Bridging the Digital Divide: Enhancing Medication Adherence

A Thesis Presented to OCAD University in partial fulfillment of the requirements for the degree of Master of Design in Inclusive Design

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By

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Abstract

This study examines how the digital divide affects medication adherence among older adults and explores how inclusive design can inform the development of more accessible digital health tools. Although smart pillboxes and health apps are increasingly available, many older users remain excluded due to barriers related to physical accessibility, digital literacy, and trust in technology.

A multi-phase qualitative approach was adopted, involving semi-structured interviews with older adults and healthcare professionals. Thematic analysis identified six recurring challenges: forgetfulness, caregiver reliance, low digital confidence, physical limitations, interface complexity, and digital distrust. These findings informed the design of a two-part system: the En-Take mobile application and a physical smart pillbox.

The app emphasizes visual clarity, simplified interaction, and core features such as QR code-based prescription import, personalized scheduling, allergy alerts, and caregiver data sharing. The pillbox supports ergonomic access, offering a rounded grip-friendly form and a circular LCD display for real-time reminders and system status.

While the small sample size and lack of caregiver representation limit generalizability, the study provides a foundational model for inclusive health technology. Future work includes user testing, caregiver interface development, and iterative hardware refinement. The findings highlight the potential of qualitative insight to inform the design of more empathetic and accessible solutions for aging populations.

Key Words: Older Adults, Digital Divide, medication non-adherence, App Design, Pillbox Design, Inclusive Design

Abbreviations

ICT Information and Communication Technologies

ADLs Activities of Daily Living

EMR Electronic Medical Record

TAM Technology Acceptance Model

HCD Human-Centered Design

REB Research Ethics Board

QR Code Quick Response Code

Acknowledgment

I would like to express my sincere gratitude to everyone who directly or indirectly contributed to the completion of this project. This work would not have been possible without the support, insight, and encouragement of many individuals along the way.

I am deeply thankful to my supervisor Peter Jones, whose guidance, expertise, and patience provided both academic direction and personal motivation throughout this research. I also extend my appreciation to all participants—older adults and healthcare professionals—who generously shared their time and experiences to inform this study.

I would like to thank my family and close friends for their unwavering emotional support, understanding, and belief in the value of this work. Their presence and encouragement were vital, especially during the most challenging moments of the research process.

To everyone who supported this journey—whether through mentorship, conversation, or quiet encouragement—thank you.

Dedication

TO

My cat, Xiang Xiang, for emotional support. ❤️

Motivation

This project traces its roots back to a moment of quiet realization around two and a half years ago. After completing my undergraduate studies, I returned to China and was struck by how rapidly technology had evolved—and how many older adults seemed left behind. I remember my grandmother telling me about a hospital visit, where a new self-service registration machine had replaced the traditional help desk. She was one of the few in line who could manage the device, while many others stood by, unsure and hesitant, too embarrassed to ask for assistance. Without enough staff support, she ended up helping other seniors complete their registrations.

That story stayed with me. It made me wonder: have we, in our enthusiasm for smart technologies, forgotten to design for those who need support the most?

At the same time, watching my grandparents manage daily medications for chronic illnesses made the challenge even more personal. Missed doses, confusion, and the struggle of organizing multiple prescriptions revealed an urgent need. Through this project, I genuinely hope to offer a small step toward technology that remembers, respects, and empowers all its users.

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INTRODUCTION

Medication non-adherence is a common challenge in healthcare, especially among older adults managing long-term health conditions. In Canada, as many as 60% of seniors do not follow prescribed medication routines consistently (Gellad et al. 2011). Which can lead to health complications, more hospital visits, and increased strain on the healthcare system. New digital health tools, like smart pillboxes, are designed to help people remember and manage their medications more easily. However, for these tools to work well for everyone, they must be user-friendly and accessible to all.

A smart pillbox is a device that can remind users to take medication through sounds, lights, or automatic alerts. Some also keep track of when medications are taken and allow family members or caregivers to monitor the user’s habits. This technology have the potential to support older adults in living independently while staying on top of medications. Yet, success depends on how well they fit into the lives of people who may not be comfortable with technology (Portz et al., 2019).

Older adults are more likely to face difficulties using digital tools. Many didn’t grow up using smartphones or computers, and some find new technology overwhelming or confusing. In addition, age-related physical changes like reduced vision or hand strength can make it harder to use devices that aren’t designed with these needs in mind (Khamaj& Ali, 2024; Wong et al, 2010). This gap in access and comfort with technology is often called the "digital divide".

In Canada, while more older adults are using the internet now than in the past, many still do not go online regularly. For example, in 2016, only about half of Canadians aged 75 to 84 used the internet. Among those over 85, the number is even lower (Statistics Canada, 2017). These differences revealed that digital health tools may not reach the people who could benefit most from them, which is an accessibility issue.

Some older adults also feel unsure or anxious about using unfamiliar devices. They may worry about making a mistake, having privacy violated, or simply feel that the technology wasn't designed with them in mind. These feelings are often reinforced by complicated interfaces and lack of support. Many seniors have expressed that technology doesn't seem "made for people like me" (Urbano, et al. 2020).

Inclusive design is one way to address these problems. Instead of creating specialized tools for specific groups, inclusive design aims to make products that work well for as many people as possible. This approach pays attention to how different users interact with a product and ensures that those with less digital experience are not left out (Fisk et al., 2009). In the case of smart pillboxes, inclusive design leads to simpler instructions, clearer buttons, and reminders that are easy to understand and respond to.

This research study focuses on how the digital divide affects older adults' ability to use smart pillboxes and how inclusive design can help make these devices more practical and trustworthy. The project uses a combination of literature review, interviews, and interaction design to better understand what older adults need in a smart pillbox. The goal is to create a tool that is not only effective at improving medication habits but also respectful of the diverse abilities and experiences of its users.

By focusing on older adults, particularly those who may feel left behind by technology, this study hopes to contribute to a more inclusive approach to digital healthcare. Helping seniors stay independent and healthy through better-designed tools can support a higher quality of life and reduce burdens on caregivers and healthcare providers.

BACKGROUND AND LITERATURE REVIEW

Background

Canada's aging population faces increasing challenges in managing chronic conditions, and medication adherence has become a critical but often overlooked issue. While technological innovations such as smart pillboxes offer new possibilities for supporting independent routine medication therapy, the success depends not only on functionality but also on accessibility and inclusion. Older adults often encounter barriers related to technology use, including limited digital literacy, physical impairments, and lack of trust in unfamiliar devices. These factors contribute to a broader digital divide that limits the impact of otherwise promising health tools. This chapter outlines key themes of research, including the prevalence and consequences of medication nonadherence, the structural and experiential dimensions of the digital divide among older adults, and the application of inclusive design principles to health technologies. Together, these sections lay the conceptual foundation for the design-led research that follows.

Medical adherence

Insufficient medication compliance is a key factor affecting the health management of the elderly. Statistics show that the overall irregular medication rate of Canadian adults is 52%, while the non-compliance rate of patients with a single disease is 35% to 56%. (Montague et al., 2017). With the increase in the number of medications, the complexity of medication methods, medication time, and dosage requirements has increased significantly, exacerbating the risk of medication errors.

At present, about 90% of the elderly take at least 1 prescription drug regularly, about 80% take at least 2 prescription drugs regularly, and 36% take at least 5 different prescription drugs regularly (Ruscin & Linnebur, 2021). This complex medication regimen can easily lead to elderly patients taking medication incorrectly due to memory loss, cognitive impairment, or lack of professional guidance, such as missed doses, repeated medications, dosage confusion, or time confusion.

Digital Divide in Older Adults

The digital divide describes the disparity in access to information and communication technologies (ICT), where certain groups possess sufficient resources while others face limited or no access (Soomro et al., 2020). Among older adults, this divide is driven by factors such as limited access (to devices or internet connectivity), lower digital literacy or skills, and lack of trust in technology. As of 2020, 65% of individuals aged 65 and above in Canada utilize smart devices, with the subset owning mobile phones demonstrating a daily usage rate exceeding 80%. ("COVID-19 has significantly increased the use of many technologies among older Canadians: poll") Despite such widespread prevalence, existing software often struggles to meet older adults specific needs, particularly in people's activities of daily living (ADLs). Older adults often express skepticism and anxiety about using unfamiliar technologies, citing concerns about privacy, reliability, and fear of making mistakes.

More than 77% of seniors indicate a need for a certain level of assistance when using electronic products, while the majority of designers for applications and smart devices have already implemented age-friendly designs (Lenhart and Duggan). While digital health innovations offer significant promise in addressing this issue, the success relies on equitable access and usability across diverse user groups.

Inclusive Design in Digital Health Smart Device

Inclusive design is an approach to creating technology that accommodates the broadest range of users, regardless of age or ability, without discriminating against any group (Zvi, 2023). In digital health, inclusive design refers to interfaces and devices that address common age-related challenges: sensory impairments (vision or hearing loss), decreased motor dexterity, cognitive changes (slower information processing, memory problems), and even skepticism about technology. Usability and accessibility are core pillars of inclusive design. For example, visual design should use large, high-contrast text and simple layouts to assist people with vision loss and reduce cognitive load. Inclusive design for digital health also means recognizing when the trade-off between high-tech and low-tech is appropriate. The most feature-rich smartphone app is useless if the patient can't operate it.

In recent years, digital medication adherence devices have proliferated, from simple pill organizers with alarms to complex automatic dispensers. These technologies generally share a common goal of reducing accidental missed doses by reminding users and simplifying the act of taking medication (Choi, 2019). However, for older users, requiring a smartphone or internet connection is a double-edged sword. Inclusive design does not mean that every device is right for everyone, but that there are options that are appropriate for different groups of older adults. The key point is that the device itself cannot ensure medication adherence - it must be matched to the individual's abilities and supported by healthcare environment.

Literature Review

This literature review used a modified scoping review method (Arksey & O'Malley, 2005) based on focused searches across OCAD U library, Omni libraries, and PubMed. Insights were synthesized from 20 relevant academic sources to inform the inclusive design of digital health technologies for older adults. Specifically, it draws on research in three interrelated areas: (1) electronic medical record (EMR) systems and data integration, (2) interface design and emotional usability for the aging population, and (3) age-related sensory and cognitive limitations that affect user interaction. This review avoids redundancy in background chapters and emphasizes the synthesis of existing design-focused scholarship. Together, these insights suggest that inclusive smart pillbox design must go beyond interface aesthetics and incorporate system compatibility, emotional safety, and physiological empathy. Rather than designing isolated devices, researchers and designers should build interconnected, emotionally attuned, and physically responsive health solutions for an aging society.

