



beyond the manual

building trust and confidence for g-tube administrators

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abstract

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Patients requiring tube feeding will typically go to the hospital at least once in 6 months due to feeding-related complications.

Feeding tube misadministration poses a serious risk to patient safety, particularly for adults with dysphagia who may be non-verbal and unable to communicate distress. MAP-trained staff and caregivers without medical backgrounds often lack structured training, resulting in low confidence and increased risk of errors. These errors can lead to complications like aspiration pneumonia, infections, and hospitalization.

Our project proposes a structured training program aimed at reducing feeding tube accidents through better knowledge retention, procedural adherence, and situational awareness. By focusing on controllable risk factors such as positioning, pressure control, and step-by-step execution, our training kit empowers caregivers through hands-on practice, real-world scenarios, and visual guidance.

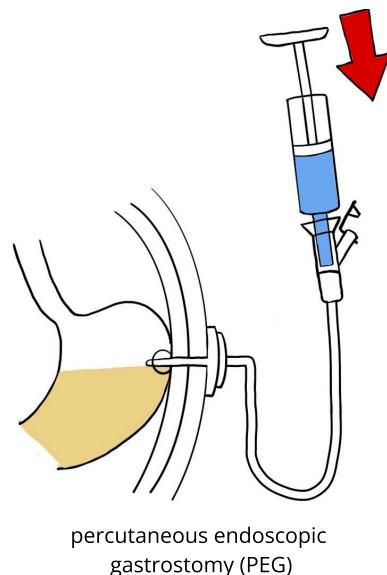
This competency-based, user-centered intervention bridges the knowledge gap for non-clinical caregivers and enhances overall patient safety.

a primer on g-tube feeding

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G-tube feeding is a vital part of care for individuals who cannot safely eat or swallow, most often due to conditions like dysphagia. A gastrostomy tube (G-tube) is typically used when long-term enteral feeding is required, as opposed to short-term options like nasogastric or orogastric tubes.

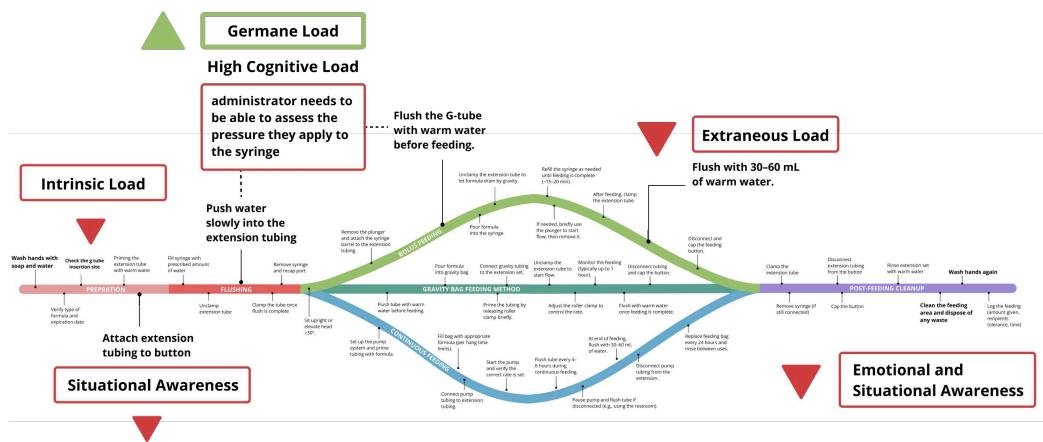
While essential for maintaining nutrition and hydration, G-tube feeding carries certain risks. Common issues arise from insufficient caregiver training, poor hygiene during setup, skipping key safety steps (which can result in the MIC-KEY button becoming detached), or overfeeding, when more formula is administered than the body can safely process.



Aspiration remains one of the most serious complications. Many individuals with feeding tubes are hospitalized at least once due to feeding-related incidents. Aspiration can occur during or after a feed, if formula is not properly digested, it can reflux into the airway, restricting oxygen flow and quickly becoming a medical emergency.

