



A Qualitative Study on Patient Perceptions Towards mHealth Technology Among High Risk, Chronic Disease Patients

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Glossary of abbreviations

CHW- Community Health Worker

FG- focus groups

HIV/AIDS - Human Immunodeficiency Virus / Acquire Immunodeficiency Virus

mHealth- Mobile Health

PACT- Prevention and Access to Care and Treatment

PRO- patient reported outcomes

SES- Socioeconomic status

SECTION I: Introduction

Brief History of PACT and Study Aims

For 17 years the Prevention and Access to Care and Treatment (PACT) Project based in Boston, a joint effort of Brigham and Women's Hospital and Partners in Health, actively developed a Community Health Worker model for care of chronically ill, high risk patients. By integrating community health workers (CHWs) into care delivery, PACT worked to improve the health outcomes of the neediest and most high risk, high expenditure patients.^{1, 2}

Complex patients suffer from multiple chronic conditions compounded by social and economic vulnerabilities. Through the successful dissemination of the community health worker model, PACT aimed to better coordinate care for complex, high-risk patients in order to fully integrate these patients into the health care system and promote better health outcomes while reducing overall medical expenditures.¹⁻³ CHWs work as a team with the patient to help manage the patient's personal care through health coaching/education and accompaniment, allowing for the development of positive relationships with the healthcare system.^{2, 4} PACT's previous success with HIV/AIDS patients has demonstrated the value and effectiveness of community health workers in managing chronic disease.^{2, 3}

As health care costs continue to rise, so do expenditures attributed to only a small number of high cost patients.⁵ By targeting Medicaid and dual-eligible populations with the greatest need, programs such as PACT are facing unique challenges compared to other patient populations: greater patient churn (moving in and out of coverage), greater mobility (not home-bound), use of more than one center for acute care, more challenging behavioral health comorbidities, and less engagement with primary care. The integration of community health workers into patient care has been one way that PACT has demonstrated success in managing care for complex patients, but further innovation is necessary in order to ensure equity of care for our most vulnerable patient populations.

In recent years, mobile health technology (mHealth) has emerged as a potential low cost, high efficacy intervention to care for complex patients with

multiple medical and behavioral health comorbidities as well as high preventable inpatient costs⁶. With over 1 billion smartphones and 5 billion mobile phones around the world, there has been an explosion in the development of mobile applications designed to aid in health care management across the entire spectrum of disease^{7, 8}. Given mHealth's potential as a cost-effective innovation to aid in patient care management, PACT is interested in how mHealth technology can serve as an additional means of improving care for our most vulnerable patient populations living with complex, chronic conditions. Altogether, community health workers and mobile health technology hold great promise for improving engagement and continuity of care for vulnerable patients with resultant potential to improve care and health outcomes while reducing medical expenditures.⁹

This qualitative study aims to explore perceptions on the use of mobile health to aid in care management of high risk, low socio-economic status (SES) patients living with chronic disease. Through focus groups (FG) with the target population, we aim to determine the feasibility of utilizing mHealth technology to complement care of high risk patients living with chronic disease and we hypothesize that our patient population will be receptive towards using mHealth technology as a tool for health care intervention and patient reported outcomes (PRO) collection. Additionally, we will assess attitudes regarding desired mHealth applications as well as facilitators and barriers of adopting mHealth in order to best inform future mHealth design. Given potential effects of age on technology literacy and accessibility, focus groups were stratified by age (over and under 55) in order to explore differences in attitudes towards mHealth technology between older and younger subgroups.¹⁰

Specific aims

1. To determine the feasibility of using mHealth technology for health care management of high risk adult patients living with chronic disease.
2. Use the data gained to inform potential implementation of mHealth technology in order to best meet patient and provider needs.

The Emergence of mHealth

Mobile health (mHealth) technology is broadly defined by the World Health Organization as “an area of electronic health (eHealth) that provides health services and information via mobile technologies such as mobile phones and PDAs”.⁸ Mobile technology and devices have seen an unprecedented global surge in usage worldwide with more than 6.8 billion mobile subscriptions globally and almost 80% of the world population in possession of a mobile device.¹¹ Following the introduction of the iPhone in 2007, commercially available smartphones (mobile devices with advanced computing capabilities) have emerged as the most popular form of mobile technology with an estimated 20% of the world population in possession of a smartphone.⁶ Given ever-improving technology as well as widespread availability of mobile devices, mobile applications designed to meet healthcare needs have likewise flourished with an estimated 500 million people having health applications on their mobile devices.⁶

Increasingly novel mHealth applications are being developed for providers and patients alike in areas ranging from medical education and health promotion to medical diagnostics and disease monitoring.¹² For example, providers may use mHealth apps for simple functions such as a quick reference tool to review guidelines or clinical cases. However, with increasingly powerful smartphone capabilities and the incorporation of peripheral attachments, mobile devices are transformed into advanced imaging software with real-time biometric data collection abilities allowing for advanced medical diagnostic capabilities.¹² Patients also benefit from a diverse array of mHealth applications, often through tailored health aids targeting specific lifestyle modifications or daily self-management of care. Common examples of mHealth applications include providing appointment reminders, improving patient medication compliance and providing psycho-social support for targeted health promotion programs such as smoking cessation.^{12, 13}