Integration of smart health technologies with electronic medical records (EMRs)

In the future, of smart pillboxes should be integrated to share medication data with with electronic medical records (EMRs). Craig and Farrell (2010) highlight the difficulties physicians face when EMR interfaces are not designed with user needs in mind. These issues, combined with poorly-matched data structures and inadequate standardization, reduce the usefulness of health monitoring tools. There is widespread recognition of the potential for medication adherence data to be automatically captured and reflected in EMRs (Weir et al, 2011). However, concerns about data quality, standardization, and privacy remain significant (Craig & Farrell, 2010). To be effective, smart pillboxes should be built on an interoperable framework that supports real-time updating of the EMR while ensuring ethical safeguards.

Interface Design and Emotional Comfort with Aging

As digital health expands, interfaces become a key intermediary between users and devices. Rhiu et al. (2018) showed how the physical characteristics of the interaction (e.g., button pressure, tactile feedback) influence emotional comfort and perceived usability. Similarly, Petrovčič, et al. (2017) analyzed how different interface styles affect the behavior of older adults and showed that simple, visually organized layouts can increase engagement. Chen et al. (2020) and Jingyi et al. (2024) compared skeuomorphic and flat designs, concluding that realistic visual metaphors are more intuitive for older users. Visual salience, the way color and layout direct attention, also plays a key role in interaction design for this population. Furthermore, Urbano, et al. (2020) applied the Technology Acceptance Model (TAM) to show that emotional comfort and perceived ease of use directly influence adoption among older adults with chronic conditions.

Designing Fort and an Aging Body and Mind

Healthy digital interfaces must be sensitive to age-related physical and cognitive decline. Alsswey & Al-Samarraie. (2020) and Liu et al. (2021) identify interface modalities (e.g., touch, voice, color coding) that improve usability for older adults. Factors such as decreased vision, decreased motor speed, decreased memory, and increased fatigue sensitivity require simplified, predictable interaction flows. Wong et al. (2021) demonstrated that older users prefer personalized interfaces that minimize text input and include large, high-contrast buttons. FlexPersonas (Gonçalves et al., 2021) is a prime example of an adaptive system that adapts content to individual user needs through IoT-based contextual awareness. Li (2021) highlights the value of "synesthetic design," which combines visual, tactile, and auditory cues to enhance comprehension and comfort for older users.

Approach

The target group of this study focuses on older adults, elderly people who often suffer from one or more chronic diseases,. They often need to rely on long-term medication and they may exhibit a certain degree of medication non-compliance. This group This age range of 59-70 is at a critical stage of transition from traditional medical support to digital health services, but they often face multiple obstacles from the physiological, cognitive and social environment. For example, vision and hearing loss, decreased operational ability, unfamiliarity with digital devices, and lack of trust in technology may affect effective use of digital medication management tools. The smart medicine box developed for this group should not only focus on the accuracy and efficiency of the functional level, but also pay attention to the accessibility, situational adaptability and psychological acceptance of the interactive experience. The study aims to understand behaviours associated with multiple medications and to create a smart medication solution that truly fits actual life and cabilities of older adults through inclusive design methods, to promote health self-management and life independence.

Inclusive Design Theory

Inclusive design theory is at the core of this research, which emphasizes the importance of creating systems that are usable by the widest possible range of people, regardless of age, ability, or experience (Cremers et al. 2013). Rather than retrofitting accessibility into existing systems, inclusive design advocates for anticipating diverse user needs from the outset. In this study, inclusive design provides the philosophical and practical foundation for analyzing smart pillbox usability issues and guiding interface decisions tailored for older adults affected by the digital divide.

METHODOLOGY

Approach

This study used a qualitative, human-centered research approach to explore how the digital divide affects older adults' use of smart pillbox technology and how inclusive design can address these barriers. The approach consisted of three sequential phases:

1. Literature review

2. Semi-structured interviews / observation

3. Research through design. Figure 1 shows the timeline of the research methods used over the total study period.

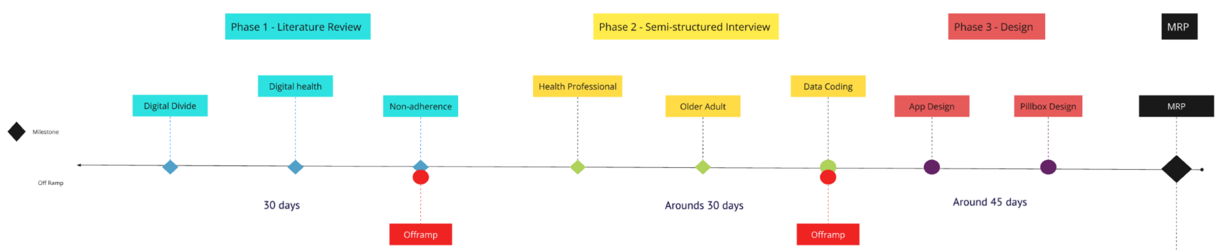

Figure 1. Research Timeline

Phase I : Literature Review

A scoping review was conducted to build foundational knowledge on medication non-adherence among older adults, digital health literacy, usability barriers, and inclusive design principles in healthcare technology. Academic journal articles, systematic reviews, and applied case studies were reviewed using thematic search strategies and scoping review across databases such as the Pubmed, OCADU Library and the Omni library. The findings informed the formulation of interview questions and provided initial design direction.

Phase II: Semi-structured Interviews

Semi-structured interviews were conducted with in total 4 healthcare professionals and 2 older adults. The interview protocol included open-ended questions focused on challenges with medication adherence, use of digital technology, and feedback on current pillbox designs. The semi-structured format allowed for consistent framing across participants while also allowing for more in-depth exploration of emerging sub-themes. Interviews were recorded with participant consent and subsequently transcribed for analysis.

Phase III: Design Iteration and Concept Development

Based on insights from Phases I and II, early design criteria were developed to guide the creation of a smart pillbox that adhered to inclusive design principles. Initial sketches, wireframes, and low-fidelity prototypes were produced to visualize interface and interaction concepts. The prototypes were iteratively improved through design review sessions, expert feedback, and reflection on needs expressed by interview participants. Design decisions focused on reducing cognitive load, improving accessibility, and enhancing clarity for older users. Each iteration aimed to translate qualitative insights into specific design solutions appropriate for older adults with varying levels of digital familiarity.

Interview Participants Criteria

This study sampled from two main participant groups: older adults aged 59–70 and healthcare professionals with direct experience supporting medication adherence in older populations. Selection criteria were specified to ensure participants could meaningfully contribute to the investigation of smart pillbox usability in relation to digital literacy and medication routines. Additionally, criteria aimed to include individuals with relevant experience in long-term medication management, either from the user's or provider's perspective.

Older Adult participants inclusion criteria consisted of:

- Age between 59 and 70 years.

- Regular management of three or more prescription medications.
- Ability to participate in a 30–45 minute interview in English.
- Capacity to provide informed consent.

The age range of 59–70 was selected to minimize potential health risks during remote interviews, given the challenges of providing immediate assistance to older adults with complex medication needs. Additional considerations included variation in living arrangements (e.g., living alone or with others) and levels of independence in daily activities, accounting for physical or cognitive limitations that might affect medication routines. Exclusion criteria included discomfort with remote interviews or lack of experience managing multiple medications.

Recruitment occurred through poster advertisements at a Canadian long-term care facility located in Vancouver, BC (Appendix A), targeting residents with experience managing complex medication regimens.

Healthcare Professional participants inclusion criteria for healthcare professionals included:

- Registered as a pharmacist or physician with at least two years of post-licensure experience.
- Direct experience supporting older adult patients (aged 59+) with chronic conditions requiring multiple medications.
- Familiar with or awareness of digital health tools, including smart pillboxes or related apps.

The recruitment process primarily involved professional contacts and referral networks affiliated with OCAD University's Design for Health program, with emphasis on practitioners regularly working with aging populations. Following initial contact and informed consent, candidates completed a brief eligibility questionnaire (Appendix B) to confirm the professional experience in older adult care and digital health interventions. Professionals unable to discuss challenges related to older adults' medication routines or lacking experience with digital health tools were excluded from this recruitment process.

Final Participant Composition

Although the study initially proposed including patient advisors, recruitment limitations resulted in a final participant pool consisting solely of older adults health-seekers and healthcare professionals. All participants were screened according to the specified criteria, and only those meeting eligibility requirements and providing informed consent were enrolled in the study.

Interview Design

Older Adults Interview

This interview design aimed to explore how older adults manage the challenges of taking multiple medications in daily life and share experiences provide suggestions for improving healthcare support and resources. The interviews sought to understand participants' strategies and routines, with the goal of informing more inclusive product and service designs to support medication adherence.

Participants were recruited through posters placed at a long-term care facility in Vancouver, BC (Appendix A). Residents who were interested in participating either contacted the research team directly via the email listed or were assisted by facility staff to obtain the informed consent form. After confirming participation, interview times were scheduled according to participant preferences, and remote access links were provided.

At the beginning of each interview, the researcher reviewed the informed consent, confirmed participant understanding of the study's purpose, clarified the voluntary nature of participation, and explained the interview's structure, including time limits, recording, and right to withdraw. Interviews followed an approved Research Ethics Board (REB) protocol and lasted approximately 30 minutes. The interview guide (Appendix C) consisted of 15 questions focused on participants' experiences with medication management. No information about specific health conditions or individual prescriptions was discussed. Recordings were stopped after the 30-minute mark, regardless of whether the discussion had concluded.

The interviews were designed to be conversational and pressure-free. Participants were given the choice to complete the interview in English or Mandarin, with all questions translated. The researcher used a slow, calm tone and adapted pacing to ensure clarity and comfort. While the approved interview guide served as the basis, questions were also adjusted in real time to respond to participants' answers and maintain a natural conversational flow.

Healthcare Professional Interview

Healthcare professional interviews, on the other hand, focused on gathering insights from healthcare professionals who regularly support older adults in managing multiple medications. The goal was to understand common challenges they observe in clinical settings and explore how future products or services could be designed to better support patients' medication routines and healthcare coordination.

Participants were recruited through direct email outreach to faculty members at OCAD University's Design for Health program and related professional networks. The email introduced the project, explained the purpose of the study, and invited those interested to participate. Respondents received a consent form and study overview via email. After reviewing the details and confirming participation, they were asked to complete a short eligibility questionnaire (Appendix B). Once eligibility was confirmed, participants scheduled a preferred time and received a secure Zoom link for the interview.