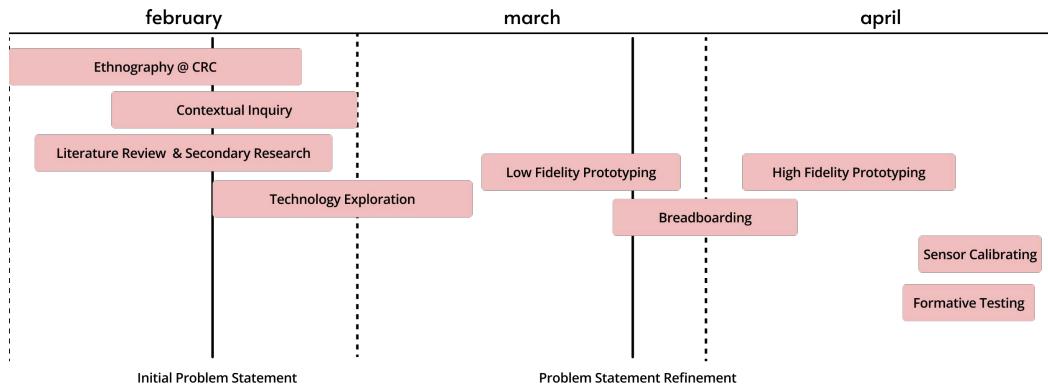
We partnered closely with the Charles River Center (CRC), an adult day habilitation program in Needham, Massachusetts, which supports around 80 residents daily, many of whom have intellectual and developmental disabilities. Staff at CRC manage a wide range of care routines, including medication, rehabilitation, and feeding. Among these, administering G-tube feeds via the MIC-KEY button is one of the most critical and high-risk tasks.

The challenge is made more complex by the fact that many residents are non-verbal. They may be unable to express discomfort or signal when something is wrong. In such cases, tools like pulse oximeters become essential, often providing the first warning signs of aspiration by detecting drops in oxygen saturation within minutes. Beyond aspiration, additional risks, such as infection, tube dislodgment, and overfeeding, are often linked to improper feeding pressure or skipped steps in the routine.



our process so far

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February: Literature review, site visits to CRC, stakeholder interviews
March: Initial concept focused on physiological monitoring; pivoted to training intervention based on expert advice
April: Development, testing, and final presentation of the G-tube training kit at NEC HFES Conference

target users



Our project focuses on the needs of two core groups of non-clinical G-tube administrators: MAP-certified staff in care facilities and family caregivers supporting loved ones at home. These individuals often play a central role in administering G-tube feeds, yet they receive limited training and support.

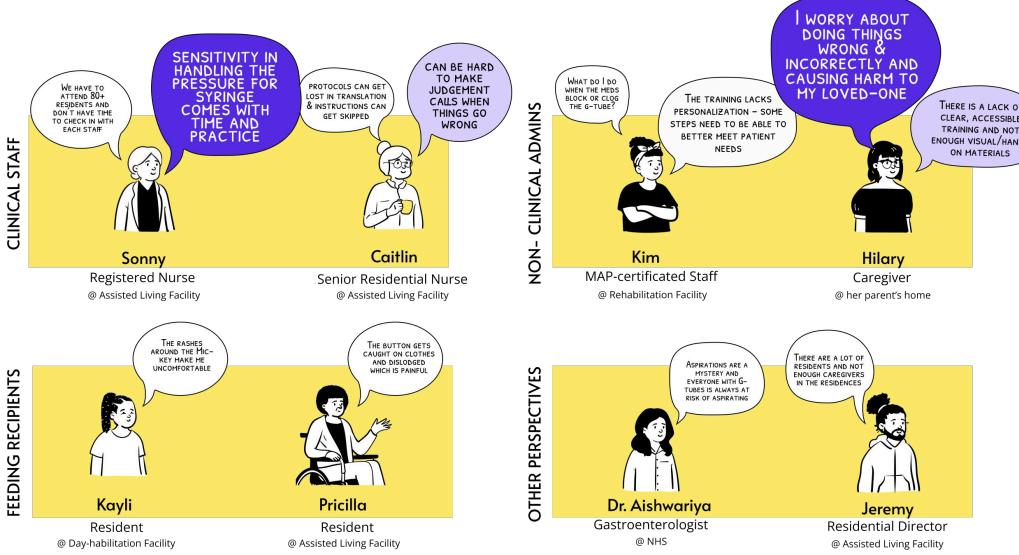
We were particularly guided by the voices of users like Kim and Hilary. Their stories reflect a broader issue: most caregivers rely on outdated, verbal, or paper-based instructions that are difficult to retain, especially in high-stress situations.

