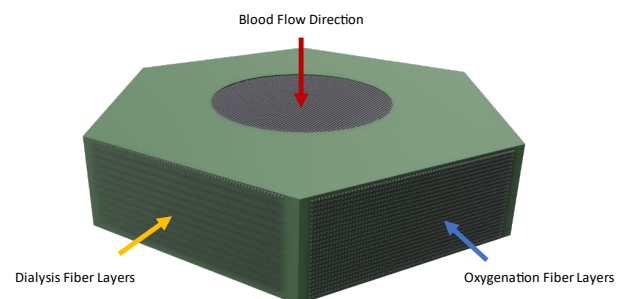


Figure 1: 3D render illustrating the configuration of oxygenation and dialysis hollow fiber mats encapsulated in potting material for phase separation of fluids and gas forming a hexagonal membrane bundle design.

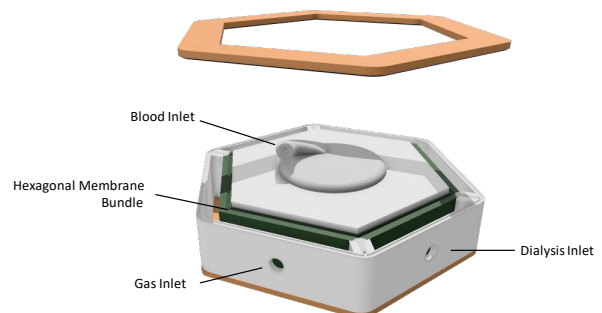


Figure 2: Initial concept design of the combined lung and kidney assist device.

## References

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