Before each interview, the researcher repeated the key points from the consent form, including the study's aims, time commitment, data recording, and participants' rights to pause or withdraw at any time. Interviews followed a semi-structured guide consisting of 14 open-ended questions (Appendix D) and lasted 30 minutes. To protect patient confidentiality, participants were asked to speak in general terms rather than about individual cases or medications.

Similarly, interviews were conducted in either English or Mandarin, depending on the participant's preference. The questions were consistent across both languages, and the interviewer used a professional, respectful tone. While the guide was used as a reference, the flow of conversation was flexible, with questions adapted based on participants' responses. One participant completed the eligibility questionnaire but was unable to join the interview due to personal health concerns and scheduling conflicts.

Data Coding

All interviews were audio-recorded with participant consent and transcribed for qualitative analysis. Thematic coding was applied to the transcripts, focusing on identifying keywords, frequently mentioned terms, and new ideas. Coding categories were derived through an inductive approach, allowing themes to emerge from participant narratives. This process enabled the researcher to distill design-relevant insights and user needs that would inform the prototype development. Figure 2 shows the data coding process.

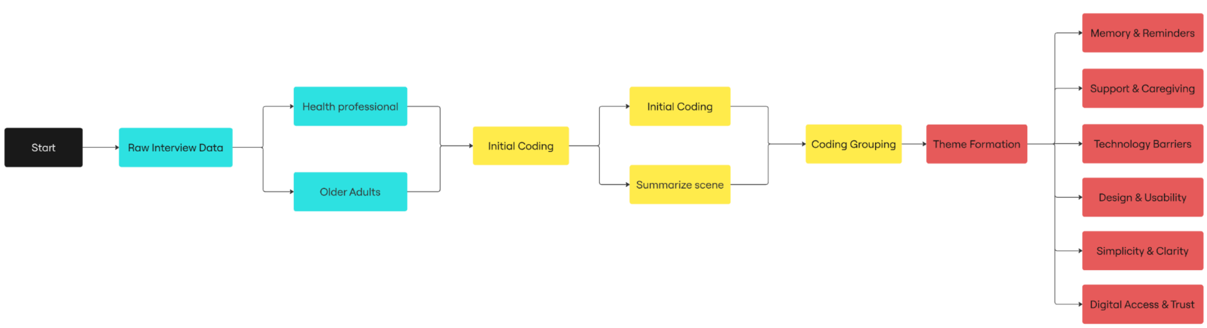

Figure 2. Data Code Process

Data Analysis

All interview recordings were transcribed using Zoom's built-in transcription feature and organized according to participant group—older adults and healthcare professionals. These transcripts were read multiple times to support immersion in the data and facilitate a nuanced understanding of participant experiences.

The analysis followed Braun and Clarke's (2006) inductive thematic analysis framework, allowing patterns to emerge from the data without reliance on predefined categories. Coding was conducted manually in English for consistency, even when transcripts originated in Mandarin. Codes captured not only frequently used words (e.g., "remind," "support," "trust") but also recurring ideas, narrative structures, and affective expressions that revealed deeper insights into participants' interactions with medication routines and digital technologies.

Data were then grouped into broader conceptual themes that captured shared challenges or opportunities for inclusive design. These included, for example, difficulties related to physical interaction with pillboxes, confusion caused by complex app interfaces, or the psychological strain of maintaining medication independence. Rather than isolating words, the process focused on understanding how participants conveyed their needs through stories, patterns of reasoning, and emotional tone.

Representative quotes were selected to illustrate each major theme and are presented in the **Discussion of findings** alongside analytic interpretation. This approach enabled the identification of design-relevant findings grounded in lived experience and professional observation, ensuring that both functional and emotional dimensions of medication adherence were accounted for.

Research Principles

The research draws on inclusive design and human-centered design principles as core methodological and theoretical orientations. Rather than relying on predetermined assumptions, the research emphasizes direct insights from stakeholders and professional caregivers to understand real-world barriers to use. The interpretive approach aligns with the belief that meaningful solutions for older adults must emerge from life experiences, environmental constraints, and interactions with care systems. The approach values adaptability, empathy, and iterative improvement as fundamental strategies for developing accessible medical technologies.

Human-Centered Design (HCD)

The study's methodological backbone draws from human-centered design (HCD) theory, which positions the user as a co-creator and knowledge source in the design process. HCD stresses empathy, observation, and iterative prototyping as tools to uncover latent needs and real-world barriers. This project applies HCD by engaging caregivers and healthcare professionals—those who interact closely with older adults to co-identify pain points and suggest actionable design criteria for the smart pillbox.

Interpretivism in Qualitative Research

Knowledge is constructed through social contexts and individual experiences. Thematic coding was used not to validate predefined categories but to discover meaning through participants' language, storytelling, and real-life examples. The interpretivist approach aligns with the study’s goal of revealing hidden social, emotional, and usability barriers that affect technology adoption in aging populations.

Design-Led Inquiry

This research is situated within the paradigm of design-led inquiry, where generating solutions is part of the knowledge-creation process. Rather than ending at user insight, the study moves forward into prototype development and iteration. This aligns with practice-based research models common in inclusive design disciplines, where design artifacts serve both as research outputs and tools for further investigation.

Semi-Structured Interviews

Participant Backgrounds

A summary of participant characteristics is provided below. To preserve confidentiality, no identifying information is included. Participants were assigned anonymized codes. The tables below reflect general demographic and experiential traits relevant to the study.

Older Adult Participants

The study included two older adult participants, both managing multiple prescription medications. One participant was independently managing over eight medications, while the other required caregiver support to manage more than ten medications daily. Both individuals reported active engagement in participants own medication management and participated in remote interviews via Zoom.

ParticipantID	Group	Experience with Medication	Assisted Medication	Medication Management	Interview Format
A01	Older Adult	8+ Daily medications	Independent	Yes	Remote (Zoom)
A02	Older Adult	10+ Daily Medications	With Support	Yes	Remote (Zoom)

Table 1. Older Adult Participant Backgroun

Healthcare Professional Participants

Four healthcare professionals participated in this study. The clinical experience with older adult patients ranged from under three years to over seven years. Roles included pharmacists, nurses, and a gerontologist. All professionals completed a screening questionnaire to verify health professionals qualifications, though one was unable to attend a scheduled interview. Interviews were conducted remotely via Zoom, except in one case where scheduling constraints prevented participation.

Participants ID	Group	Experience with Older Participants	Role / Profession	Work Background	Questionnaire	Interview Format
P01	Health Professional	0 - 3 Years	Pharmacist	Pharmcy	Yes	Remote (Zoom)
P02	Health Professional	3 - 5 Years	Nurce	Hospital	Yes	Remote (Zoom)
P03	Health Professional	5 - 7 Years	Pharmacist	Hospital	Yes	N/A
P04	Health Professional	7+ Years	Gerontologist	Hospital	Yes	Remote (Zoom)

Table 2. Health professional Participants Background

Although the sample of participants in this study is relatively small, it is appropriate for qualitative research that seeks to explore personal experiences and contextual factors in depth. A smaller sample allowed the researcher to focus more closely on each individual's perspectives, particularly regarding medication management and digital health interactions (Guest, Bunce, & Johnson, 2006). This approach aligns with established practices in qualitative inquiry, where rich, detailed data are prioritized overbroad generalization (Patton, 2015). In addition, the study design posed minimal risk to participants, as no unfamiliar technologies were tested and all interactions were conducted remotely in a manner comfortable to those involved. The approach also ensured minimal risk to participants, who were not asked to use unfamiliar technology or alter care routines.

DISCUSSION OF FINDINGS

Findings

Thematic Summary Table

This chapter presents the main findings derived from thematic analysis of interviews with older adults and healthcare professionals. The themes identified reflect both emotional and practical challenges in medication management and technology use and highlight opportunities for inclusive smart pillbox design (Table 3).

Theme Category	Example Keywords	Summary Description
Memory & Reminders	remind, forget, routine	Participants frequently discussed forgetting doses and needing reminders and alarms.
Support & Caregiving	support, help, doctor	Many older adults relied on caregivers or professionals to manage medications.
Technology & Barriers	trust, confuse, error	Frustrations with digital tools, lack of clarity, or difficulty learning were noted.
Design & Usability	open, hard, screan	Physical and visual limitations affected how users interacted with pill boxes.
Simplicity & Clarity	simple, instuaction	Both group valued intuitive design and clear step by step guidance.
Digital Acess & Trust	app, access, technology	Mixed views on apps and digital tools, often linked to trust and prior exposure.

Table 3. Main category and keywords findings

Key Themes with Supporting Quotes

The interviews revealed several key user needs shaped by both emotional and functional dimensions of medication management. These needs are not isolated incidents, but recurring patterns observed across older adults and healthcare professionals, highlighting shared vulnerabilities in existing systems and technologies.

Memory & Reminders

Forgetfulness was frequently cited as a barrier to medication adherence. One older adult stated, "Sometimes I just forget... I need something to remind me" (A01), emphasizing the need for external prompting systems. However, professionals expressed concern over the limitations of conventional reminders, noting, "They often rely on alarms or visual cues, but even then, it's easy to miss a dose" (P02). These responses suggest that effective reminder systems must go beyond basic alerts to offer adaptable and redundant support tailored to individual routines.

Support & Caregiving

The role of caregivers emerged as central to daily medication routines, especially for users managing multiple prescriptions. One participant shared, "My daughter helps me sort the pills every Sunday" (A02), underscoring both logistical and emotional reliance.

From the institutional side, a pharmacist observed, "We always ask the caregiver to double-check the blister packs before delivery" (P01), revealing a system-wide dependency on caregiver accuracy. This highlights a need for tools that enable shared accountability and accessible caregiver integration.

Technology Barriers

Low digital confidence was a prominent concern. As one older adult admitted, "Apps are too complicated, I get confused" (A01), reflecting a lack of comfort with unfamiliar interfaces. This sentiment was echoed by a nurse who noted, "*If they press the wrong thing, they panic and stop using it*" (P02), pointing to the fragility of user trust. Together, these quotes illustrate the importance of intuitive, forgiving design that minimizes perceived risk and offers immediate reassurance.

Design & Usability

Physical interaction with devices was a common challenge. "Hard to open with my fingers" (A02) was a recurring issue for older adults with limited dexterity. From a clinical perspective, "Big screens and single buttons help reduce mistakes" (P04) was offered as a practical guideline. These insights suggest that ergonomic, simplified interfaces are not optional features, but fundamental requirements for this user group.

Simplicity & Clarity

Participants consistently favored clarity over complexity. One older adult explained, "I want it to tell me what to do, not guess" (A01), reflecting a broader preference for directive systems that reduce cognitive burden. Similarly, a healthcare professional stated, "Simple instructions work better than too many features" (P03), reinforcing that simplicity in design often enhances—not limits—functionality for older users.