By designing a training intervention that addresses their needs, clarity, confidence, and repeatability, we aim to empower caregivers to deliver safe, effective care.

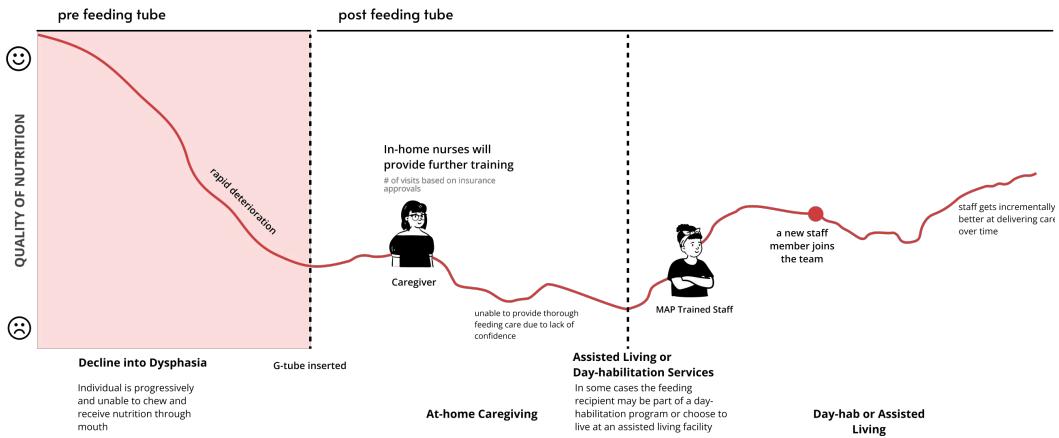
design & research methodology

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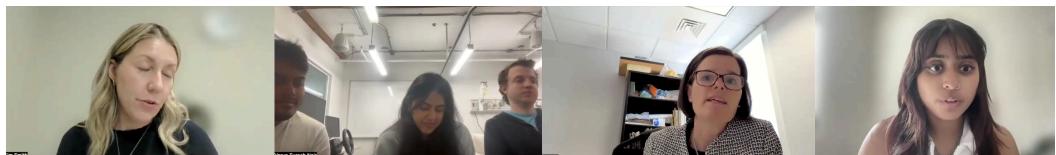
1) Ethnographic interviews with MAP staff, nurses, & caregivers; contextual inquiries at CRC



2) Journey Mapping of the caregiver experience



3) Usability Testing and Think-Aloud Sessions with stakeholders



4) Cognitive Task Analysis to identify key risk steps in the feeding process ([Click here](#))