Proponents of mHealth technology claim that the ability to design low cost, patient-centered interventions may potentially reduce care disparities through the

efficient and accurate delivery of individualized health care education and services.¹⁴ The ability to communicate with health providers through mHealth platforms may bridge issues of access and simplify complexity of care.¹⁵ mHealth allows for quick dissemination of accurate medical information to patients, but also provides a two way street for reporting information to providers. For example, patient's are able to monitor, track and relate to their providers pertinent biometric data as it relates to their chronic medical condition (e.g., glucose levels for diabetics, blood pressure for hypertension), ultimately strengthening the partnership between patient and provider teams and allowing the patient to be an activate participant in their health care.¹⁴ The bidirectional transfer of information through mobile devices is inherently appealing due to the ability to collect patient-reported outcomes data, allowing providers to monitor outcomes and populations longitudinally. Furthermore, creating such a platform for near instantaneous data collection and monitoring allows for exciting opportunities for live medical intervention and outcomes evaluation.

Overview of the mHealth Landscape

Furthermore, the widespread adoption of mHealth is not limited to the United States but has become a global phenomenon. Thanks in part to decreasing costs of telecommunication infrastructures as well as simpler "lo-tech" options such as plain text message based interventions; mHealth applications are being increasingly used in low resource settings such as sub-saharan Africa with most global health applications focusing on medication adherence, health-worker communication, health education and emergency/disaster response efforts.^{8, 16, 17} One systematic review of 62 articles examining mHealth efforts for HIV treatment and prevention by Catalani et. al highlighted promising efforts from multiple small-scale pilot projects which provided some evidence that mHealth can improve linkage to care, retention and adherence to anti-retrovirals in low resource settings.¹⁸ Despite these promising results, the authors noted that the field of mHealth and HIV research is still very young and given the limited nature of these small pilot studies, future efforts should be aimed at upscaling these

projects with more rigorous mHealth study designs.

For many low resource settings challenged by disease epidemic and a shortage of medical personnel, CHWs serve as essential components of a patient's care team, often providing the only bridge between formal health care systems and surrounding communities.⁹ Given how stretched these CHWs can be, mHealth has been recently developed to aid CHWs with managing their patient panel and enhancing delivery of care services provided by CHWs.¹⁶ A systematic review by Braun et. al., reviewed 25 research articles regarding the use of mHealth tools by community health workers. The findings are notable for showing increased utilization of mHealth over the last decade with common uses including the ability to collect field data, as an educational resource for both continued self learning and patient health education and as communication tool between patient and providers.⁹ Additionally, the review showed increased utilization as well as effectiveness of care delivery in the areas of maternal and child health, reproductive health and HIV, particularly for CHWs based in Africa.⁹ While these early results are promising, the majority of the reviewed articles are small-scale pilot studies with limited data on cost effectiveness or long-term outcomes, further underscoring the need for well designed prospective studies to evaluate mHealth applications.

With the sudden explosion of mHealth applications over the past decade, the field of mHealth research has naturally emerged as an increasingly active field in order to examine the gamut of mHealth applications. However, despite the feverous output of mHealth application development, many aspects of the mHealth research seem to be lagging behind. In an effort to map out the past decade of mHealth research, Fiordelli et al, conducted a systematic review of 117 articles published between 2002-2012. In general, the state of mHealth research and rigor showed progressive growth with the amount of studies doubling between 2007-2008 and more varied study designs being implemented in recent years.¹³ The majority of studies focused on mHealth and chronic disease with very few studies examining mHealth for acute conditions.¹³ One

glaring omission revealed in this systematic review is the near total omission of studies using smart phones or more advanced mobile phone capabilities despite the widespread commercial availability of smart phones over 5 years ago.¹³ Given the popularity and sheer abundance of mHealth smartphone apps, this represents a significant research void. Furthermore, the authors note that recent research has switched focus to assessing outcomes versus assessing the technology itself, but adequate large-scale studies have yet to be done in order to assess long-term mHealth impact and outcomes.

Although the vast majority of mHealth studies examine mHealth applications for chronic conditions, well-powered prospective trials examining mHealth's effects on self-management are currently lacking.¹⁹ A recent Cochrane systematic review examining mobile phone messaging applications for self-management of chronic disease showed some albeit limited evidence suggesting positive benefits of message based interventions in patients with diabetes, hypertension and asthma.¹⁹ However the evidence is noted to be weak given the limited number of enrolled patients in these studies and the short duration of enrollment. Another Cochrane review examined mHealth interventions for preventative health care as a method to mitigate risk factors associated with progression to more chronic, debilitating diseases and was notable for strong evidence in one smoking cessation trial showing that regular supportive messages can help patient quit smoking, at least for the short term.²⁰