Digital Access & Trust

Finally, underlying several concerns was a general skepticism toward digital solutions. "I don’t really trust apps... what if I lose my data?" (A02) revealed anxiety around privacy and reliability. A pharmacist further commented, "Some patients refuse smart devices altogether—they just don’t trust them" (P01). These quotes highlight that trust must be actively earned through transparent, dependable, and user-controlled design elements.

Design Insights from Interview

Drawing from the key findings, several fundamental design requirements have emerged that are essential to developing an inclusive and effective smart pillbox tailored to the needs of older adults. These requirements reflect both the practical demands and emotional realities of medication management, as described by users and healthcare professionals.

A primary concern identified across interviews was the need for robust and flexible reminder systems. Forgetfulness was a persistent barrier, underscoring the inadequacy of uniform notification methods. Participants emphasized that reminders must be both dependable and adaptable to users' individual schedules and sensory needs—particularly for those with hearing or cognitive impairments.

The involvement of caregivers in medication routines further pointed to the importance of shared-access functionalities. Medication adherence was frequently described as a collaborative effort, involving family members or health aides. Consequently, smart pillbox systems should facilitate caregiver participation through accessible interfaces or linked notification mechanisms.

Additionally, frustration with complex digital interfaces was a recurring theme. Older adults reported confusion and hesitation when engaging with unfamiliar technologies, and healthcare professionals noted that even minor usability breakdowns could lead to total disengagement. These insights underscore the necessity of highly intuitive, low-friction user interfaces with clear, directive interaction flows. Physical accessibility was also repeatedly highlighted. Participants reported challenges with tasks such as opening compartments or interacting with small touch targets. Accordingly, ergonomic considerations—such as larger buttons, tactile feedback, and easy-to-operate lids—should be regarded as essential design features rather than enhancements.

Finally, many participants expressed a general skepticism toward digital tools, especially among those with limited prior exposure to technology. Concerns regarding data privacy, potential errors, and loss of control contributed to a pervasive lack of trust. Addressing this requires not only secure systems, but also designs that communicate transparency and foster user confidence through simplicity and reliability. Collectively, these findings suggest that future smart pillbox solutions must be grounded in principles of clarity, empathy, and adaptability. The following section articulates how these user needs can be operationalized through an inclusive design framework.

Learning Path

The interview process offered critical insights that refined the initial understanding of medication adherence among older adults managing chronic conditions. Contrary to early assumptions that most older adults would handle a relatively limited number of prescriptions, it became evident that polypharmacy is a common reality. Participants managing multiple chronic illnesses frequently reported taking ten or more different medications daily, with some cases involving over twenty prescriptions. This degree of complexity substantially increases the cognitive and organizational demands placed on users.

An equally important observation emerged regarding the coping mechanisms developed by older adults. Despite the challenges posed by complex regimens, many participants had established personalized routines to support adherence. Strategies such as linking medication intake to daily activities (e.g., meals or television programs), visible pill placement, and self-made reminder cues were frequently mentioned. These practices indicate that while forgetfulness remains a risk, it is often proactively addressed through individualized behavioural adaptations. Figure 3 below displays a smart pillbox design that integrated these behavioural adaptation strategies (EllieGrid, 2025).

Figure 3. EllieGrid smart pill organizer

This evolving understanding underscored the importance of designing medication management technologies that do not disrupt these embedded coping strategies. Instead of introducing entirely new behaviors, supportive technologies must be designed to integrate with, reinforce, and respect the adaptive routines that older adults have cultivated over time. Recognizing and working with these existing strategies is essential to promoting trust, usability, and sustainable adoption.

DESIGN SOLUTION

Defining an Inclusive Solution

Building upon the qualitative findings and inclusive design framework developed earlier in this study, the design response takes the form of a two-part system: a mobile application (Appendix E) and a physical smart pillbox. Together, these components aim to support older adults in managing complex medication routines by reducing cognitive burden, increasing system transparency, and enabling meaningful caregiver collaboration. The system is intended not only to improve adherence outcomes but also to address the emotional and usability challenges that often prevent sustained engagement with digital health tools.

The EnTake platform (E stands for electronic) was developed to respond directly to issues of forgetfulness, digital inaccessibility, and trust identified in the interviews. The mobile application serves as a digital hub, offering clear scheduling, integrated medication information, and communication tools for families and care teams. Meanwhile, the pillbox complements the app with physical cues, reminders, and ergonomic access to daily doses. Rather than treating digital and physical systems separately, the design integrates them into a cohesive user experience that supports autonomy while acknowledging interdependence.

In what follows, the design is broken down into two core components—application and pillbox—each of which was shaped by user insights and guided by principles of simplicity, clarity, and empathy.

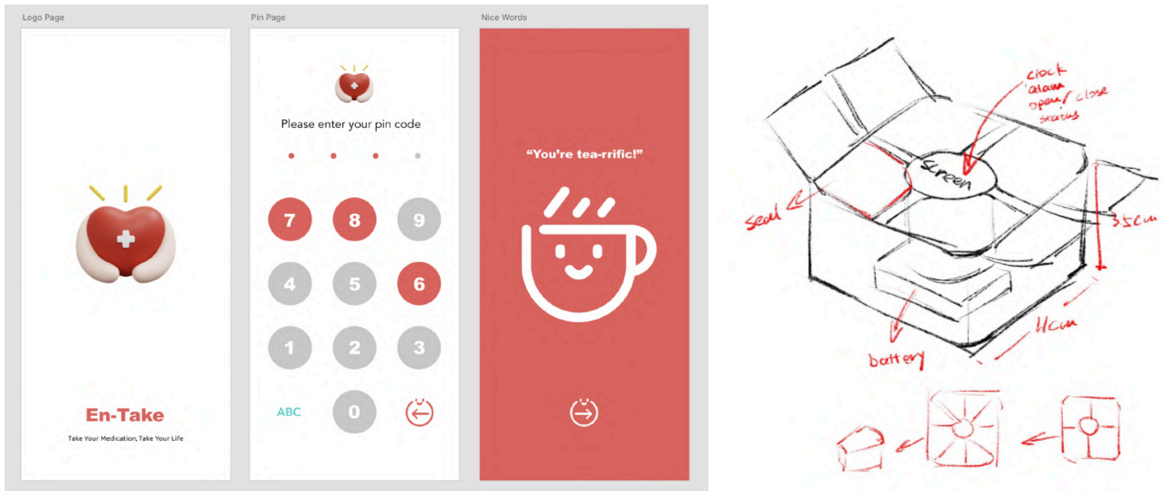

Figure 5. & 4. Mobile App Login & Sketch Pillbox Isometric View

Mobile Application

The En-Take application was developed directly in response to the user needs identified through interviews with older adults and healthcare professionals. These needs—ranging from unintentional forgetfulness and low digital confidence to physical accessibility limitations and reliance on caregiver support—formed the conceptual foundation for both interface and functional design strategies. The design process emphasized a balance between simplicity, clarity, and emotional engagement, aiming to support adherence behaviors while minimizing cognitive and operational barriers. The application addresses these challenges through two key design dimensions: interface layout and core functionality.

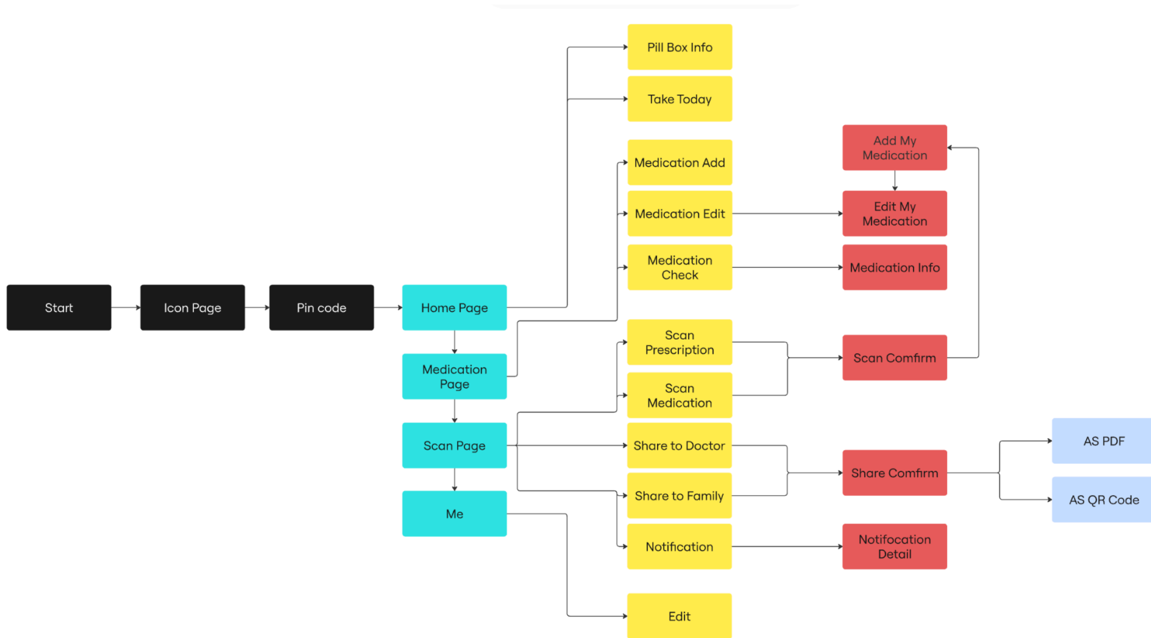

Figure 6. Mobile App Functional Structure

Design Interface

To mitigate the visual strain and interface confusion commonly reported by older users, the En-Take application adopts a flat design aesthetic that emphasizes simplicity, high contrast, and clear visual hierarchy. This approach is consistent with inclusive interface design literature, which highlights the need to minimize clutter, enhance visual separation, and present information in an accessible and interpretable format for aging populations (Petrovčič, et al., 2017).

