Research and Development of a soft Robotic Shower Head (SoRoSH) for Older Adults with Mobility Limitations

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Technologies to Support Aging among People with Long-Term Disabilities

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NIDILRR National Institute on Disability, Independent Living, and Rehabilitation Research

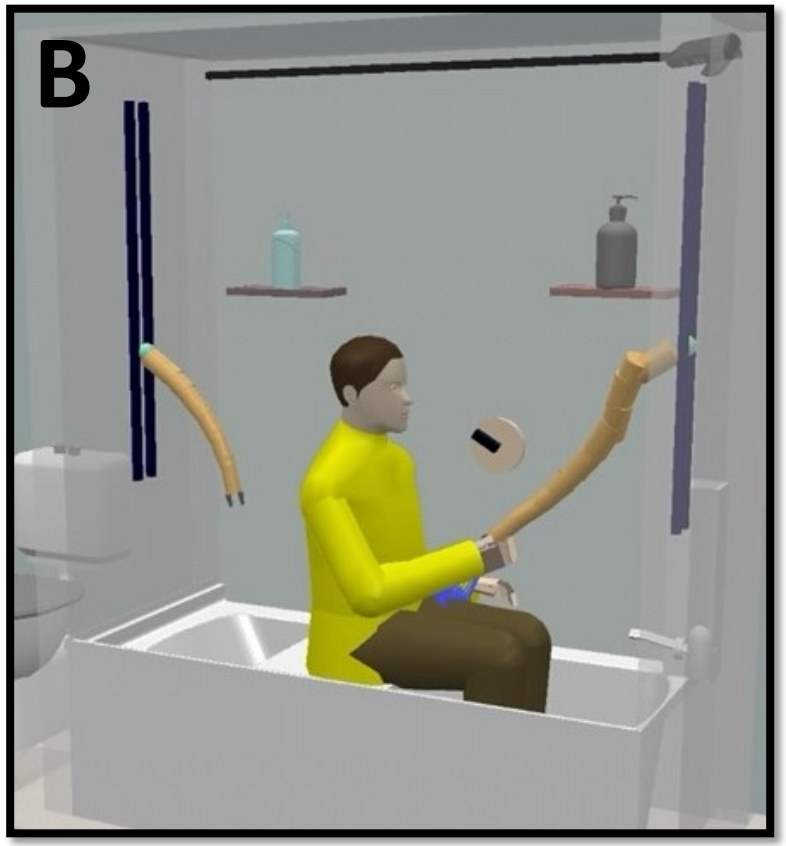
Importance of the Problem

- Self-care and bathing activities are among the most challenging, dangerous, and consequential activities affecting independence and QOL in adult wheelchair users (AWU)
- Assistive devices and technology can be extremely beneficial to older adults for bathing and self-care
- Specific technology needs for self-care and bathing are largely unknown in older adult wheelchair users(AWU), even though they experience more falls and unique challenges with bathing and self-care tasks

Purpose & Specific Aims

1. to systematically **assess the needs and preferences** of AWU to develop **design requirements** for bathing and self-care technologies, to inform the design of the soft robotic shower head (SoRoSH) D3project
2. test active components of the prototype SoRoSH to demonstrate feasibility and to **refine the design** as well as intervention protocols for measuring essential outcomes of bathing and self-care needs.

Complimentary and Emerging Technologies



Passive unit

- User guided
- 4-6 feet long
- Low cost

Active unit

- “Robotic”
- Motor driven/automated/powered
- User control flexibility

Target Population

1. Older Adult Mobility Device Users
   - 50-80 years of age
   - self-identify as having a mobility impairment
   - use a mobility aid (i.e., manual/power wheelchair or scooter) ~ 40 hour per week.
2. Subject Matter experts (SME)
   - family care partners or professional caregivers who have supported wheelchair users for at least 2 years

Methodology

SA1 assess the **(user)** needs and preferences of AWU to develop design requirements

A. Secondary Data Analysis
B. Structured Interviews
C. Usability Study

→

Demographics
Home photos
Functional capabilities
Facilitators/barriers
Perceptions of technology
Reaching body with tech

SA2 obtain **(user)** feedback on SoRoSH design in a simulated bathing/self-care environment; refine our procedures for measuring essential outcomes