For now, there exists a substantial gap as the generation of non-evidence-based mHealth applications continues to outpace research validating their merits.¹² This may in part reflect the young nature of the field with relatively few published prospective studies and current trials still in progress. Additionally, this may be secondary to the rapid rate of mHealth innovation and inherent time delays associated with designing and completing a well-planned experiment and subsequently publishing scientific evidence.¹² Despite great enthusiasm for mHealth, there exists a large need for evidence-based research to assess long term outcomes and implementation of mHealth interventions which will hopefully

be addressed as more well designed prospective studies are underway.^{13, 16}

Significance and Innovation

Chronic disease such as diabetes, HIV and heart disease affects patient over an extended period of time with progressive burdens placed on both financial and social supports leading to poor patient quality of life and health outcomes.¹⁹ With the emergence of mobile technologies and partnerships with primary care networks, there exists a potential for a radical shift in the delivery of care that extends beyond care that can be provided solely within the clinic. Altogether, mHealth technology has the potential to reduce patient barriers preventing access to care, improve communication with health providers while providing care teams with a platform for live intervention, monitoring and population management. This study aims to assess patient attitudes towards mHealth technology in order to best tailor interventions to the needs of high-risk adults patients living with chronic disease. Ultimately the results of this pilot study may inform mHealth design allowing for optimal evaluation of mHealth's merits in future prospective studies.

SECTION 2: Methods

Design

This project is a qualitative study using focus groups to assess patient perceptions of mHealth technology among patients living with chronic disease. The semi structured interview guide explored patient attitudes and perceptions surrounding 3 domains: 1) accessibility of mHealth 2) desired mHealth applications and 3) mHealth design.

Study Sites

All recruited patients received their primary care at the Brigham and Women's Hospital Jen Center for Primary care. Each focus group session also took place at the Jen Center given presumed familiarity and ease of access for recruited patients. The study was approved by the Harvard University Faculty of Medicine

Committee of Human Studies. Prior to each focus group, participants gave informed consent and were supplied with documentation detailing the purpose and rationale of the study, associated risks and benefits as well as contact information.

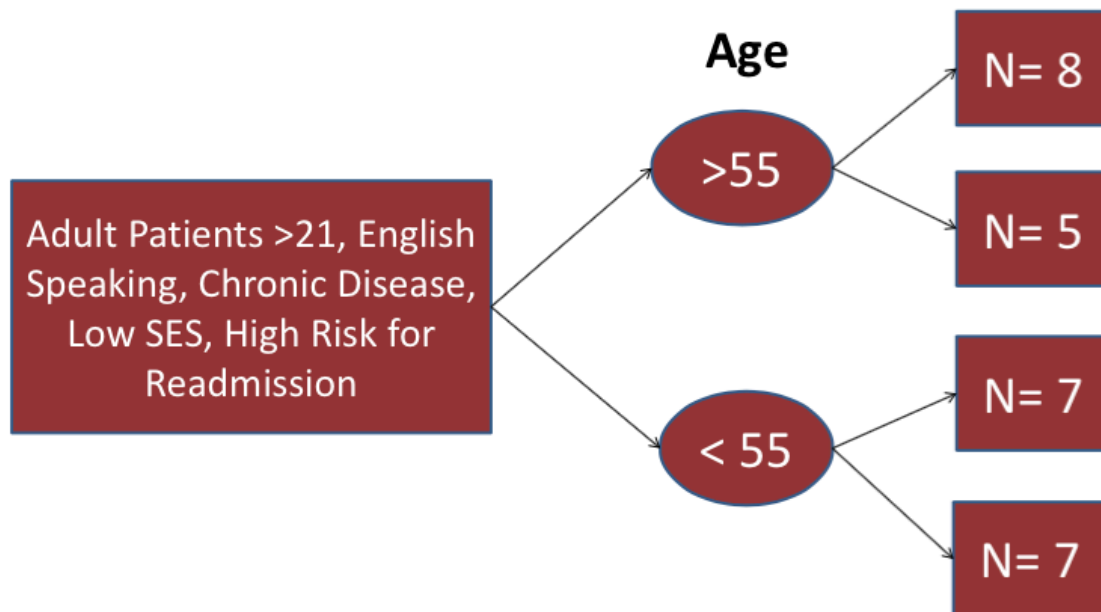
Participant Recruitment

This qualitative study consisted of 4 focus groups stratified by age >55 y.o (n=8 and 5) and <55 y.o. (n=7 and n=7). Inclusion criteria include adult patients >21, English speaking, low SES (identified by clinic staff as Medicaid/dual-eligible) and living with at least one chronic disease. Children and non-english speaking patients were excluded from the study.

Active recruitment took place either in person or over the telephone. For patients with scheduled Jen Center for Primary Care appointments, appropriate candidates were identified by the patient's providers prior to their visit, and these patients were directly solicited in the Jen Center for Primary Care waiting room. Additionally, a call list was generated from the provider's primary care panel, which identified potential candidates for phone solicitation. Interested participants scheduled a tentative focus group date and received follow-up letters finalizing the logistics of their participation. Given potentially high no-show rates, efforts were made to schedule up to 15 participants for each FG date. Scheduled patients were given reminder calls 3 days prior to their focus group session to reconfirm participation and answer any questions. For incentives, a 20\$ gift card was presented to all participants who attended their scheduled FG session. A light dinner and refreshments were served at the start of each focus group. Additionally, to cover transportation costs participants either received a parking voucher or 5\$ prepaid MTBA ® ticket if they required public transportation.