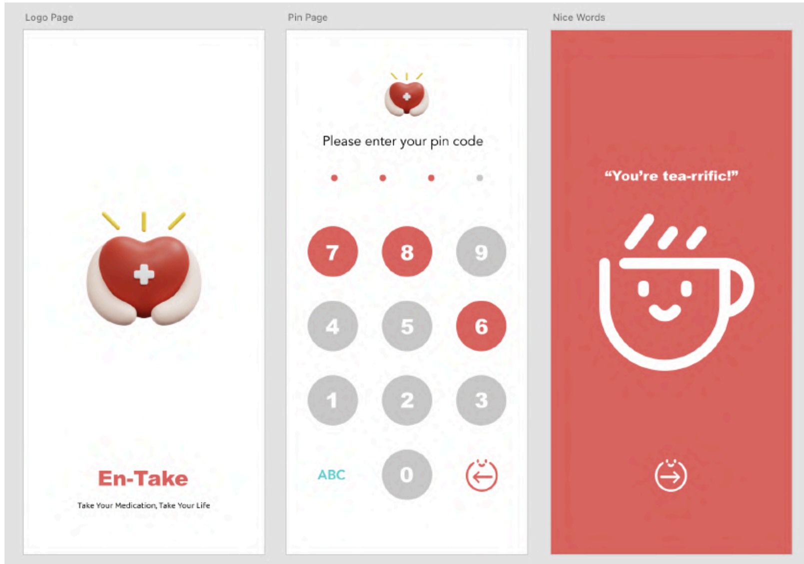

Figure 7. Mobile App Log-in

Typography was carefully calibrated to enhance legibility without overwhelming the user. The application retains the iOS default body font size of 17pt for general text, while increasing the minimum font size from the platform's standard 11pt to 14pt for all interactive elements and smaller labels. This adjustment accounts for reduced visual acuity among older adults and aligns with best practices in mobile readability for accessibility.

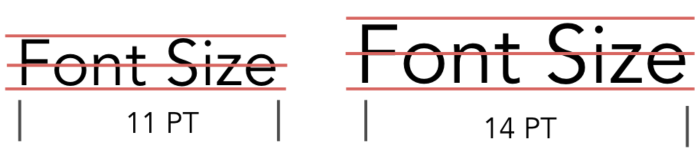

Figure 8. Font Size Comparison

Likewise, iconography was scaled to 60pt, the upper limit recommended by Apple Human Interface Guidelines, surpassing Android's 48dp standard (Apple HIG; Material Design), thereby enhancing "tapability" for users with diminished motor control.

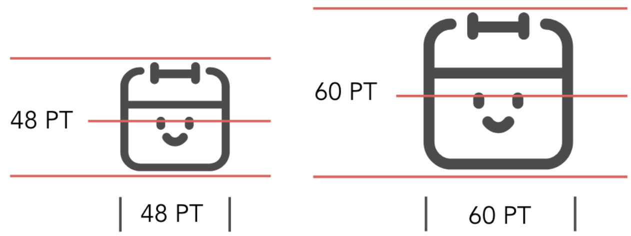

Figure 9. UI Size Comparison

Color and visual structure further reinforce accessibility. The design employs black text on white backgrounds to maximize legibility, while using gentle, distinguishable accent colors for categorization and emphasis. Key content blocks are paired with intuitive icons and text labels to support recognition across different literacy and language backgrounds. These strategies were intentionally selected to address themes such as ***Design & Usability*** and ***Simplicity & Clarity***, both of which emerged repeatedly in participant narratives as determinants of trust and engagement with digital health tools.

Core Functions

The functional architecture of the En-Take application is intentionally streamlined to minimize user confusion and cognitive burden. Adhering to the three-tap interaction rule—a standard in mobile usability that advocates for limiting the number of steps required to complete a core task—the application enables users to access all primary features within three interactions (Nielsen, 2020). This design logic directly addresses the usability concerns expressed by participants, many of whom described digital technologies as overwhelming or difficult to navigate.

The main interface is anchored by a persistent bottom navigation bar comprising four clearly labeled modules: Schedule, My Medication, Scan, and Me. This modular layout reduces decision fatigue and enhances predictability in user navigation. The Schedule page presents a chronological breakdown of the day's medication regimen, visually aligned with the physical pillbox layout to reinforce spatial memory. The My Medication module provides a centralized space for reviewing, editing, or manually entering medication data, including dosage, timing, and administration notes. The Scan function enables quick and error-reducing data input via prescription QR codes or over-the-counter barcodes. Finally, the Me section houses personal profile information, allergy documentation, and options to share data with caregivers or medical professionals. By organizing functionality into these discrete, high-frequency categories, the design enhances usability while preserving a sense of control for users with limited technological confidence.

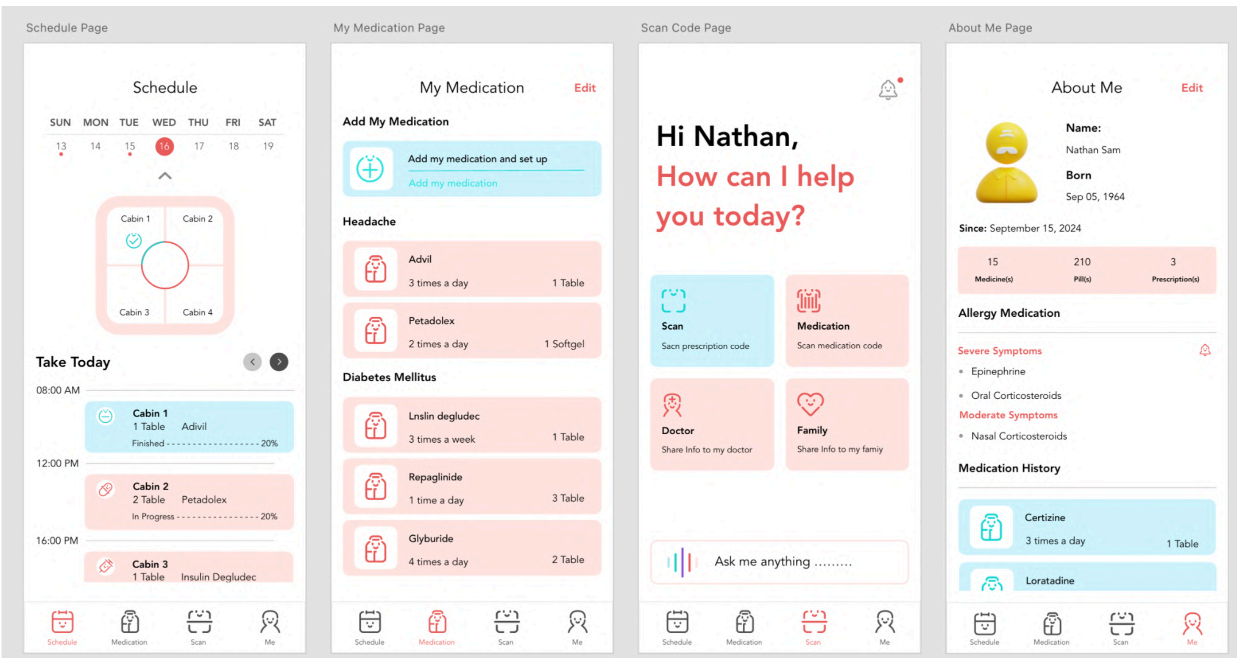

Figure 10. Mobile Application 4 Main Screen

A key innovation is the prescription code scanning feature, which enables users to import structured medication data directly from hospital-issued QR codes. Healthcare professionals interviewed for this study noted that such QR codes are already used within clinical environments to encode essential data, including medication name, dosage, timing, and frequency. By replicating this mechanism within the app, users can bypass manual data entry and significantly reduce setup friction. After scanning, users retain the ability to edit scheduling preferences before the medication is automatically integrated into their active list and schedule display.

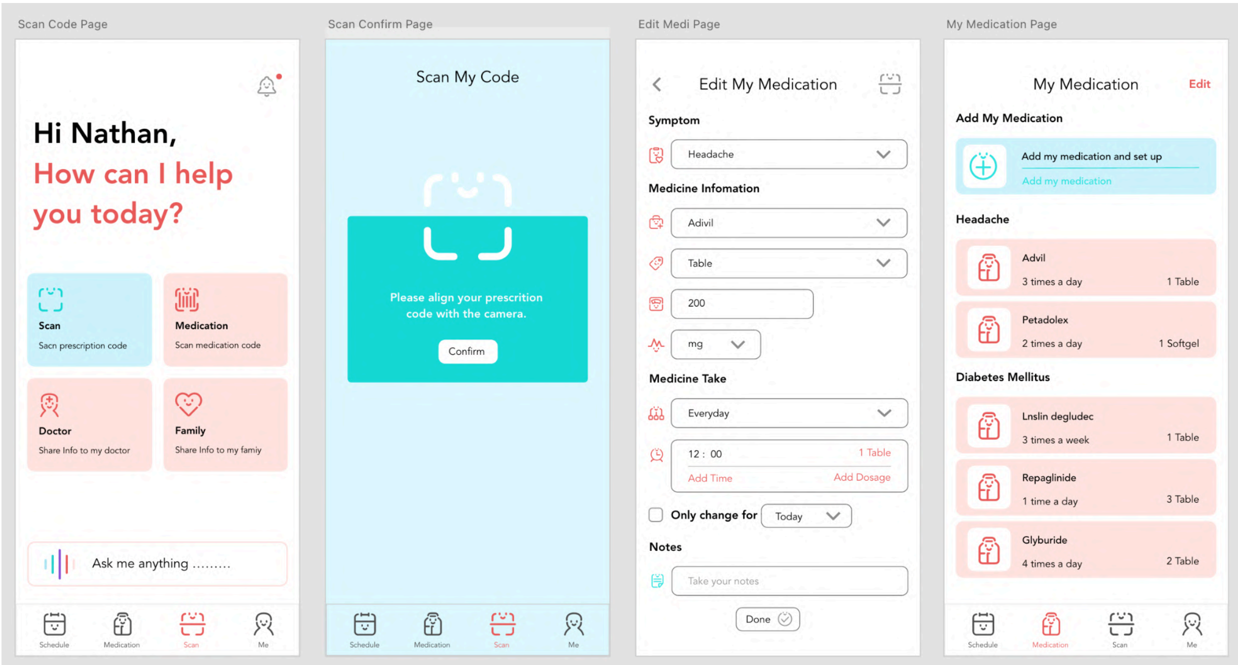

Figure 11. Scan Code Flow

Complementing the scan-based input, the My Medication module also supports manual data entry. This feature is structured to guide users through symptom-based categorization, drug selection, dosage configuration, and personalized notes. Additionally, a medication Info page linked to each entry presents usage guidelines, warnings, and dosage limits—mirroring the physical insert often overlooked in medication packaging. This component directly addresses needs related to Medication Literacy, Trust, and Support, as identified in participant interviews.

