A Peritoneal-Based Automated Wearable Artificial Kidney (AWAK)

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Disclosure

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Why a Continuous Wearable Artificial Kidney

Provides *continuous* dialysis
  – Steady-state physiologic
    and metabolic control
  – Higher clearance of solutes

Patient freedom from need to:
  – For HD go to dialysis unit 3 days a week for 3-4 hrs
  – For CAPD take 30 min every 4 hrs to drain and infuse PD solution
  – For APD set up cycler every night and clean up in the morning
Continuous Wearable Artificial Kidney

- Extracorporeal
  - Hemofiltration
  - Hemodialysis
- Peritoneal Dialysis
  - CAPD
  - APD
Continuous Wearable Artificial Kidney

(Continuous use more than 16 hr/ day)

- Hemofiltration
  - Neff
  - Murisasco
Neff Wearable Artificial Glomerulus*

Murisasco Continuous AV HF*

Disadvantages of Extracorporeal Wearable Kidneys

- Coagulation even with anticoagulant
- Need for anticoagulation
- Internal hemorrhage
- Accidental disconnects resulting in fatal bleeding
- Interaction between blood and plastics
- Deposition of protein on membranes
- Extracorporeal wearables failed
Continuous Wearable Artificial Kidney

(Continuous use more than 16 hr/day)

- Peritoneal Dialysis
  - Popovich
Portable/Wearable Equilibrium Dialysis Technique* (now CAPD)

Disadvantages of CAPD

- Minimum Dialysis
- Patient Fatigue
- Peritonitis
- Exit-Site Infection
- Hernias
- Ultrafiltration Failure
- Peritoneal Membrane Sclerosis
Why Peritoneal Based?

- “Bloodless”
- “Waterless”: regenerate used dialysate
- Regenerate & recycle proteins
  - No protein loss
  - Removes protein-bound toxins
Flow diagram of the Sorbsystem (Redy) regenerating peritoneal dialysis system 1974
Sorbent PD
Automated Wearable Artificial Kidney (AWAK)

Continuous Flow

Enrichment Module
For dialysate reconstitution

Sorbent Cartridge
For continuous dialysate regeneration

Ammonia sensing, &
De-gassing assemblies

Double Lumen or 2 catheters

Patient’s Peritoneal Cavity
AWAK: Basic Components:

- **Sorbent Cartridge**: For continuous dialysate regeneration
- **Enrichment Module**: For dialysate reconstitution
- **Ammonia sensing & De-gassing assembly**
- **Storage Module**
- **Tidal Flow**
- **Single Lumen Catheter**

*Patient’s Peritoneal Cavity*
Baxter HomeChoice PD Machine

- Average flow 4 L/hr
- Zero dwell
- Zero UF
- 5 hr of dialysis
- Dialysate – 1.5% Dianeal neutralized with sodium bicarbonate
<table>
<thead>
<tr>
<th>Reserve Volume (ml)</th>
<th>Tidal Volume (ml)</th>
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<tbody>
<tr>
<td>Desired (Actual)</td>
<td>Desired (Actual)</td>
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<tr>
<td>250 (250)</td>
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<tr>
<td>250 (262)</td>
<td>500 (488)</td>
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<td>1000 (975)</td>
<td>500 (525)</td>
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At a flow rate of 4 L/hr and dialysate glucose of 1.31%, extrapolated results indicate:

1. Adequate daily UF even in average high transporters (1.8-2.3 L/24 hr)
2. High weekly Kt/V even in average low transporters (3.4-5.9)
AWAK Flow Diagram

Disposible

Non-Disposible

Enrichment Module

Gas Remove

Sorbent Cartridge

Storage Module

Pinch Valve

During Ultrafiltration

UF Module

Connector

EM Pump

Ammonia Detector

Pump

Two-way Connector

Peritoneal Cavity
Automated Wearable Artificial Kidney
AWAK

2 lbs/1Kg Prototype (Development)

6 lbs/3Kg Prototype (Functional)
Advantages of Protein Regeneration & Recycling

- Prevents endogenous protein-loss
- Oncotic pressure reduces glucose requirement for ultrafiltration
- Removes protein-bound (middle molecule?) toxins
- Selective protein plasmapheresis