Reference #	Task	Subtask	User Step	Potential User Error	Potential Causes	Hazard	Hazardous Situation	Potential Harm	Severity	Critical Task Yes/No	Mitigation/Control
1.1	Hand Hygiene	Gather soap and clean towel	Before touching g-tube or supplies	Uses contaminated towel or no soap	Improper setup or rush	Incomplete hand cleaning	Contaminants remain on hands	Infection at g-tube site	3 Yes	Checklist for setup	
1.2		Wash hands with soap for 15 seconds	Before g-tube care or medication	Short duration or poor scrubbing	Lack of attention or awareness	Residual germs	Bacteria transferred during care	Site infection	3 Yes	Demonstration and signage	
2.1	Clearing the Site	Apply warm soapy water with q-tips/gauze	Daily cleaning	Uses dirty or cold tools	Forgot to check supplies	Contaminated cleaning	Ineffective cleaning	Infection	3 Yes	Teach step-by-step method	
2.2		Rinse with clean water after soap	After soap application	Forgets to rinse or uses未经clean water	Skipped step or using tap water without boiling	Site remains moist	Bacterial growth	Skin breakdown or infection	2 Yes	Written checklist + reminders	
2.3		Dry with fresh gauze	After rinsing	Reuses gauze or leaves it damp	Lack of clean gauze or forgetfulness	Site remains moist	Infective flushing	Water doesn't reach tube	2 Yes	Ensure adequate supply in kit	
3.1	Flushing the Tube	Fill syringe with prescribed water volume	Before administering medication	Incorrect volume or sterile syringe	Measurement mistake or syringe reuse	Leakage or misdelivery	Medication blockage or overfeeding	Tube damage or overfeed	3 Yes	Clear labeling and instruction	
3.2		Attach syringe to extension tubing	Before flushing	Loose connection or wrong tubing	Rushing or confusion between ports	Leakage or misdelivery	Incomplete flushing	Pain or tube dislodgement	2 Yes	Use labeled syringe + demo	
3.3		Unclog and push water slowly	Flushing process	Pushes too fast	Inexperience or impatience	Pressure buildup	Discomfort or damage	Stress on stoma or port	3 Yes	Teach steady pressure technique	
4.1	Using Extension Tubing	Align black lines and attach securely	Before feed medication	Forces wrong alignment	Not supporting bottle or skipping check	Misplacement or leakage	Stoma injury or feeding failure	4 Yes	Hands-on practice + visual guide		
4.2		Remove tubing if forgotten to twist	Post-feeding	Carlessness or poor training	Tube dislodgement	Emergency reinsertion	Pain or ER visit	5 Yes	Emphasize disconnection method in training		

design decisions & rationale

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Key Findings:



safety pivot after expert insights

training gaps & inconsistency

ensure workflow compatibility



caregiver and staff confidence & risk aversion



language & comm. barriers

From a Human Factors perspective, we broke down the bolus feeding process into micro-steps, identified where users deviate, and redesigned training to emphasize:

- Reducing cognitive load with layered information
- Visual and tactile feedback for procedural confidence
- Emotional reassurance through realistic practice