Figure 1:

Enrollment of Patients into Focus Groups.



Focus Group Methodology and Qualitative Data Analysis

Each focus group was moderated by a trained focus group moderator and lasted approximately 1 hour and 30 minutes. At the onset of focus group, the moderator reintroduced the concept of mHealth and explained the basic courtesy and ground rules for participating in a focus group. The moderator followed a focus group instrument designed to explore the following 3 key domains:

- 1) **Accessibility** – How accessible/feasible is mHealth to our patients?
- 2) **Applications and Concerns**- Which mHealth applications would be most helpful? What are your main mHealth concerns?
- 3) **Design** – What are the key facilitators and barriers with regards to mHealth design?

To ensure an exhaustive exploration of these domains, discussion was facilitated by seven key guiding questions with corresponding probes available to promote deeper discussion, clarify important discussion points and redirect participants as needed [see appendix for complete FG instrument]. A notetaker was present to

record important quotes and observations from each FG session. Following each FG session, the notetaker and moderator debriefed for 15-20 minutes to discuss the FG and summarize important points.

Additionally, each FG was audio recorded and subsequently transcribed verbatim in order to provide full transcripts for content analysis. All transcripts were uploaded into the qualitative data analysis software MaxQDA and analyzed for emergent themes using content analysis based on grounded theory methodology.²¹ Transcripts are broken down into quotes and as unique concepts are identified, they are assigned descriptors and undergo coding. As this data is being coded, emerging relationships between concepts are recognized and categorized into key themes for analysis and potential hypothesis generation.

Section 3: Results

Participant breakdown

A total of 27 patients participated in four focus groups with the target population stratified by age >55 y.o (n=8 and 5) and <55 y.o. (n=7 and n=7) resulting in the identification of 22 key themes [see table 1: Summary of Key Themes]. Of note, within our study, 25/27 patients have regular access to a mobile device, 17 of which endorse using their mobile device as their primary phone. Regarding the gender breakdown, of the 27 participants only 3 were male with 2 in the >55 y.o. age group. For this study additional descriptors including health status were not recorded.

Domain 1: Accessibility of mHealth to target population

With 92.6% of patients having regular access to mobile devices and many participants already using their devices for health related reasons (programming medical appointments into calendars, fitness apps, prescription refills), there was a largely **positive reception** towards mHealth technology with many believing that widespread adoption of mHealth is **the direction we are already moving towards**. One major theme involved the **pervasiveness** of mobile technology in

every day life and increasing **dependence** on mobile devices as noted by one participant in the <55 subgroup:

“It’s almost like a lifeline, I keep all my contacts , appointments and personal information on there, it’s almost like without my phone I can’t do anything without it”

Another participant agreed with this comment, further emphasizing the importance of mobile devices in her own medical care.

“For me it is definitely important and a lifeline. If there is ever a health emergency I have all my emergency contacts, if I need a refill I shoot a text. I even email my doctors on my phone. I use it almost every day!”

While participants were overall receptive towards utilizing mHealth in their own care self-management, 3 participants in the older patient subgroup expressed concerns given current or past struggles with mobile devices.

“For me it is mobile phone 101, I am crawling, not even walking yet and it’s a pain to figure it out, especially since I am not very technology savvy.”

Regarding past frustrations with using mobile devices, having someone such as a family member or friend sit down and **provide one on one teaching** has been the most effective way to overcome these initial difficulties. Despite the range of comfort levels with mobile technologies, it is worth noting that participants were enthusiastic about potential mHealth applications and expressed their **willingness to learn** in order to utilize mHealth.

Along with assessing the feasibility of utilizing mHealth in our patient population, attitudes towards how mHealth could affect access to care and communication with provider teams were additionally explored. In all four groups, the ability to **quickly communicate with providers** in order to meet their health needs was an apparent theme and area where mHealth held great promise.

“I know having a phone so that I can quickly communicate with my doctor to get something like a prior auth has been really helpful and this technology could be very helpful for disabled patients like me who may need medical attention quickly”

However, study participants still acknowledged that adopting mHealth could have the *opposite* effect on communication with health teams. The increasing utility and integration of mobile communication technologies certainly has merits but there is a fear that overreliance on technology diminishes our engagement with community and the human value gained from live face-to-face interaction.

“I remember when you had to visit people to know what’s going on in their life. Now it’s all through the computer. I feel like I was forced to learn to text since that’s the only way my kids will communicate with me!”

Taken to the extreme, a less common but important theme discussed at length among one of the older patient FGs is that widespread adoption of similar technologies in medicine could lead to **depersonalized interactions** with the medical community.

“Sometimes I wish we did not have it, with all our ipads and iphones we do not see each other anymore, we have lost our intimacy and we have gotten so lost in technology. I want my doctor to sit down and talk with me”

Domain 2: Exploring Desired mHealth Applications and Concerns

In exploring which potential applications of mHealth would be most useful, study participants showed great enthusiasm for apps that allowed for **self-monitoring and self-management** of their health needs.