A. Usability Testing
- **Structured interviews**
- **Focus groups**
- **Validated surveys**

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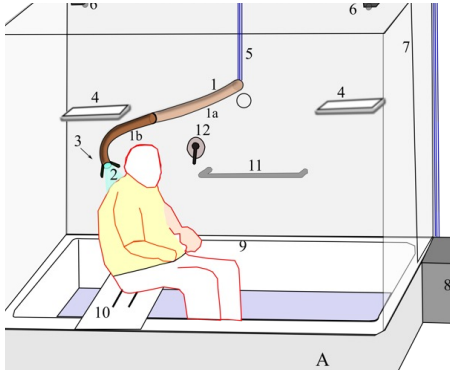
Comfort
Usability performance
Safety
Trust
SoRoSH prototypes
Satisfaction



Simulated bathing experience

Specific Aim 1A (Secondary Analysis) : What we have learned

- N=28 (Age : 52 – 86yrs)
- (M: 64; SD=9.2)
- Reach limitations
  - Body
  - Bathing objects
  - Water controls and temp
- Strength loss
- Falls

- 82% of the participants stopped bathing (i.e., submerging in a tub)
- Primarily relied on overhead shower systems with handheld over fixed showerheads.

Results SA1 B. (Structured interview)
End Users and Subject Matter Experts(SME)
Design Feedback (Zoom)

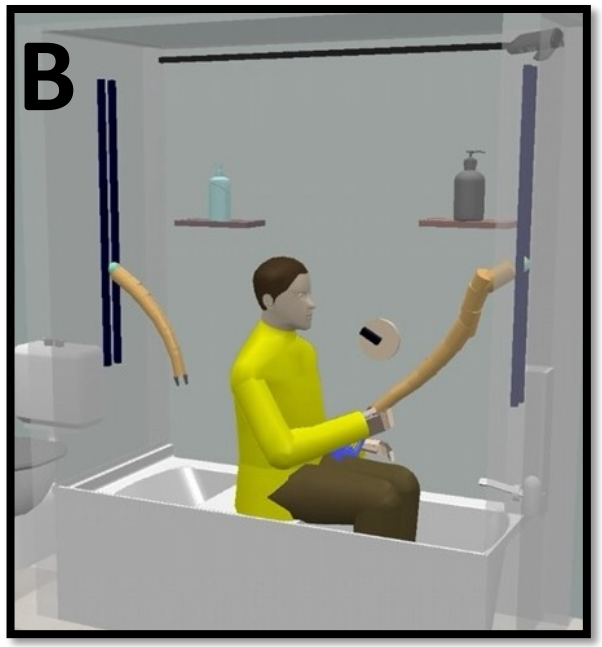
1. Current Showering Challenges
2. Ease of Use
3. Showerhead Concepts (preferences)
    1. Elongation, Swing, and Two Showerheads
4. Interaction Modes: voice, gesture, user-guided & voice control
5. Environmental and Structural Constraints
6. Emotional and Psychological Impacts
7. Thoughts on Sensors and Cameras

Ave interview time= 1.6 hr.

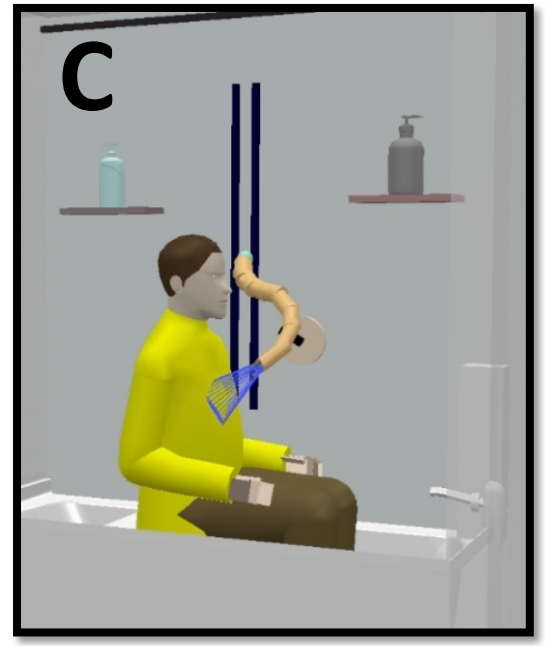
Participant	Age Range (yrs)	Mean /SD (yrs)	Sex
End user (n=6)	63-77	72.8 ± 5.0	4 female 2 male
SME (n=6)	30-78	60.8 ± 16.8	6 females

