# Monitoring Continuous Bladder Irrigation (CBI)

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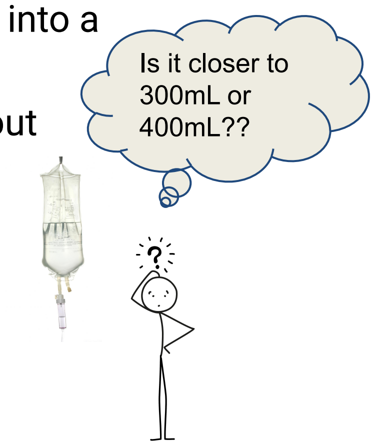
## Background and Design Problem

What is Continuous Bladder Irrigation (CBI)?

- Saline from IV bag enters bladder through a catheter
- Rinses urine and blood into output bag
- Used for patients with trauma or surgery on the bladder and surrounding areas

What's the Problem?

- During the CBI process, there is a lack of a medical instrument to quickly and concisely measure:
  - The volume of IV fluid flowing into a patient
  - The volume of fluids flowing out of a patient
- Current method involves either:
  - Waiting until the bag is empty
  - Estimating volumes based on 100mL increments




## Motivation and Goal

Why is a solution important?

- Fluctuations in these measurements are the first indications of complications including:
  - Renal failure
  - Blood clots
  - Post-op bleeding
  - Hematuria

**Our goal is to engineer a solution that more efficiently and accurately measures input and output volumes during CBI.**

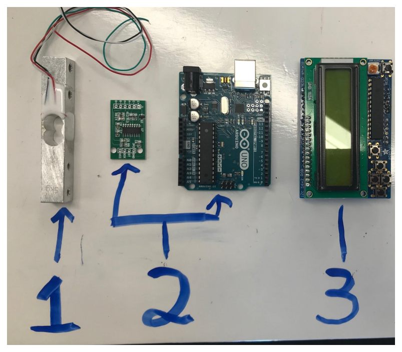
## Overview of the System

Our final design attaches to a standard IV pole to measure, store, and display changes in volume in both the IV bag and urine output bag.

Components include:

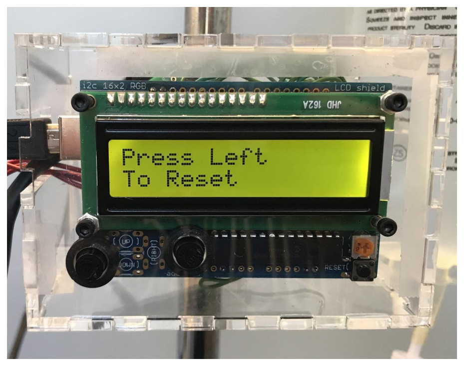
- Electronic **load cell** to measure changes in mass of IV bag
- **IV bag**
- **Microcontroller** with **load cell amplifiers** to make calculations
- **LCD Display shield** to display results
- Laser-cut **acrylic box** to house components
- Electronic **load cell** to measure changes in mass of urine output bag
- Urine **output bag**

A closer look at important components

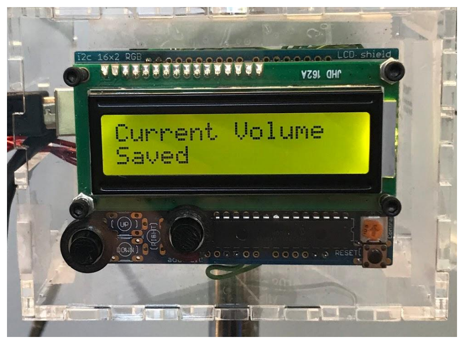



1. **Load cell**: Outputs electrical signals proportional to force
2. Load cell **amplifier** and **Arduino**: Receives signals from load cell and interprets
3. **LCD shield**: Device interface containing display and buttons

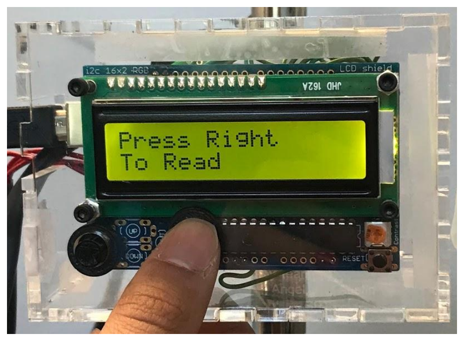
## Operation of the Device



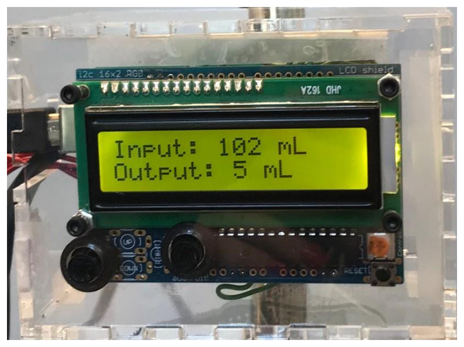

Nurse hangs IV bag and output bag and presses "reset" button




Microcontroller saves the current mass of each bag




CBI process occurs and nurse presses "read" button




Microcontroller checks current masses and outputs the differences since the last reading on LCD screen

## Design Criteria

| | Design Criteria | Target Value |
|---|---|---|
| Constraints | Accuracy | Accurate within 50 mL over 24 hours (2 mL per hour) |
| | Safety | No harm to patient or nurse; No interference with other equipment (physical and signal) |
| | Materials | No latex; Sterile if closed system is broken |
| Objectives | Size | Device dimensions ≤ 1 ½ ft per edge |
| | Ease of Use | Average of ≥ 4 on User Defined Scale |
| | Durability | Device lifetime ≥ 5 years |
| | Cost | Production cost < $50 per unit |

## Testing

Several tests were completed at the School of Nursing to ensure the device met our design criteria.

- Accuracy: Measurements compared to known volumes
- Size: Dimensions measured with ruler
- Durability: Simulated CBI process over time

Results of Accuracy Testing

| Location | Target Vol. (mL) | n | % Error |
|---|---|---|---|
| Input | ~30 | 6 | 2.78 |
| | ~60 | 1 | 3.33 |
| | ~100 | 1 | 1.00 |
| | ~120 | 2 | 4.17 |
| Output | ~60 | 3 | 2.22 |
| | ~120 | 2 | 0.83 |

## Future Work

What's Next?

- Continue testing final prototype
  - Ease of use surveys and long term durability
- Improve fidelity of parts
- Replicate for multiple usages
- Make this device "universal" so it can be integrated in other departments throughout the medical facility.

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