“I think it would be great to have an app that asks you a series of questions like ‘Did you exercise today? Check. Did you take your medicine today? Check.’ Just some questions which help you to remember the things you should be doing and can check off for the day.”

While many potential self-management strategies were discussed, programmed **medication reminders and appointment reminders** were the two most often cited useful features by study participants. These type of reminders and the ability to self-track your progress over time was felt to be a rewarding way to use the mHealth and promote healthy behaviors. Furthermore, the **two way**

communication with health providers allowing for real time medical decision making and health interventions was another highly desired mHealth application.

“I know being able to report things like my weight or sugar would be a great way to have my doctor receive information and let me know if something is wrong with a medication I’m taking or if we need to make some changes”

Some participants felt that ultimately, the benefits of this type of real-time communication and personalized intervention could **prevent unnecessary illness and health care costs.**

“I feel if you are reporting back to the doctor for the high blood pressure or diabetes, reporting back these numbers can help in a way to not prolong illness, it can almost stop it before it goes overboard. And if your doctor sees that your blood pressure is high and you need medication, she can prescribe that medication over the phone to you and get it to the pharmacy within a day time frame. What you give to them is what they give back to you.”

Although the ability to self-report and self-monitor data were almost universally supported, participant attitudes towards receiving test results and personal health information from medical providers were somewhat mixed, dependent on the sensitive nature or urgency of the health data being received.

“They don’t give things like AIDS results over the phone, you have to come in, and I think all things should be like that.”

However, participants were receptive in cases where quick reporting of test results could **lead to immediate changes** in medical decision-making.

“I know for certain things, especially if it’s an emergency, I would appreciate being notified. I know my PCP tells me things like if my potassium is low and she will call me to let me know and prescribe me some potassium. I don’t really like getting test results but in cases where it might be an emergency I would really like to know.”

Ultimately, **confidentiality concerns** emerged as one of the major recurring themes seen as a barrier to successful adoption of mHealth. Participant

responses reflected suspicious and mistrustful attitudes towards information and wireless communication security in the digital age. This was noted by several quotes revolving around “big brother” and fear of online hackers.

“There are so many geniuses out there that can hack anything!”

In general, older patients were more distrustful of using their phones to transmit or receive health data, with more explicit fears of **having health data stolen** and **the lack of transparency** in who potentially accesses their information.

“I’m definitely concerned about where my information is going I would never know if this stuff is going out to one person, where its going and who sees it”

Additional concerns brought up by study participants included potential monetary **costs and expenses** assumed by the patient, which would negatively affect mHealth uptake.

“This all sounds great and all, at the end of the day who is going to pay for this? I hope not me”

Domain 3: Informing mHealth design by understanding perceived facilitators and barriers of mHealth technology

Study participants varied greatly with regards to technological literacy and comfort and therefore a wide range of inputs were discussed with many design pros and cons noted. Younger patients expressed a preference towards **touch screen** and **text message based input interfaces**. Older patients in this study expressed a strong preference for **interactive voice response** and simple 1 button inputs for binary yes/no style prompts (e.g, press 1 if you have taken your medication today?). These patients cited potential **mechanical** barriers such as difficulty reading small screens or finding texting too slow or difficult as reasons for this design preference as noted by the following participant.

“Sometimes with my eyes I have difficulty reading my screen and sometimes the screen, like the iphone has too much glare making it even harder to see.”

However, the major theme and desired design element which would facilitate adoption of mHealth technology was **customizability and personalized mHealth tailored to individual preferences.**

“I think it would be best if we had all the options, that way you can pick the ones you like or find most helpful...like I may want the medication reminders but not the appointment reminders”

Overall, participants felt it would be best to have a user interface that allows users to opt in and out of various features so that they can focus on utilizing the aspect of mHealth technology that would be most helpful for self-management of their care without being seen as overwhelming. However, given earlier concerns regarding confidentiality, **security features such as passwords/access codes to protect sensitive health information** emerged as a universally desired design element among study participants. Mobile devices are easily lost or misplaced and therefore security features to protect sensitive data were deemed a necessity. While protecting health information from strangers is an obvious concern, the importance of keeping health information private from loved ones and close contacts was also voiced by participants.

“I’d definitely want some sort of passcode system to protect my information... like even my spouse saw it, I know I wouldn’t want him to see any of my health information unless I wanted him to.”

Section 4: Discussion

Chronic health conditions are both pervasive and costly with an estimated half of the adult US population living with at least one chronic condition and yet accounting for over 90% of health care expenditures.⁵ Given such unsustainable healthcare spending and the current landscape of healthcare reform, tremendous pressure is felt by health care professionals, policy makers and health care consumers to identify low cost, high-efficacy patient centered solutions.¹⁴ At the same time, mobile wireless communication capabilities have become more

powerful, widespread and cheaper than ever before allowing for the emergence of mHealth as a promising solution to the health care spending puzzle.⁵

This pilot study indicates that high-risk patients living with chronic disease find mHealth accessible with many participants remarking that widespread utilization of mHealth is already the direction we are moving towards. Across both subgroups of patients, attitudes were enthusiastic towards embracing mHealth technology. All participants had some existing familiarity and comfort with mobile devices with many participants already using their mobile devices for health related reasons. While some of the older and less tech-savvy individuals noted current difficulties using mobile devices, they expressed a desire to learn given perceived health benefits and felt that one-on-one teaching, typically with a family member or a close friend would be the best way to facilitate learning.