Visibility of System Status



Portable Training Kit



Match System & Real World

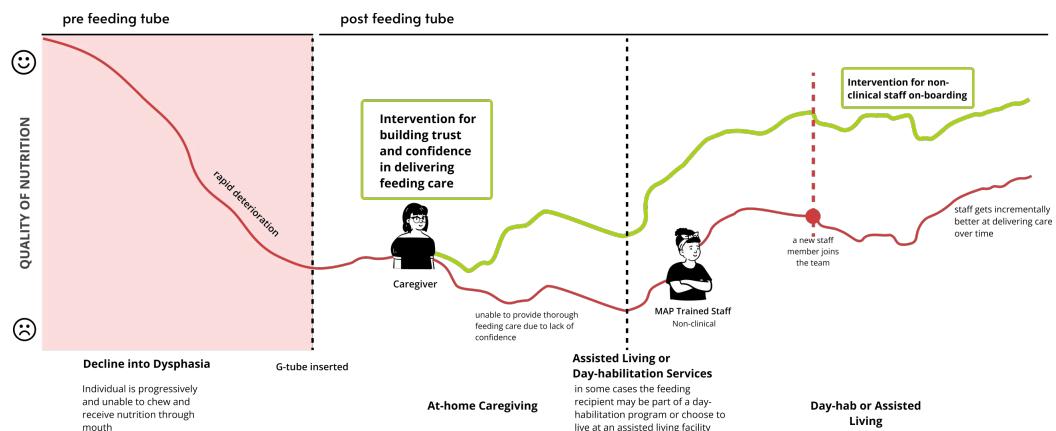


MAP Protocol Compliance



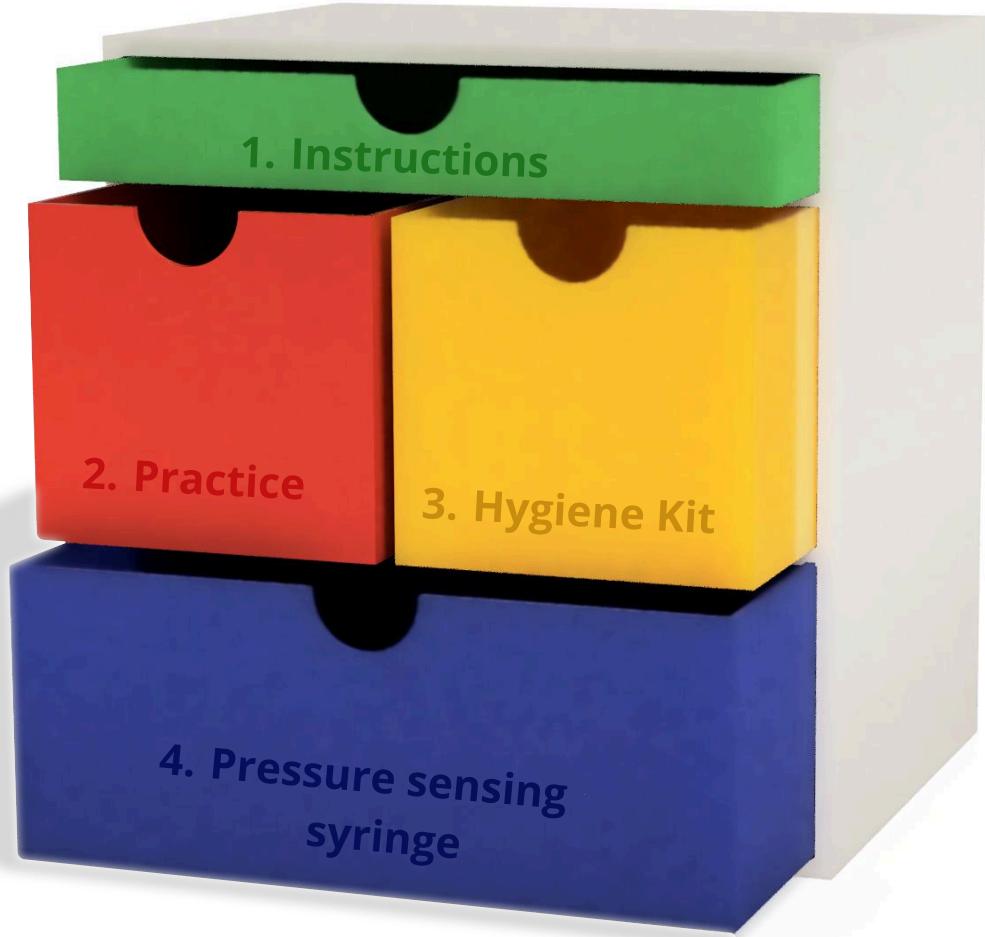
G-Tube Help Manual

Our structured training kit was built to simulate real-world use, minimize risk, and build trust.



our solution

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a training kit to build confidence