SA1 B. Interview Feedback

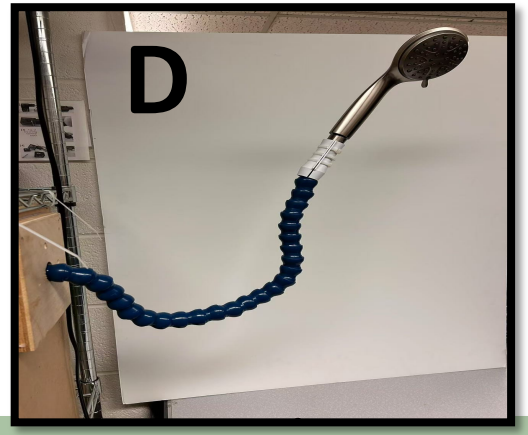
Wall mounted elongator



Dual showerhead with split controls



Sideward mount with dual front/back access



Mode of Operation & Simulation

User Guided
Voice Control
Gesture
Automated

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SA1 B. Preliminary Interview Results (Design priorities)

- Retrofit ability- “plug and play”(e.g. plumbing, renovation, complexity)
- Low cost
- Adjustable water pressure and temperature
- Design for shared environment needs
- Cognitive and memory demand concerns
- Showerhead that moves hands-free or “stays in place” reduces arm strain was the most valued feature.
- Users liked that the showerhead “stays where you leave it” and prevents accidental drops.
- Participants valued not having to lift or hold the device.

SA1 B. Preliminary Interview Results continued

Perceived benefits

- Extends bathing independently without caregiver help
- Reduces strain and fall risk while improving safety and comfort
- Promotes dignity, confidence, and emotional well-being

SA2 Usability Study SA1.C (In progress)

- IRB submission completed
- End users will use passive version of SoRoSH to reach body targets, experience two different clutch mechanisms for feedback