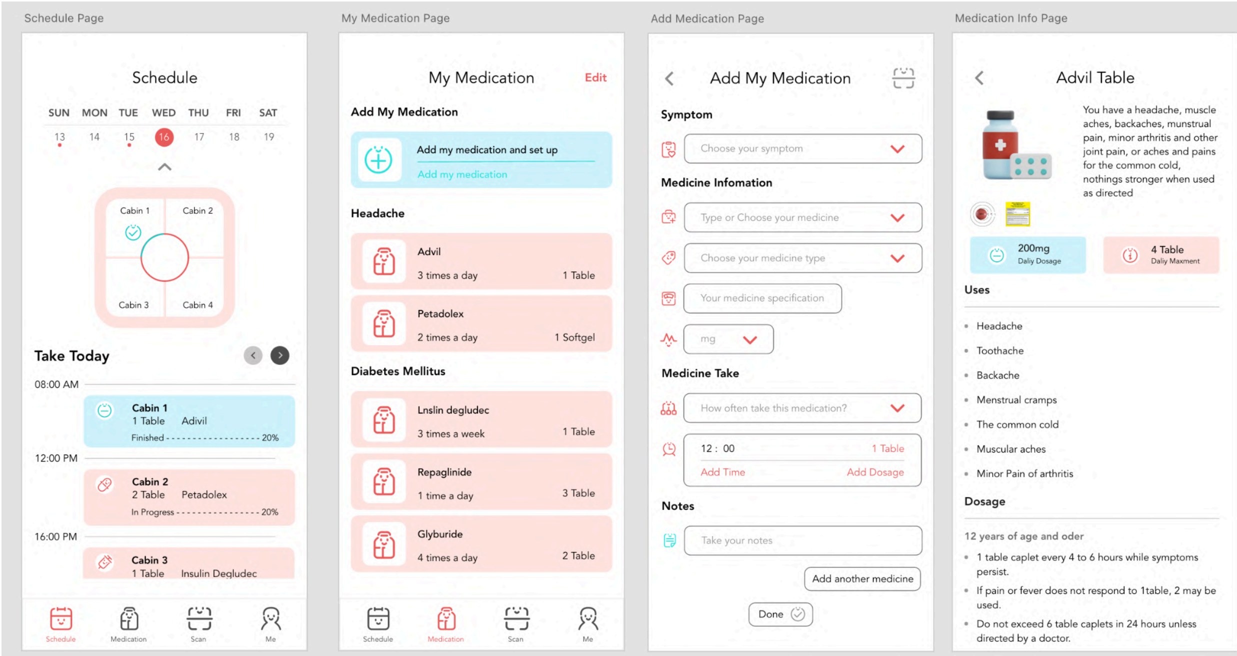

Figure 12. Add Medication Flow

Further supportive features include:

- **Barcode scanning** for over-the-counter medications, expanding usability beyond prescribed drugs;
- **Notification alerts** to remind users of scheduled doses and upcoming refills;
- **Allergy tagging** to highlight known sensitivities and minimize risk;
- **Information sharing** tools, offering secure, format-flexible options (PDF or QR) to transmit medication records to family members or healthcare providers.

Together, these functions translate qualitative insights—such as forgetfulness, digital anxiety, and reliance on caregiver support—into practical features that reinforce autonomy, reduce error potential, and promote trust. They demonstrate how a systems-level understanding of user experience can be transformed into tangible, inclusive digital health interventions.

Smart Pill Box

The physical design of the En-Take smart pillbox was developed to align with the identified user needs concerning physical usability, storage sufficiency, and clear medication prompts (Figure 12). Informed by both ergonomic principles and qualitative data from interviews, the device supports older adults in managing complex medication regimens through a compact, intuitive, and accessible form.

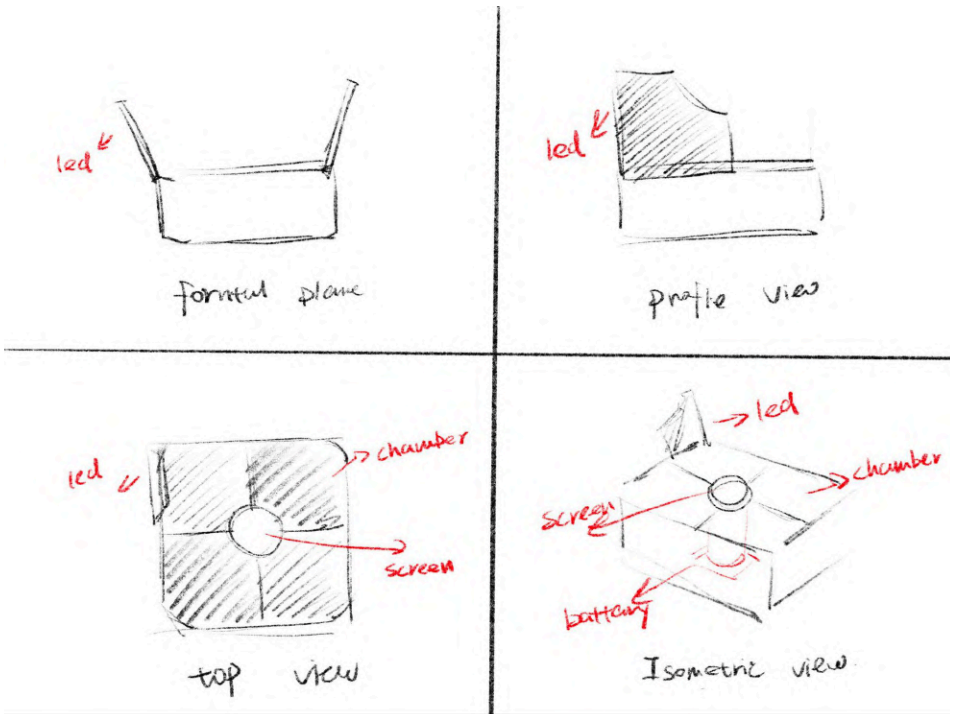

Figure 13. Pillbox Three-View Sketch

Ergonomics and Form Factor

The pillbox was designed to be 120 × 110 × 50 mm, a size intentionally selected to accommodate an average adult hand without compromising grip stability. Human hand anthropometry data suggest an average adult hand breadth ranging from 85 mm to 95 mm (NASA, 1995), making this form factor suitable for one-handed handling without strain. The rounded rectangular profile and softened corners were chosen not only to minimize perceived sharpness but also to facilitate easier grasping, particularly for users with joint stiffness or reduced dexterity due to age-related conditions such as arthritis.

The device's compactness enables ease of use in both domestic and mobile contexts, while its smooth geometry promotes a sense of familiarity and approachability—key considerations in reducing resistance toward assistive health technology among older populations.

Capacity Assumptions

Insights from interviews with older adult participants revealed that many take approximately 10 medications per day, typically distributed across two doses per medication, totaling 20 pills daily. The pillbox is designed to store around 60 pills, thereby supporting up to three full days of use for most older adults with polypharmacy routines. This configuration balances the need for sufficient storage with the importance of portability and reduced device complexity.

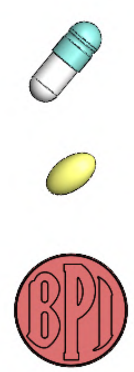

Figure 14. 3D Pills

Compartments are divided to prevent mixing of pills while remaining deep enough to accommodate multiple units without overcrowding. The internal structure was optimized to reduce the cognitive and manual burden associated with sorting and retrieving medications, particularly for users with limited hand precision.

Display Features

The pillbox includes a central circular LCD screen, which serves as the primary point of interaction for the user. This interface was designed to deliver essential information in a visually digestible format, mimicking the logic and layout of familiar smart devices such as digital watches. The display supports:

- **Auditory and visual reminders** for scheduled medications;
- **Real-time clock** and date to anchor user routines;
- **Medication information** summaries, including dosage and timing;
- **Pillbox status indicators**, such as battery level or connection alerts.

These functions were developed in response to interview data suggesting that older adults benefit from redundant cue systems, clearly presented schedules, and low-effort access to core information. By positioning the display centrally and aligning its circular shape with the physical form, the design reinforces spatial and cognitive consistency. This configuration aims to reduce errors and promote a sense of control and reliability in daily use.

CONCLUSION

Limitations

This study presents a focused examination of inclusive design in medication management systems for older adults; however, several limitations must be acknowledged.

First, the participant pool was relatively small—comprising only two older adults and four healthcare professionals. While appropriate for exploratory qualitative inquiry, this limited sample size and demographic scope constrain the broader applicability of the findings. The results should be interpreted as indicative rather than representative.

Second, the study did not include health advisors or personal caregivers, such as home care workers or support staff in long-term care settings. These individuals play a central role in daily medication routines for many older adults, and their perspectives could have revealed additional usability challenges, workflow dependencies, or safety considerations that are not immediately visible to patients or clinical professionals.

Third, although participants engaged in interviews and reviewed app and pillbox concepts, the study did not include real-world usability testing. As such, it remains unclear how users might interact with the system in their home environments, particularly under conditions such as low adherence, physical discomfort, or emergency disruptions. These untested variables limit the conclusions that can be drawn about long-term usage patterns or error recovery behaviors.

A full-scale prototype of the smart pillbox, including detailed design schematics and 3d-printed components, was developed as part of this study to explore the practical application of inclusive design principles. However, the technical specifications are not disclosed due to the early stage of intellectual property protection. This lack of disclosure may limit the replicability and independent evaluation of the design by external researchers.

That said, the limitations outlined here do not diminish the relevance of the insights gathered. Rather, they point toward the need for broader stakeholder inclusion and empirical validation in future work. The findings serve as an essential starting point for iterative development, while also highlighting key questions that should be addressed in subsequent design and evaluation phases.

Next Steps

The next phase of this project will focus on extending the system into a multi-user platform, optimizing the physical device, and validating the current prototype through structured testing.

One future direction involves the development of dedicated interfaces for caregivers and clinicians. Interviews revealed that older adults often rely on external support for medication adherence, yet current systems rarely offer integrated tools for shared monitoring. Designing linked portals for physicians, pharmacists, and family members would enable secure data access, schedule adjustment, and two-way communication—all without increasing cognitive burden on the primary user.

In parallel, continued optimization of the physical pillbox will be prioritized. Initial feedback suggests opportunities to improve tactile affordances (e.g., lid grip zones, feedback on compartment closure), compartment flexibility, and charging mechanisms. Future prototypes will explore how modularity and adjustability can accommodate diverse medication regimens while maintaining portability and ease of use.

Perhaps most critically, a formal user testing phase is being planned. This stage will involve task-based usability assessments with a more diverse participant group, including older adults with varying levels of digital literacy and physical ability. Data from these sessions will inform refinements in interaction flow, interface clarity, and physical ergonomics, ensuring that the final product reflects both technical feasibility and lived experience.

Taken together, these next steps are intended not merely to refine existing features, but to deepen the system's capacity to adapt across user contexts. The ultimate goal remains clear: to deliver an inclusive, responsive, and trustworthy smart medication system that reflects the real-world conditions in which adherence must occur.