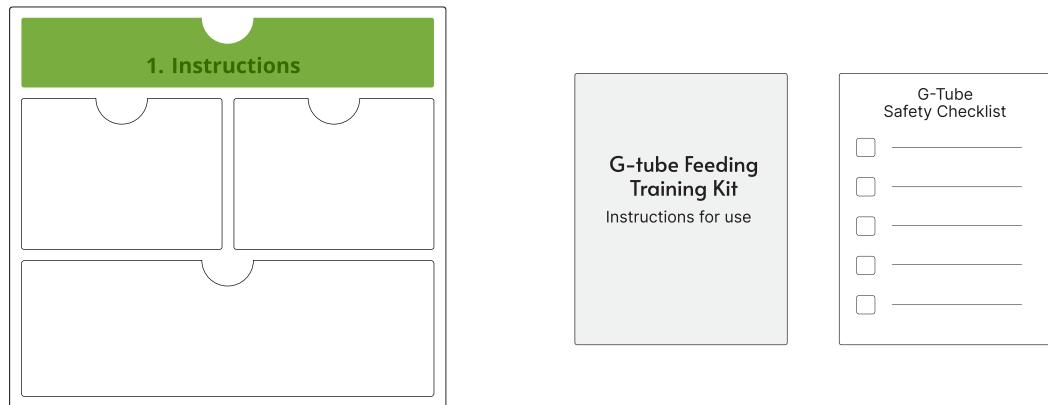
Our project proposes a structured training program designed to reduce feeding tube accidents by improving **knowledge retention**, **procedural adherence**, and **situational awareness** among administrators.

Our solution is a structured G-tube training kit, designed to reduce feeding-related errors through hands-on repetition. It includes a pressure-sensitive syringe, a realistic MIC-KEY training pad, a G-tube safety checklist, and a visual IFU. All elements are designed to simulate real scenarios while providing immediate feedback, so users build both skill and confidence.

To create a smooth and intuitive learning experience, the G-tube training kit is thoughtfully organized into four clearly labeled drawers. Each drawer represents a specific stage in the G-tube placement and care process, guiding the learner step-by-step in a logical, hands-on progression. This structured approach not only builds confidence but also ensures that essential skills are mastered in the correct order—making the training both effective and easy to follow

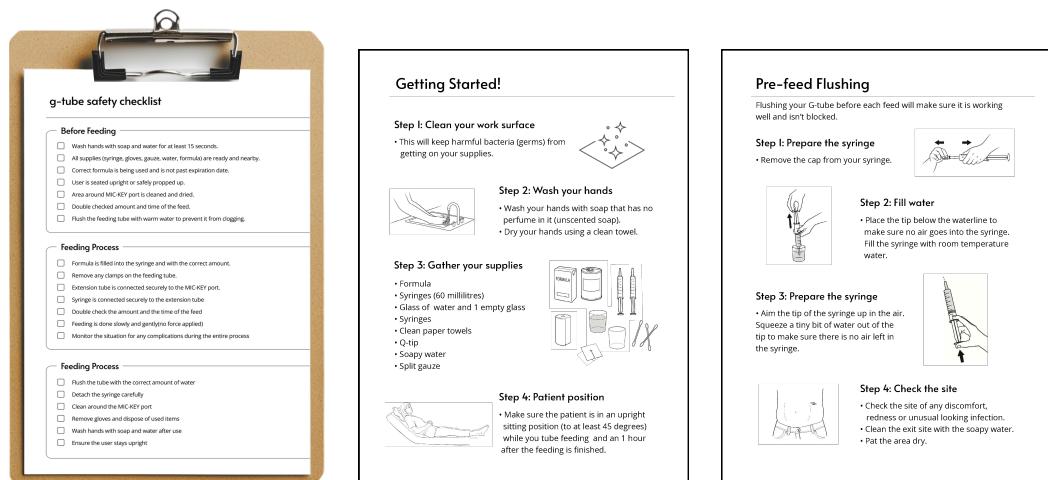
i. clear directions

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We started with the basics—reducing decision-making during critical moments.