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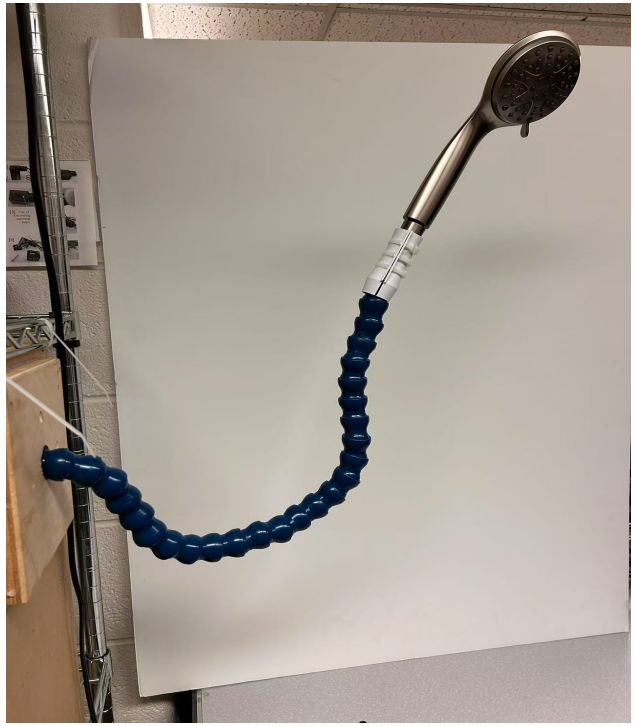
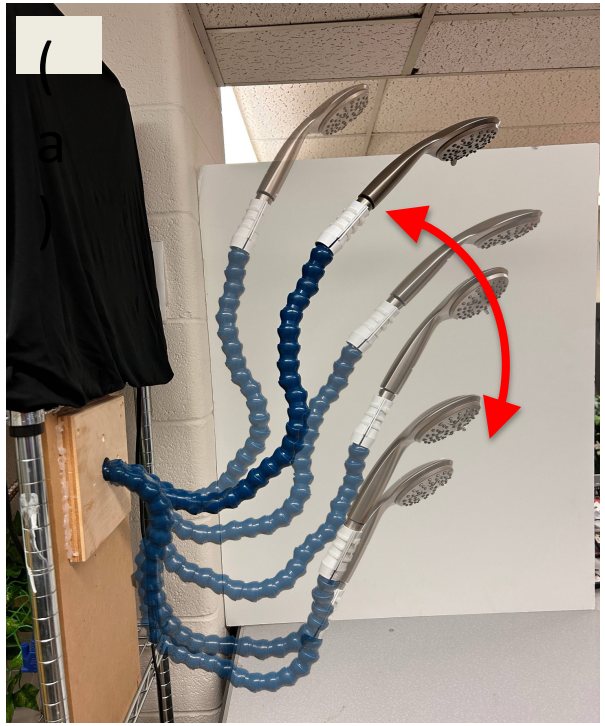
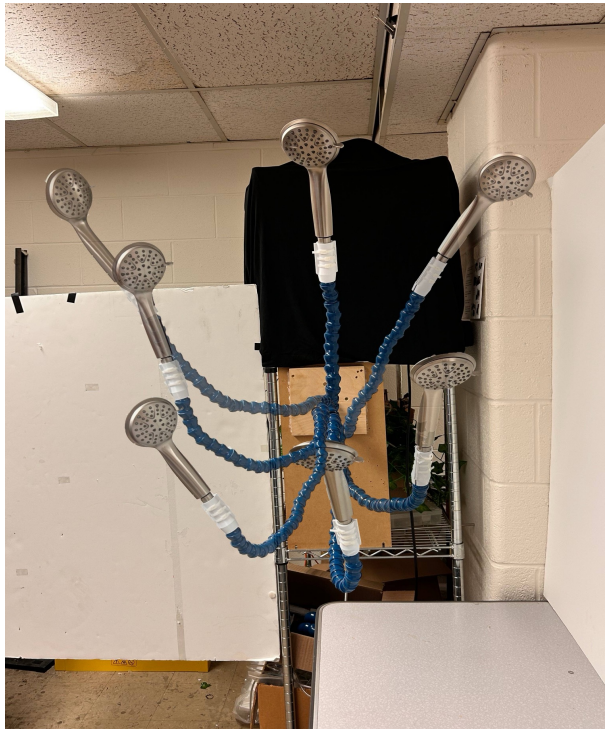
SA2 Usability Study SA1.C

Prototype Development: Gooseneck Backbone







User guided, low cost, plug and play, no motors/electricity

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Abstracts/ Presentations

Peer Reviewed Abstracts:

1. Rogers W, Sanford J, Rice I & Rice L. *Supporting Aging with Long-Term Disabilities: TechSAge Research & Development.* Assistive Technology Industry Association (ATIA). Orlando Fl, January 30th – February 1st, 2025.
2. Bhowmick P, Remillard E, Daliparthi M, Shahid K, Rogers W, & Rice I. *Understanding Challenges & Adaptive Strategies for Bathing & Showering Among Adults With Mobility Disabilities*. Gerontological Society of America (GSA) Annual Scientific Meeting. Seattle, WA; November 13 -16, 2024
3. Bhowmick P, Remillard ET, Shahid K, Rogers WA, & Rice I . *Understanding the Needs of Individuals With Multiple Sclerosis to Guide the Design of Assistive Technologies*. International Symposium on Human Factors and Ergonomics in Health Care (HFES), convening March 30 - April 2, 2025 in Toronto, Ontario, Canada.

Presentations

4. Rogers W, Sanford J, Rice I & Rice L. *Supporting Aging with Long-Term Disabilities: TechSAge Research & Development.* Assistive Technology Industry Association (ATIA). Orlando Fl, January 30th – February 1st, 2025.
5. Rice I, Krishnan G & Rogers W. *Research and Development of a soft Robotic Shower Head (SoRoSH) for Older Adults with Mobility Limitations*. 19th World Federation of Occupational Therapists (WFOT) Congress, 9 – 12 February, Bangkok, Thailand. (accepted)

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Thank you

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