Additionally, this study identifies desired applications as well as facilitators and barriers to maximize the success of future mHealth design. There exists a wide range of technological literacy and comfort across the age spectrum necessitating a highly customizable and tailored user interface. This is consistent with other studies examining design preferences for mHealth applications for self-management in patients with various chronic conditions and the movement towards delivering personalized patient centered mHealth interventions.²² Some general differences in design preference did emerge between older and younger patients; with younger patients preferring text based or touch screen user interfaces. Older patients in this study preferred interactive voice prompts given difficulties with typing on smaller keyboards or reading small font.

Through tailored, patient centered interventions, mHealth avoids the risk of depersonalized care and study participants most desired mHealth interventions that facilitate daily self-management of their health with medication reminders and appointment scheduling considered the number one and two most useful features of mHealth respectively. Participants were particularly excited about the potential for two-way communication with provider teams and how monitoring their chronic conditions in this way may allow for timely medical interventions, preventing unnecessary illness and hospital spending. Despite

these potential financial savings however, participants in this study highlighted a preference for avoiding personal monetary costs/expenses associated with using mHealth. Instead, the service should either be free, cost a negligible amount or be covered by insurance. Finally, participants were very vocal regarding their confidentiality concerns and the lack of privacy in today's digital age; citing concerns of "hackers" and mentioning "big brother" to express their mistrust regarding the current state of digital information security. With the recent "Sony Hacks" and other high-profile cyber threats and online hacking attacks frequently making the news, their attitudes likely mirror the greater national sentiment regarding the relative like of safety in online digital security. Therefore, addressing confidentiality concerns and maintaining digital security of private health information are paramount to successful adoption of mHealth.

Limitations

Since this is a small-scale qualitative study, there are immediate limitations of the design that affect the ability to generalize the results to our target population including selection bias. Our recruitment efforts aimed for ~15 patients per session to ideally meet our goal of 7-10 patients per FG. High no-show rates resulted in relatively smaller sample sizes. Furthermore, despite active recruitment efforts, the voluntary nature of FG design leads to participant self-selection and individuals with stronger opinions are more likely to participate in the study or potentially dominate discussion. Given that all patients were recruited from one primary site within Boston, this is less likely to reflect the broader population of adults living with chronic disease. Similarly, Boston has areas with large Spanish, Portuguese and Haitian Creole speaking populations. We intentionally limited our design to English but language, and by proxy culture, is likely to influence perceptions on mHealth feasibility and design. This study targets low SES patient populations but given the disproportionate percentage of disadvantaged and underserved patient populations that are primarily non-english speaking, we are excluding information from a significant portion of our intended patient population who may benefit from mHealth technology.

Additionally, it is worth noting that of the 27 participants, only 3 were male and it is uncertain if gender differences may have a potential effect with regards to FG participation, mHealth accessibility or design preferences.

By design, we did not stratify by nature of the chronic condition in order to make the data broadly applicable and not tailored to any individual disease. We enrolled patients living with chronic conditions but the nature of the disease itself as well as the patient populations they typically affect is likely to affect attitudes and perceptions towards mHealth.^{10, 23} Although our interview guide was designed so that patients can discuss mHealth broadly without having to divulge personal health information, personal insights and experiences with disease largely informed perceptions of mHealth and thus were shared in discussion. This may create unintended discomfort for some participants who would otherwise feel more open in a non-mixed disease setting. For example a single HIV/AIDs patient might feel uncomfortable participating in the focus group while a congestive heart failure patient may be more inclined to offer their views on mHealth technology.

Conclusion and Future Directions

This study suggests that high risk, adult patients living with chronic disease are willing to embrace mHealth to assist in self-management of chronic health conditions. One particularly important theme is that patients are not only willing to embrace mHealth, many feels as if this is the current direction of health technology services and delivery. This is certainly supported by the development and commercial availability of over 31,000 free and paid health applications on smartphone app stores a mere 7 years since the iOS App Store opened publicly in 2008.²⁴ Despite such obvious enthusiasm for these applications, there is almost zero evidence to support their use in care management as the research community has not kept pace with production and there is a paucity of studies evaluating long term mHealth outcomes.^{12, 13} This gap is even more striking given the current lack of mHealth studies evaluating smartphone apps or more advanced mobile device capabilities.

As health care professionals, researchers and policy makers we are stewards of health care and it is imperative that well-designed prospective research evaluating long term outcomes are underway in order to fill this information gap. This study contributes to the body of research informing mHealth design to maximize its potential for success among high risk patients living with chronic disease, thus setting up the most optimal conditions for long term evaluation of mHealth technology. By ensuring well-designed mHealth applications, we can then create a live platform for collection of patient report outcomes measures and evaluation of targeted interventions on patient health outcomes, utilization patterns and medical expenditures.

