Accessible Infusion Pump User-Interface

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Rehabilitation Education Research Center on Accessible Medical Instrumentation

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Background

- For patients with physical limitations, infusion pumps can be difficult to operate correctly.

- Disabilities increase the risk of patient error in device operation.

- At least one patient from our client list suffers from some form of a vision problem, a hearing impairment or an ailment that restricts motor function.
  - Carpal tunnel syndrome
  - Parkinson’s disease
  - Arthritis
  - Partial paralysis.
Purpose of the Project

- With current infusion pumps there is not appropriate feedback to the input controls of the unit. This gives an opportunity for erroneous entries without any warning.

- To encourage widespread use for all patients, a simple method of operation and short learning curve should be implemented.

- The buttons must be large enough to accommodate an unsteady hand while also being easily triggered with slight pressure.

- Warnings from the interface will need to be communicated through both auditory and visual cues in order to encompass the wide variety of the patients’ disabilities.

- A small interface would ensure portability and patient privacy.
Previous Work Done by Others

- A research team from the University of Texas Health Science Center at Houston studied and prototyped an interface for an infusion pump. They accomplished this through the usability Engineering Lifecycle to develop ideas and create solutions to design errors.

- A group from Chalmers University of Technology Department of Human Factors Engineering in Göteborg, Sweden also researched infusion pump interfacing. To create a baseline, they used the facilities current infusion pumps and problems were recorded via video-recording, think-aloud protocols, and surveys. No prototype was created but the information was passed to the clinicians and developers to produce a better product and avoid misuse.

- Doctors and researchers from Columbia University’s College of Physicians and Surgeons along with members from the University of Texas Health Science Center also did clinical research on infusion pump interfacing. This was accomplished by assigning ratings to problems and creating a catastrophic error group. However, no prototype was created but the information was given to the infusion pump field and market.
Products

- Abbott – Aim Plus, Lifecare 5000 Plum and Plum XL - [www.abbott.com](http://www.abbott.com)

- Baxter – Colleague - [www.baxter.com](http://www.baxter.com)

- B Braun – Outlook Safety Infusion Systems - [www.bbraunusa.com](http://www.bbraunusa.com)
Products (Cont.)

- Cardinal Health – Alaris®, Alaris® SE pump, MedSystem III® - www.cardinalhealth.com/alaris/

- Curlin Medical – PainSmart, 4000 CMS, 4000 Plus, and 2000 Plus - www.curlinmedical.com

- Sigma International – 8000 and 6000 series pumps - www.sigmapumps.com
Describes the infusion pump as a complete unit including the main body with interface.

Medrad, Inc. generic medical device interface design patent.
Patent Research (Complimentary)

- 5,664,270 - Patient interface system - September 9, 1997 - Bell, et al.
  Patent for interfacing a multitude of medical devices into one remote controller for ease of use and independence.

  This patent allows the infusion pump to be loaded with a library of drugs which could be selected from or added to by the user.

  This patent describes the need for a more-readily usable interface for electronics devices but it could be implemented for a medical device.
Objectives

- Design a portable, steadfast, low-cost user interface to allow easy operation of a medical infusion pump

  - Reduce input errors
    1. Auditory Output
    2. Distinguishable Confirmation Buttons
    3. Visual Display

  - Increase Independence
    1. Simple Operation with Short Learning Curve
    2. Small and Portable with Infusion Pump
    3. Promote Privacy

  - Cost-Effective
    1. Budget < $2,000

INNOVATION
Methods

- Primary Requirements of the Interface
  - Increase Accessibility
  - Maintain Patient Safety
Increasing Accessibility

- Ensure accessibility be enhancing infusion pumps:
  - Visually
  - Auditorially
  - Tactilely
Visual Enhancement

- Bright High-Contrast Screen
- Large Characters
- Aesthetic Appeal
- Limitations
  - Battery Considerations
  - Size and Weight Considerations
Auditory Enhancement

- Ideally Use Voice Software
- Independent Auditory Control

Limitations:
- Speaker Size
- Power Concerns
Tactile Enhancement

- Large Distinct Buttons
- Trigger Pressure Tuning
- Intuitive Integration with SW Structure
- Minimal Number

Possible Button Layouts
Other Accessibility Issues

- Battery Power
- Size and Weight
- Mounting
- Maintenance
Promoting Patient Safety

- Review and Confirm Inputs
- Investigate Barcode Systems
- Saving Dosing Schedules
Promoting Patient Safety

- Alarms and Warnings
  - Conveying Pump Warnings
  - Low-Battery Warning
Other Considerations

- Physical Interface with Pump
- Universal Compatibility
Budget

- Budget currently under rough estimation
  - No excessive work done on Design Project
  - Final Budget established near optimal design
  - WILL be below $2,000
- Market/Industrial Influence
  - Quick and Steadfast Implication
  - More Reliable Product
  - Higher Credibility
## Budget Estimation

<table>
<thead>
<tr>
<th>Item</th>
<th>Retail Value in Market</th>
<th>Estimated Buying Price for Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Infusion Pump</td>
<td>$1000 - $5,500</td>
<td>$0</td>
</tr>
<tr>
<td>LCD Display Interface</td>
<td>$100 - $1000</td>
<td>$200 - $400</td>
</tr>
<tr>
<td>Voice Hardware</td>
<td>$20 - $400</td>
<td>$100</td>
</tr>
<tr>
<td>Software Components</td>
<td>$200 - $800</td>
<td>$100 - $300</td>
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<tr>
<td>Electrical Components</td>
<td>$200 - $600</td>
<td>$100 - $400</td>
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<tr>
<td>Miscellaneous</td>
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<td>$100 - $200</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$1620 - $8500</strong></td>
<td><strong>$600 - $1400</strong></td>
</tr>
</tbody>
</table>
Project Highlights

- Project Uniqueness
  - Reduce Calculation Errors
    - Visual Display
    - Distinguishable Tactile Cues
    - Auditory Output
  - Navigation Ease with Reduced Learning Curve
  - Cost-effective Device for Biomedical Corporations
  - Increasing Company Credibility
  - Satisfied/Healthier Patients