

# T12 Semi-Automatic Irrigation System for Bladder Augmentation Post-Operative Management



Kayla Guevara, Meher Mehta, Rithi Joghee  
Advisor: Dr. Kenneth Barbee



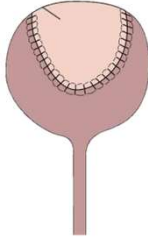
Scan Me!

## Need

**Augmentation cystoplasty (AC)** enlarges the bladder using intestinal tissue, which produces mucus.

Documented low adherence to lifelong, daily bladder irrigation leads to complications: [1][2]

<b>30%</b> Additional Surgeries	<b>3-40%</b> Bladder Stones
<b>13%</b> Graft Perforation	<b>25%</b> Mortality Rate



### Objective:

Create a **semi-automatic, user-friendly** bladder irrigation system that can **effectively clear mucus** for patients recovering from Augmentation Cystoplasty (AC) **at home.**

## Design Inputs

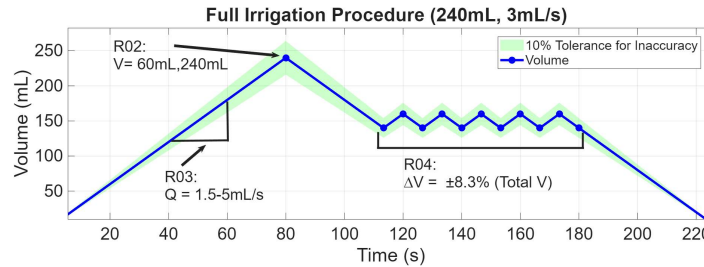
**Key Constraints:**

Biocompatibility

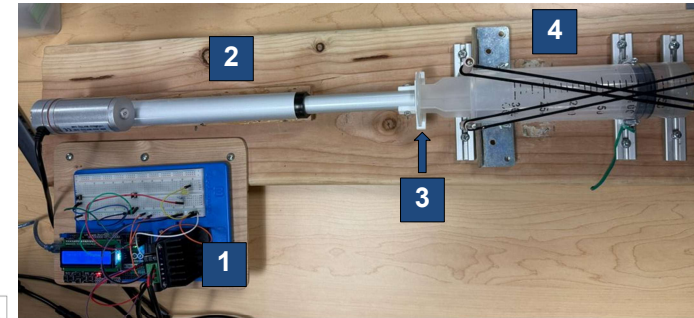
Internal pressure < 40 cmH<sub>2</sub>O<sub>[3]</sub>

Closed System Integration

R#	Requirements	Quantified
01	User-Triggered Irrigation	Full irrigation procedure initiation
02	Irrigation Volume	60 mL - 240 mL, ± 10%
03	Irrigation Flow Rate	1.5 mL/s - 5 mL/s, ± 10%
04	Barbotage	$\Delta V = \pm 8.3\%$ of Total V, ± 10%



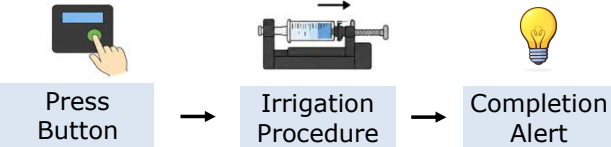
## Assembly/Intended Use



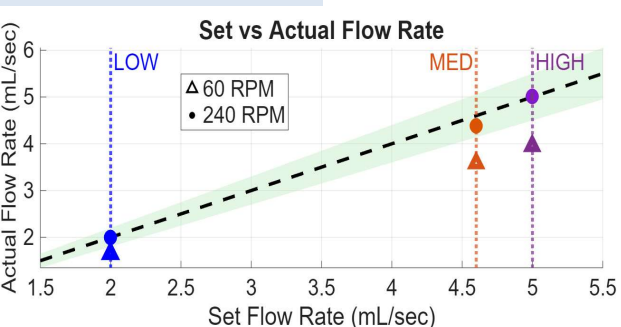
Component #	Description
1. Controller	Arduino-based control system
2. Linear Actuator	Generates push-pull motion
3. 3D-Printed Coupler	Connects actuator to syringe plunger
4. Syringe Mechanism	Delivers irrigation fluid

## Verification/Validation

### User-Trigger Test<sub>[4]</sub> → R01: **100% PASS**



### Flow Rate Testing<sub>[5]</sub> → R03: **Mixed Results**

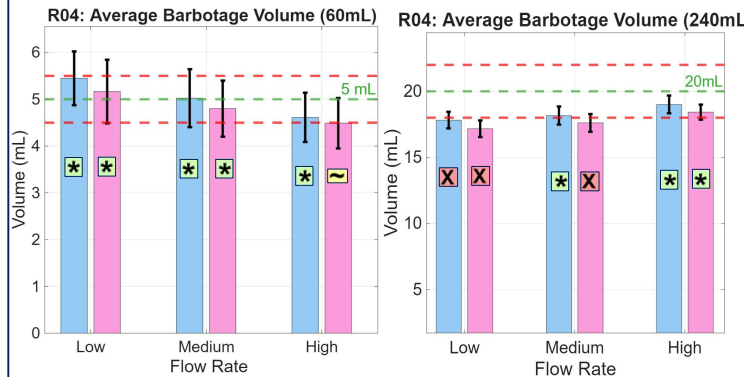


### Volume Testing<sub>[4]</sub> → R02, R04

R02 (60mL, 240mL): **100% PASS**  
R04 ( $\Delta V = \pm 8.3\%$  of V): **Mixed Results**

P/F Criteria<sub>[4]</sub>:  
Pass (\*)  
Inconclusive (~)  
Fail (X)

Legend:  
- 10% Inaccuracy  
- Target  
- Forward Disp.  
- Backward Disp.



## Conclusion

This **user-friendly** device **successfully semi-automates** the bladder irrigation procedure for patients recovering from AC.

**Impact:** Prioritizes patient comfort and reduces caregiver burden

**Future:** Enclosed housing, upgraded actuator, & integrated feedback mechanisms for improved displacement accuracy

### Acknowledgements

- Senior Design Professors (Dr. Sarver, Dr. Dougherty, Dr. Shih)
- Drexel University Machine Shop
- Funding Provided by Drexel School of Biomed

### References

[1] B. Cetinel, E. Kocjancic, and C. Demirbag, "Augmentation cystoplasty in neurogenic bladder," *Investigative and Clinical Urology*, vol. 57, no. 5, p. 316, 2016, doi:10.4111/icu.2016.57.5.316

[2] P. D. Metcalfe et al., "What is the need for additional bladder surgery after bladder augmentation in childhood?," *Journal of Urology*, vol. 176, no. 45, pp. 1801-1805, Oct. 2006, doi:10.1016/j.juro.2006.03.126

[3] P. I. Ellsworth, "Bladder pressure assessment," <https://emedicine.medscape.com/article/2113529-overview> (accessed Nov. 30, 2025).

[4] (2023). Standard Specification for Piston or Plunger Operated Volumetric Apparatus and Operator Qualification (ASTM, Ed.; No. E1154-23) [Review of ]. ASTM.

[5] Infusion Pump Testing - 2019.