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Table 1: Summary of Key Themes

Domains	Patients Under 55 y.o.	Patients Over 55 y.o.	General Themes and Comments
ACCESS Is mHealth tech accessible to the target population?	<ul style="list-style-type: none"> Most patients already use cell phones for medically related reasons (etc. setting up appointments, programming calendar appointments) Belief that this is already the direction we are moving in. 	<ul style="list-style-type: none"> Generally less comfortable using cell phones for functions other than calling, but all expressed that they would be willing to learn. Some concern that using phones this way would prevent face-to-face contact with a physician. Themes of ever-increasing adoption of technology leading to depersonalized care frequently came up. 	<ul style="list-style-type: none"> 25/27 patients (92.6%) have regular access to a mobile device Improved ability to maintain constant and speedy communication with health team.
APPLICATIONS AND CONCERNS What would patients want to use mHealth for? What would they not want to use it for?	<ul style="list-style-type: none"> Generally felt that using cell phones in this manner would improve access to care 	<ul style="list-style-type: none"> Patients over 55 were generally more distrustful of using their phones to transmit or receive health data. Much greater concern among patients over 55 that this data could be stolen compared to patients under 55 Believed that using the phone for self-reporting (daily weight, blood glucose, etc.) would be highly beneficial 	<ul style="list-style-type: none"> Medication reminders were considered the most beneficial features of mHealth followed by appointment reminders. Biggest concerns were confidentiality. Who has access to data? Where is it going? Patients split about receiving test results via mobile technology. Concerns about expenses and costs. Potential to prevent unnecessary medical utilization.
DESIGN What are important facilitators and barriers of mobile technology?	<ul style="list-style-type: none"> Preferred text-based responses. Touch Screen interface would be helpful. 	<ul style="list-style-type: none"> Generally preferred Interactive Voice Response (voice response to automated prompts) Concerns that texting is too difficult (arthritis, small keys) 	<ul style="list-style-type: none"> Patients believe that there should be an access code to prevent others from accessing sensitive health information. Single button responses for medication reminders. (Press 1 if you have taken your meds today) Custom tailoring of mobile tech frequently came up.

Tables and Figures

Appendix

Focus Group Instrument

Domains	Questions	Probes
<p>Accessibility Is mHealth tech feasible/accessible by the target population</p>	<p>1. [Ice Breaker] How many of you currently use mobile technology? How often do you use it? For those of you who don't use it, why?</p> <p>2. Do you currently use your cell phone for medical reasons?</p> <p>3. How comfortable do you feel about using mobile technology to help manage your health care? Why?</p>	<p>1. What about those people who have only started using cell phones, what were some of the initial barriers? -All of us at one point in our lives didn't have mobile technology, can you think of barriers that prevented you at the beginning from using the phones? Frustrations? Difficulties? Costs?</p> <p>2. What are some of the ways that you have used it for your health? Set-up appointments? Program reminders? Lists? Specific apps? How often do you talk to people about your health on the phone, doctors? Other type of health professionals? Friends?</p>
<p>Applications and Concerns What would patients want to use mHealth for? What would they not want to use it for?</p>	<p>4. What are ways that you think mHealth would be most beneficial for you?</p> <p>5a. What are the things you would <u>NOT</u> want to use this type of technology for?</p> <p>5b. What is most concerning about the use of mobile health technology?</p>	<p>4.. Do you think it would improve access to care? How would you feel about getting health information and medical reminders over the phone? What type of health information would be helpful over phone? How do you feel about 2 way communications between you and your provider via texting, etc?</p> <p>5. Is there any type of information that you WOULD NOT want communicated over the phone via text message? Via phone call? Why? [EXPLORE CONFIDENTIALITY ISSUES]</p>

<p>Design What are important facilitators and barriers with regards to the design and delivery of mHealth technology?</p>	<p>6. How would you like mHealth to be designed and delivered? What features would make mHealth technology easier to use?</p> <p>7. What do you believe would be challenging about using mobile health technology for the management of your health? What are the obstacles to avoid?</p>	<p>6. Interactive Voice Response VS Texting? A dedicated APP? Problems with internet access? -Physical capacity- vision impairment? Difficulty viewing or reading from a digital screen?</p> <p>7. Areas we really want to probe on are care management strategies- Explore the following: Appointment reminders? Medication reminders? – How often would you like reminders? When would it begin to become annoying?</p> <p>Other options to explore- reporting weight, Finger sticks (DM), having to answer questions about how the patient is doing- pain, did u pick up medications- food access- home security- depression screening? → If you did get these questions, how would you want them and how frequently?</p>
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MHEALTH FOCUS GROUPS

Welcome and Introductions by MODERATOR:

Welcome, and thank you all for coming. My name is **MODERATOR** and I will be the facilitator for tonight's discussion. We also have **PHILLIP MARTINEZ** with us, who will be observing and taking notes for me.

Before we get started, I'd like for all of you to introduce yourselves by telling us your first name.

Tonight you will be participating in a research study about the use of mobile health technology in the management of your care.

You were invited to participate in this discussion because of experiences you have living with a long term illness. Your physicians at the **PHYLLIS JEN CENTER FOR PRIMARY CARE** informed us that you may be interested in the study and that is how we contacted you.