The G-tube Safety Checklist is designed as a quick-reference, step-by-step guide that caregivers can follow at a glance. By clearly outlining each step in the G-tube care process, it significantly reduces cognitive load—especially in moments of stress, urgency, or emotional overwhelm—when recalling steps from memory can become challenging. This checklist acts as a calming, reliable companion, helping caregivers stay focused and confident during feeding procedures.

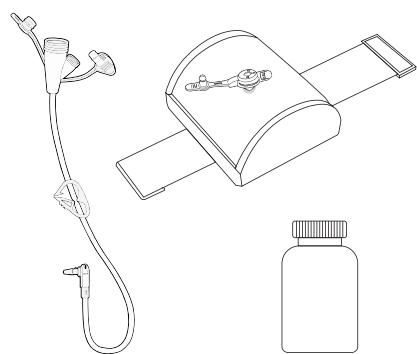
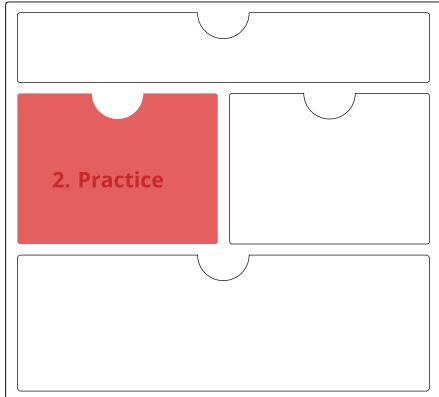


Complementing the checklist is our thoughtfully designed 'Instructions for Use' booklet. This guide organizes the entire kit visually, using clearly labeled diagrams, intuitive icons, and minimal text, allowing users to easily identify the necessary components and follow instructions without extensive reading. Whether a caregiver is new to G-tube feeding or needs a quick refresher, this visual approach ensures accessibility and ease of use.

Together, these tools create a supportive system for caregivers—one that acknowledges the real-world pressures they face while trying to provide safe, effective care. By reducing confusion and streamlining the process, we aim to empower caregivers to focus less on logistics and more on what matters most: the comfort and well-being of the person they're caring for."

ii. a safe space for learning

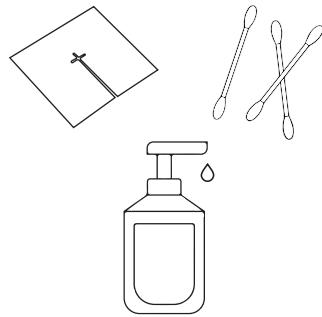
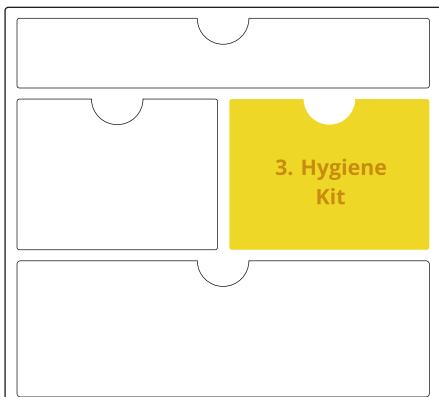
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A huge contributor to cognitive overload is a lack of hands-on familiarity. Caregivers often handle a MIC-KEY button for the first time during real patient care. To fix that, we included this realistic injection pad, fitted with an actual MIC-KEY button and extension tubing. It allows users to safely repeat core steps like connecting, securing, and flushing until they build muscle memory. This practice reduces hesitation and helps caregivers feel more prepared when it matters most.