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Appendixes

Appendix A - Older Adults Recruit Poster

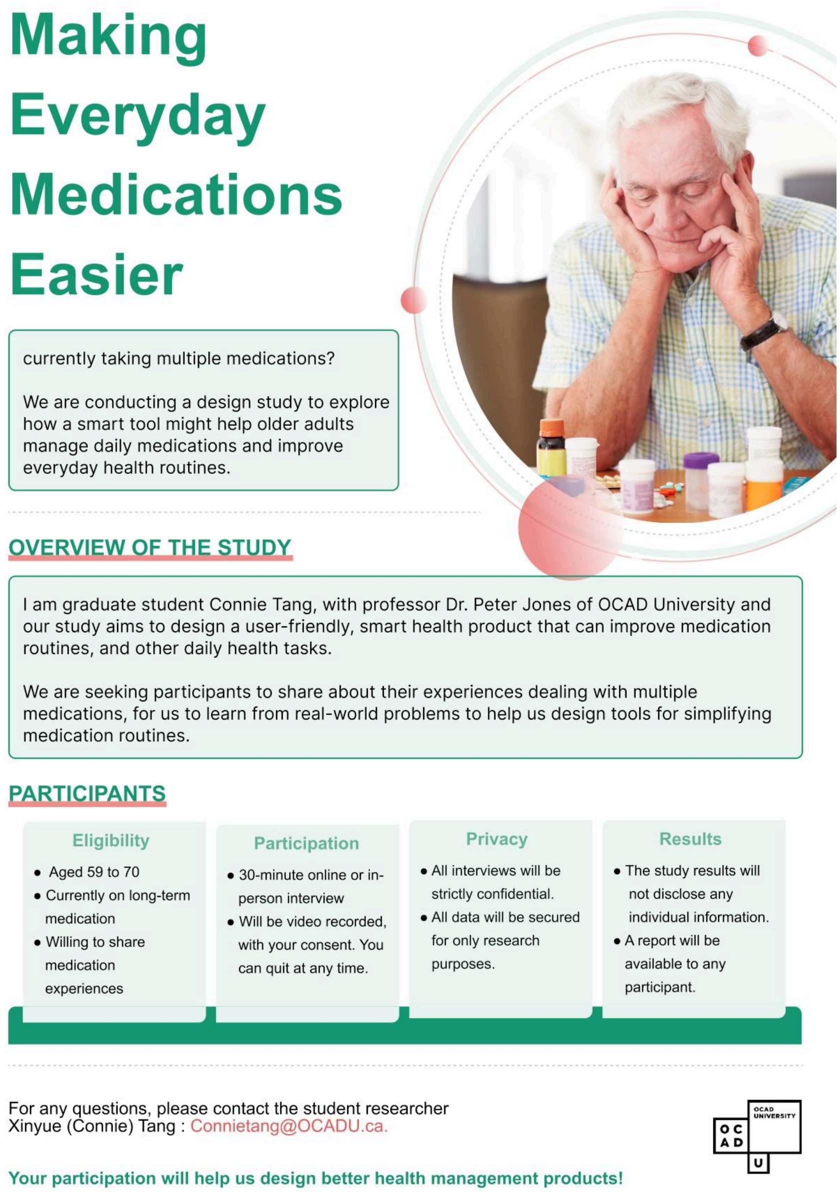
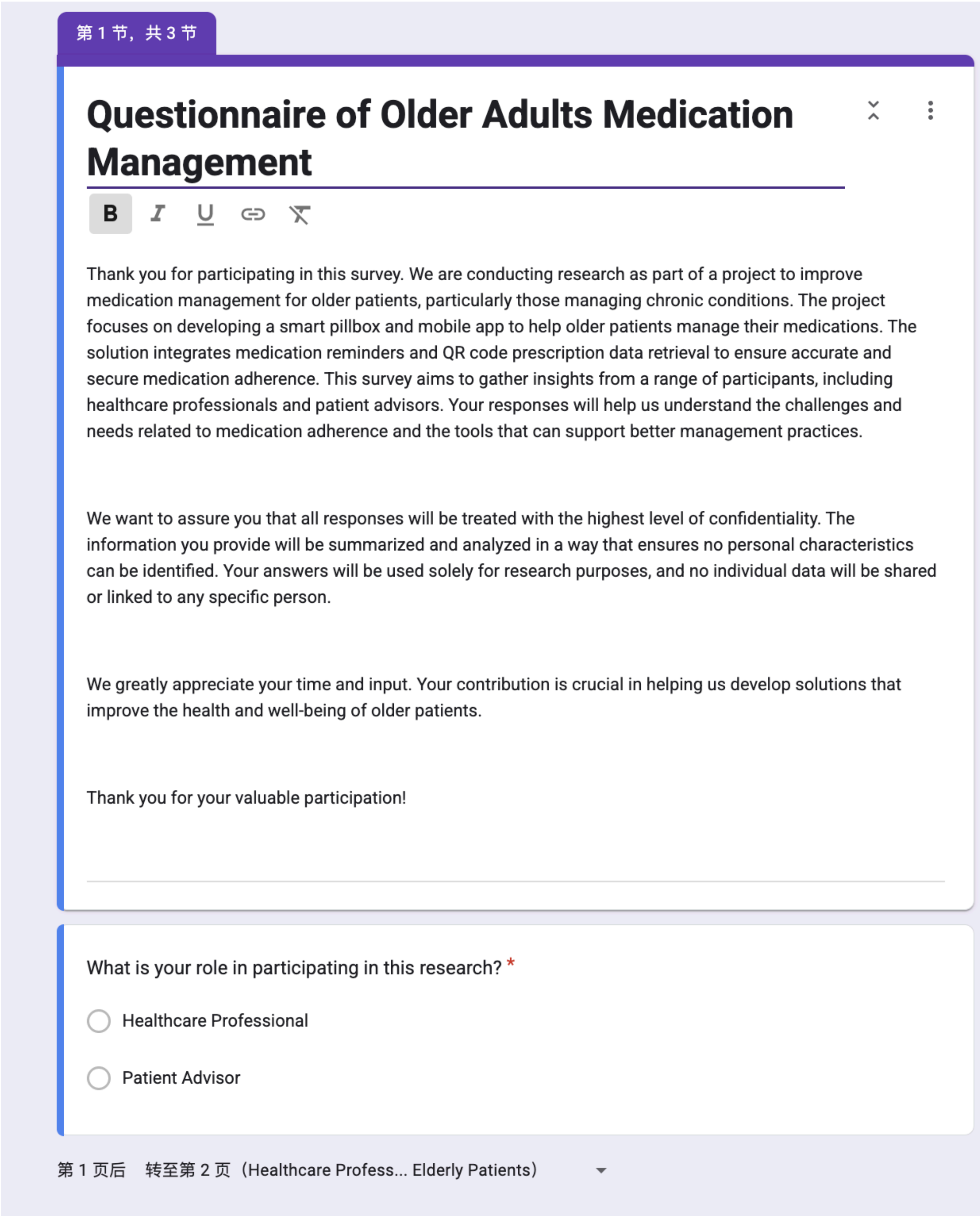


Figure 15. Older Adults Recruitment Poster

Appendix B - Health Professional Questionnaire



第 1 节，共 3 节

Questionnaire of Older Adults Medication Management

Thank you for participating in this survey. We are conducting research as part of a project to improve medication management for older patients, particularly those managing chronic conditions. The project focuses on developing a smart pillbox and mobile app to help older patients manage their medications. The solution integrates medication reminders and QR code prescription data retrieval to ensure accurate and secure medication adherence. This survey aims to gather insights from a range of participants, including healthcare professionals and patient advisors. Your responses will help us understand the challenges and needs related to medication adherence and the tools that can support better management practices.

We want to assure you that all responses will be treated with the highest level of confidentiality. The information you provide will be summarized and analyzed in a way that ensures no personal characteristics can be identified. Your answers will be used solely for research purposes, and no individual data will be shared or linked to any specific person.

We greatly appreciate your time and input. Your contribution is crucial in helping us develop solutions that improve the health and well-being of older patients.

Thank you for your valuable participation!

What is your role in participating in this research? *

- Healthcare Professional
- Patient Advisor

第 1 页后 转至第 2 页（Healthcare Profess... Elderly Patients）

Figure 16. Healthcare Professional Questionnaire Main Page

第 2 节，共 3 节

Healthcare Professional Questionnaire: Medication Management for Elderly Patients

Thank you for participating in this survey. Your insights will help improve medication management solutions for older patients. Please answer the following questions based on your experience working with older patients.

1. How many years of experience do you have working with patients managing chronic diseases?

- ◯ Less than 3 years
- ◯ 3-5 years
- ◯ 5-7 years
- ◯ More than 7 years

2. To what extent is medication adherence is a significant challenge for older patients?

- ◯ None
- ◯ Somewhat
- ◯ Typical problem
- ◯ Severe problem

3. In your experience, how often do older patients have difficulty managing their medications?

- ◯ Never
- ◯ Rarely
- ◯ Occasionally
- ◯ Frequently

4. To what extent have you encountered or used assistive technologies (e.g., smart pillboxes, medication reminder apps) for medication management in older patients?

- ◯ Never
- ◯ Rarely
- ◯ Occasionally
- ◯ Frequently

5. To what extent have you recommended digital tools or technologies to older patients to help with medication adherence?

- ◯ Yes
- ◯ No

6. Are the current tools for medication management sufficient or helpful?

- ◯ Not at all
- ◯ Slightly
- ◯ Somewhat
- ◯ Moderately
- ◯ Highly

7. To what extent would you consider recommending a smart pillbox or medication management app to older patients

- ◯ Not at all
- ◯ Unlikely

8. To what extent do you believe there are gaps in existing medication management tools for older patients?

- ◯ No gaps at all
- ◯ Minor gaps
- ◯ Some gaps
- ◯ Significant gaps
- ◯ Major gaps

9. In your opinion, what is the biggest barrier to medication adherence among older patients?

- ☐ Forgetfulness
- ☐ Complexity of medication regimen
- ☐ Lack of support or guidance
- ☐ Difficulty in understanding instructions
- ☐ Other

10. What features do you think would help older patients use medication management software? (Select up to 4 features)

- ☐ Medication reminders
- ☐ Easy-to-read interface
- ☐ Integration with prescription data (QR codes, etc.)
- ☐ Voice activation or audio assistance
- ☐ Notifications for missed doses
- ☐ Medication history tracking

- [ ] Difficulty in understanding instructions
- [ ] Other

10. What features do you think would help older patients use medication management software? (Select up to 4 features)

- [ ] Medication reminders
- [ ] Easy-to-read interface
- [ ] Integration with prescription data (QR codes, etc.)
- [ ] Voice activation or audio assistance
- [ ] Notifications for missed doses
- [ ] Medication history tracking
- [ ] Simple medication list management
- [ ] Compatibility with other health apps or devices
- [ ] 其他...