Mobile Health, shortened as mHealth refers to using mobile technology such as cell phones and mobile applications to take care of your health. For example, these may include medication and appointment reminders, or brief 2 or 3 question surveys asking you about how you are feeling. This data would be used by your health care provider to ensure that all your health needs are being met.

The information we collect tonight will be used to inform us about the best ways of using mHealth technology.

I will be leading the discussion tonight. My job is to make sure the questions we are interested in are answered in the time we have. I will also make sure that everyone has a chance to speak and add to the discussion. I'd like to explain some rules or "guidelines" for the meeting.

We want to know what each of you honestly thinks about the topics that we will bring up for discussion.

Have any of you participated in a focus group discussion before? If you have, you know there are three simple rules (*moderator explains 3 rules of FG*):

- **There are no right or wrong answers- Just opinions.** Please feel free to say what is on your mind.
- Feel free to comment on other's opinions. It is ok to disagree, the point of the discussion is to see what everyone's views and opinions are, **not to come to a consensus or have everyone agree, nor to convince each other.** Be respectful of others.
- Voice overlap – I would like to make sure that everyone has a chance to speak and be heard. Let's **try to speak one at a time**, especially when the discussion starts getting exciting. I will be trying to stay on top of that.

Are there any questions about those three rules?

Another important piece is confidentiality- All of your comments within this session are confidential, and we expect each of you to respect that. This means not sharing the discussion that we will have here with anyone outside of this session. Also, we

are recording the session in addition to taking notes, because we don't want to miss any comments.

It is important to me that you are all as comfortable here tonight. Feel free to grab some refreshments or use the restroom at any time.

As we mentioned before, your participation in this focus group discussion is completely voluntary. You do not have to answer any questions you do not want to, and you are free to leave at any time. If you have any questions or concerns about your rights in this study and how the data would be used, please contact the investigator Phillip Rico Martinez. He can be reached at PSM16@hms.harvard.edu or called directly at 973-202-6256.

Are there any questions at this point? Let's begin...

FOCUS GROUP GUIDE

Intro: Tonight we would like to hear your views on the use of mobile health technology. Mobile health technology (shortened mHealth) is the use of mobile phones in managing your health care. There are many possible ways that mHealth can be used and these can include appointment reminders, medication reminders or short surveys that can be sent to your healthcare providers. mHealth is designed to keep you connected to your healthcare team and make sure that all your health needs are being met.

I would like to ask you some general questions to begin.

There are many types of mobile technology, ranging from cell phones, to laptop devices, pagers and video games. For the purposes of this discussion, I want to restrict the discussion on mobile technology to handheld mobile devices like cell phones.

1. [Ice Breaker] How many of you currently use mobile technology like cell phones? How often do you use it? For those of you who don't use it, why? What about those people who have only started using cell phones, what were some of the initial barriers?

Probes- All of us at one point in our lives didn't have mobile technology, can you think of barriers that prevented you at the beginning from using the phones? Frustrations? Difficulties? Costs? **Are you comfortable with using phones? When and where are you more vs. less comfortable?**

Key Questions:

2. Do you currently use your cell phone for health reasons?

Probes- What are some of the ways that you have used it for your health? Set-up appointments? Program reminders? Lists? Specific apps?

How often do you talk to people about your health on the phone, doctors? Other type of health professionals? Friends?

3. How comfortable do you feel about the idea of using cell phones to help manage your health care? Why?

4. What are some ways that you think using cell phones to help manage your care would be most beneficial for you?

Probes- Do you think it would improve access to care?

How would you feel about getting health information and medical reminders over the phone?

What type of health information would be helpful over phone? What about 2 way communications between you and a member of your health team (doctor, nurse) via simple texting, etc.

5. What are the things you would NOT want to use this type of technology for? What is most concerning about the use of mobile health technology?

Probes- Is there any type of information that you WOULD NOT want communicated over the phone via text message? Via phone call? Why? [EXPLORE CONFIDENTIALITY ISSUES]

6. What are ways that mHealth would be most helpful in managing your health?

Probes- *Areas we really want to probe on are care management strategies-* Explore the following: How would you feel about Appointment reminders? Medication reminders? – How often would you like reminders? When would it begin to become annoying?

Other options to explore- How about reporting information to your provider. Examples include reporting weight, Finger sticks for diabetes patients, having to answer questions about how the patient is doing- pain, did u pick up medications- food access surveys- home security surveys- depression screening? → If you did get these questions, how would you want them and how frequently?

7. What would make mHealth technology more accessible to you? How would you like to receive information via mobile technology?

Interactive Voice Response (the patient responds to prompts verbally) VS Texting? A dedicated application on a smart phone?

7B. Anything that you believe would be challenging about using mobile health technology for the management of your health? What will be the hardest thing about using cell phones to manage your health?

Probes- Diminished physical capacity- vision impairment. Do you feel like it can be difficult viewing or reading from a digital screen?

General difficulty with electronics?

Safety issues- Is theft a worry? What about paying for phone- affordability?

CLOSING

Does anyone have any final thoughts they would like to share? Thank you for your time and input into this important topic.

Pass out gift certificates to participants.