iii. reducing decision fatigue



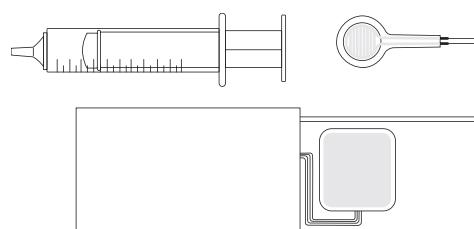
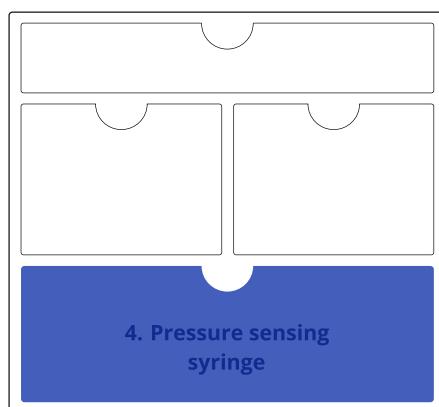
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To reduce decision fatigue, we included a pre-assembled hygiene kit with everything needed for safe feeding site care:

- Dry split gauze
- Hand sanitizer
- And soapy water with Q-tips

These tools remove the friction of having to gather supplies, and more importantly, they normalize proper hygiene as part of the care routine, not an afterthought.

iv. a safe space for learning



Here, we address one of the most invisible—but significant—sources of cognitive load in G-tube feeding: judging the correct amount of pressure to apply. Caregivers are often left uncertain, wondering how much force is too much when pushing formula through the tube.

Our innovative pressure-sensing syringe system eliminates the guesswork by providing real-time visual feedback. As the caregiver administers the feed, a connected digital display guides them with a simple yet effective color-coded system: green indicates the ‘safe zone,’ yellow signals a ‘warning’ that the pressure is increasing, and red provides an immediate ‘danger’ alert if force becomes excessive. This intuitive interface allows users to self-correct in the moment, without relying on prior experience or verbal cues.



By transforming a subtle and often anxiety-inducing task into a clear, visual experience, we make learning and performing G-tube feeding safer, easier, and more empowering—especially for new caregivers or those operating under stress. Importantly, all visual signage and alerts on the device adhere to ANSI Z535 standards for safety colors and labeling.

This ensures high visibility, consistent interpretation, and alignment with established best practices for safety communication in medical environments.

evaluation methods & findings

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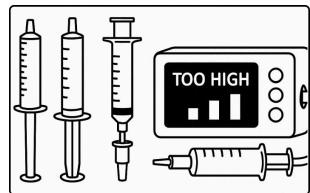
We conducted:

- Scenario-based usability testing
- Observation studies tracking errors, pauses, and technique
- Think-aloud protocols capturing real-time feedback

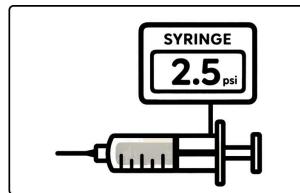
Participants reported:

- Increased confidence with MIC-KEY setup after using the pad
- Immediate correction of pressure-related errors using syringe feedback
- Reduced anxiety thanks to checklist and visual guidance

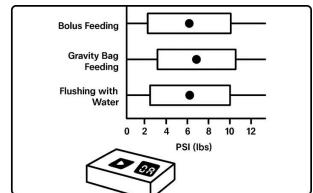
future steps



Syringe Type Calibration for Flushing and Feeding Pressure



Real-Time Monitoring of Syringe Content Pressure



Normalized Pressure Ranges Across Feeding Scenarios

- Syringe type calibration for accurate pressure matching
- Pressure range database based on real-world scenarios
- Real-time pressure monitoring of syringe contents

These steps aim to build smarter, adaptive training to reduce cognitive load.

reflection

- Empowering the User: This project reinforced the importance of co-design and participatory design. By involving caregivers and staff in the process, we were able to create tools that addressed real needs, not assumed ones.
- Build Early + "Fail" Early: Rapid prototyping helped us test ideas early and often. We learned how to strike a balance between prototype fidelity and simplicity, avoiding distractions that come with over-engineering.
- No Such Thing as Linear: Design is rarely straightforward. This process taught us that while the steps may be iterative and unpredictable, they are still far less complex than human emotion and behavior, which we must always consider.

This project showed us how Human Factors can transform safety, not through complexity, but through clarity, empathy, and thoughtful design.

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