I. Introduction

Without hemodialysis (HD), water and waste quickly build up in a renal patient’s bloodstream. HD is typically performed 3 times a week for 3-5 hours per session and consumes large amounts of power and water. Emergencies put strain on an already difficult schedule. There may be a struggle to provide the resources and locations necessary for dialysis treatments in these situations.

Our solution to this problem is a mobile, self-sufficient, hemodialysis kit. It requires a battery capable of storing power for multiple dialysis sessions, a water purifying home-dialysis unit, and a vehicle to transport everything. The battery charges off the alternator of a vehicle when electricity is unavailable. Tap water can be purified and turned into dialysate via NxStage PureFlow SL. If tap water is unavailable, the water filtration unit can purify river water to tap water standards. The unit will become the NxStage System One home-dialysis unit, and a vehicle is driving between locations necessary for dialysis treatments in these situations.

Figure 2. Design of final water filtration system

II. Methods

The design of this mobile dialysis system was decided through the use of design matrices. These design matrices were backed by research and experiments in the power systems and type of vehicle, as well as the overall design (Table 1). The water treatment system was finalized through a system of experiments testing the viability of the design to ensure adequate quality of water.

Table 1. Example of one design matrix, for water filtration unit

<table>
<thead>
<tr>
<th>Sediments</th>
<th>Anti-Microbial Properties</th>
<th>Heavy Metal/Contaminant Concentration</th>
<th>Cost</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

III. Results

**Power**

An ambulance-type battery was chosen for the power source, as opposed to a gas generator or solar panels. A battery won’t be reliant on sunny weather or extra gasoline and can be recharged by the alternator while the vehicle is driving between locations.

**Water System**

Our water tests show that the “P&G Purifier of Water” flocculant, followed by a Brita carbon filter (WHF-104), is capable of cleaning river water to a level within NxStage PureFlow SL’s allowances.

**Vehicle**

Instead of choosing a specialized vehicle (military Humvee, ambulance, all-terrain truck), we selected a basic windowless van. They’re widely available, fully enclosed, spacious, and are reasonably fuel-efficient compared to the other options considered.

IV. Conclusions and Future State

In an emergency situation, necessary resources often either need to be packed-in or modified from existing resources. In order to provide the resources for life-saving hemodialysis to renal patients, a mobile dialysis unit was designed that takes into account clean water shortages, energy limitations, and servicing multiple patients at once. To allow for use in all circumstances, an ambulance battery that can be powered from the vehicle’s alternator was chosen. “P&G Purifier of Water” flocculant and a Brita carbon filter (WHF-104) were chosen in order to take any available water to a clean enough state that the NxStage PureFlow SL Dialysis machine can make it into dialysate. Finally, a basic windowless van was found to have sufficient space for all the equipment and is widely available.

V. References


VI. Acknowledgements

Special thanks to Craig Kamerath, Senior Scientist Interface Leader of Fresenius Medical Care; Kami McNeil, Graduate Program Coordinator for the USU Department of Biological Engineering; Dr. Ronald Sims, Course Instructor for the USU Department of Biological Engineering; Cass Long of the USU Interior Design Program; Dr. Foster Agblevor, Faculty Advisor for the USU Department of Biological Engineering.