Wearable Artificial Kidney

Juan Malvar
Biomedical Engineering
University of Rhode Island
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CKD AND ESKD

- CKD (Chronic Kidney Disease) - presence of kidney damage
- ESKD (End-Stage Kidney Disease) - critical stage of renal failure and irreversible
- ESKD patients will require continuous dialysis until they receive a transplant
- 3.3% increase of CKD and 3.7% increase of ESKD patients (data collected in 2012 and 2013 by USRDS and ANZDATA)
- Accumulation of solutes for ESKD patients will result to high blood pressure
Hemodialysis

- Blood circulated into external filter called a dialyzer
- Dialyzer contains a semipermeable membrane
- Sorbent unit contains electrolyte called dialysate which flows the opposite direction of blood
- Counter flow helps with maximization of concentration gradient of solutions between blood and dialysate

https://kidneyfailureweb.files.wordpress.com/2013/11/what-is-hemodialysis.jpeg
ESKD patients require constant hemodialysis treatment until they receive a kidney donor.

Typically done three times a week and require 120L of dialysate per treatment.

Patients are tethered to a machine for up to 4 hours of no movement.

Dr. Victor Gura designed the WAK, which miniaturized hemodialysis machines into a belt.
Design

- WAK (Wearable Artificial Kidney) is powered by a 3-watt Faulhaber DC motor
- Allows a mechanism to use two metal arms that alternately compress two elastic chambers
- Two chambers allows for alternating pulsatile flow of both blood and dialysate
- Battery life is approximately 3 days

Experimented for:

- effectiveness of pumps
- the clearance of solutes
- the effect of dialysate flow and its pH level
Effectiveness of WAK Pumps

## Clearance of Solutes

**Conventional Pump**

<table>
<thead>
<tr>
<th>Q&lt;sub&gt;b&lt;/sub&gt;</th>
<th>Q&lt;sub&gt;d&lt;/sub&gt;</th>
<th>K&lt;sub&gt;urea&lt;/sub&gt;</th>
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<th>K&lt;sub&gt;crea&lt;/sub&gt;</th>
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<tr>
<td>22</td>
<td>28</td>
<td>17.9 ± 4.7</td>
<td>15.1 ± 4.7</td>
<td>17.3 ± 2.1</td>
<td>15.6 ± 0.1</td>
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<td>40</td>
<td>22.5 ± 1.6</td>
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<td>45</td>
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<td>43.5 ± 2.8</td>
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<td>92</td>
<td>70</td>
<td>52.7 ± 6.4</td>
<td>47.0 ± 1.8</td>
<td>49.7 ± 2.9</td>
<td>37.8 ± 6.8</td>
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<tr>
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<td>95</td>
<td>56.0 ± 1.6</td>
<td>50.5 ± 1.9</td>
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<td>44.0 ± 4.1</td>
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<tr>
<td>110</td>
<td>139</td>
<td>63.3 ± 6.8</td>
<td>58.6 ± 4.4</td>
<td>75.1 ± 9.9</td>
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Effectiveness of Dialysate pH

Results and Plans

- The Dr. Gura and colleague’s WAK is designed to have dialysate to be reused
- It is designed to be worn for 24 hours 7 days a week
- WAK prevents ESKD patients to travel long distances to go to hospitals for hemodialysis treatment, may also reduce the cost for having dialysis treatment
- Increased mobility for ESKD patients
- In the middle of clinical safety trials by the FDA
ANY QUESTIONS?
References