11. To what extent would you be interested in participating in future research or pilot testing for new medication management solutions?

- ○ Not at all
- ○ Slightly
- ○ Somewhat
- ○ Moderately
- ○ Highly

Figure 20. - 16. Healthcare Professional Questionnaire Rest Page

Appendix C - Older Patient Interview Guide

Older Patient Interview Guide - Semi-Structured

1. How many medications do you take on a daily basis?
2. Have you had a change in the number of medications in the last year or two? From what number was it earlier?
3. What difficulties do you face when keeping track of or taking multiple medications?
4. Can you describe your daily habits and behaviors related to taking medications?
5. How do you currently keep track of your medication schedule and dosage?
6. Have you ever experienced side effects from your medications? How did you handle the adverse reaction? Is there anything you would do differently in the future?
7. How confident do you feel managing your medications on your own?
8. Have you ever forgotten a dose or taken the wrong one? Could you tell me about those experiences?
9. How do you manage your medications when traveling?
10. Do you use a smartphone or tablet to help manage your medications? How has that experience been for you?
11. How often do you need help with using smart devices or apps? Who usually helps you if needed?
12. How do you feel about the support you receive when using smart technologies?
13. How does your pharmacy assist you with understanding and managing your prescription medications?
14. What features would you like to see in a medication management tool to make it more helpful for you?
15. How do you feel about privacy and security when using technology to manage your health information?

Figure 21. Older Patient Interview Question

Appendix D – Healthcare Professional Interview Guide

<u>Healthcare Professional Guide - Semi-Structured</u>

1. What would you say is the proportion of your patients that are taking three or more prescriptions continuously? How do you take multiple prescriptions and their interactions into account when considering prescribing a new medication for a patient?

2. How many types of medications do your chronic disease patients typically take? What's the maximum number of medications you've encountered for a single patient?

3. What are the common types of problems you see with patients taking too many medications for their ability to manage them on a daily basis?
4. What are the contributing factors? Age, mental acuity, overall wellness, having no family support?
5. Do you often encounter patients who mistakenly take the wrong medications when managing multiple prescriptions? Is this a common issue?
6. Are there patients who choose not to take prescribed medications? What are the common reasons for non-adherence?
7. When prescribing multiple medications, do you frequently encounter concerns about potential side effects from drug interactions?
8. What medication management systems or tools do you know about or recommend for patients? (If at a long-term care) What is used currently at your facility?

9. How effective are those management systems or tools in supporting patients with complex medication routines?
10. What strategies or tools do you find most effective in helping older patients manage their medications?
11. Do you provide training or support for patients using smart devices or apps for medication management?
12. How do patients generally respond to these technologies?
13. What are the biggest challenges you've observed when older patients use technology for medication management?
14. In your experience, what improvements could be made to current systems or technologies to better support medication adherence in older patients?

Figure 22. Healthcare Professional Interview Question

Appendix E - App Design

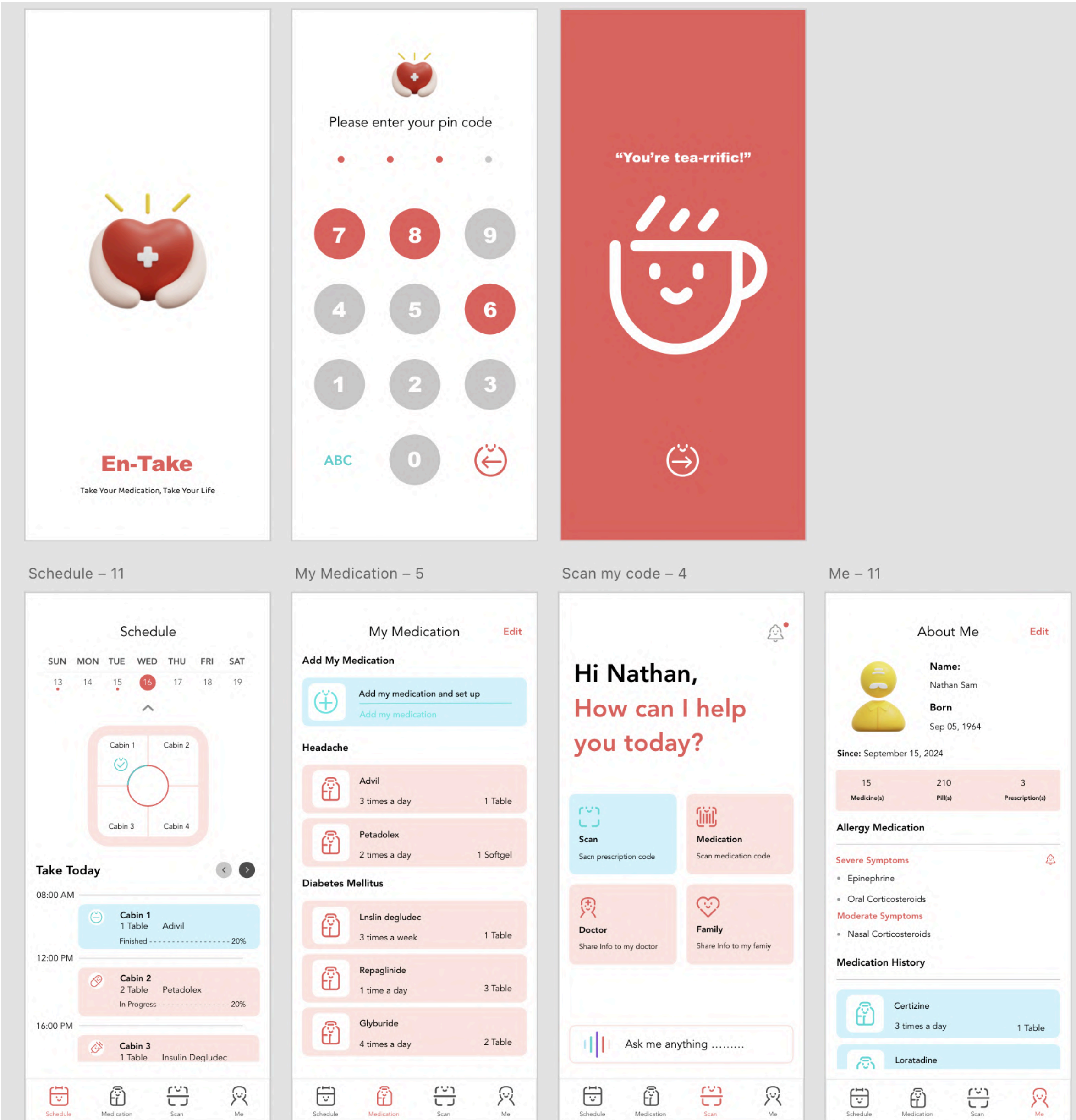


Figure 23. Mobile Application Page 1

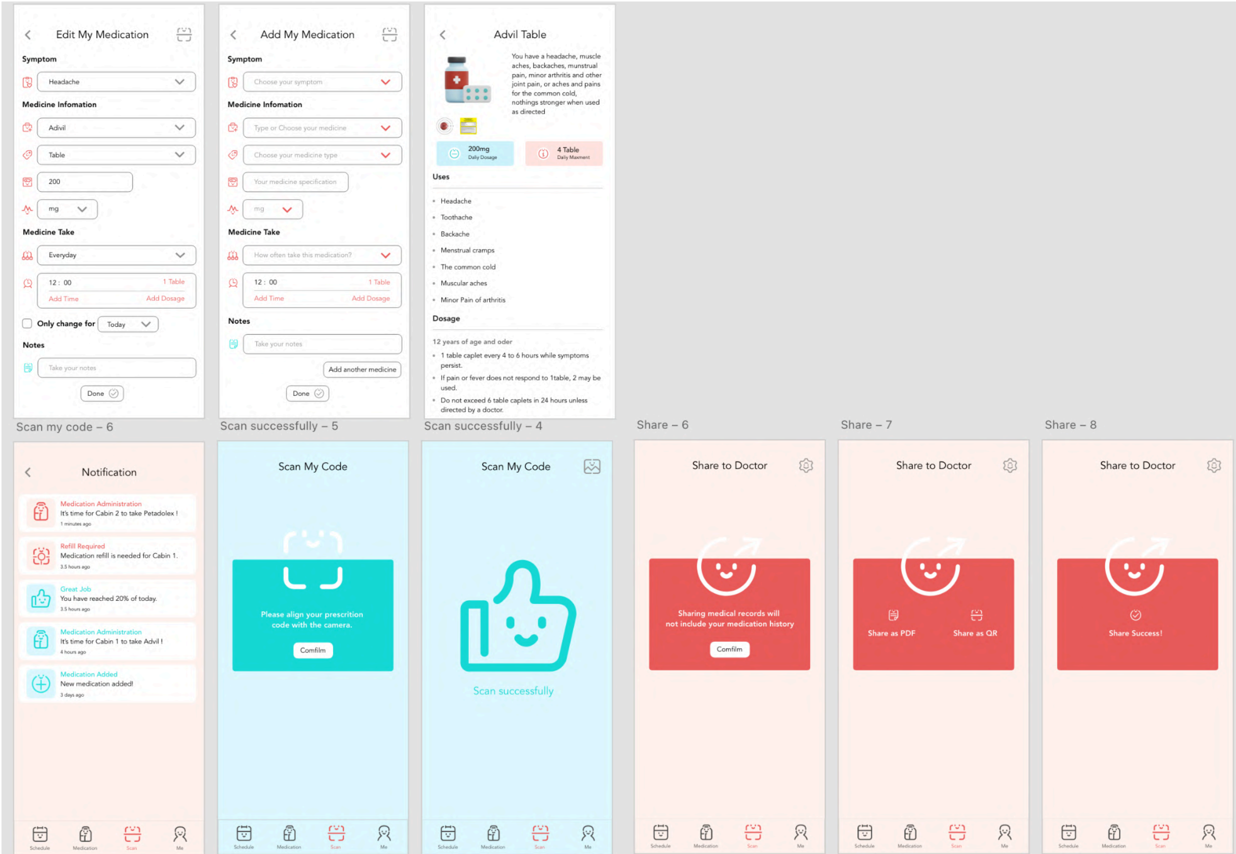


Figure 24. Mobile Application Page 2

Appendix F - Other Reference

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