Design and Development of a Digital Decision Support Tool for Clinical Trials Consent

Paper Type: Original Article

*Robert D. Furberg, PhD, MBA
Digital Health and Clinical Informatics
RTI International, Research Triangle Park, NC, USA

Alexa Ortiz, MSN, RN
Digital Health and Clinical Informatics
RTI International, Research Triangle Park, NC, USA

Rebecca Moultrie
Patient and Family Engagement
RTI International, Research Triangle Park, NC, USA

Melissa Raspa, PhD
Center for Newborn Screening, Ethics, and Disability Studies
RTI International, Research Triangle Park, NC, USA

Anne C. Wheeler, PhD
Center for Newborn Screening, Ethics, and Disability Studies
RTI International, Research Triangle Park, NC, USA

Lauren A. McCormack, PhD, MSPH
Public Health Research Division
RTI International, Research Triangle Park, NC, USA

Donald B. Bailey, PhD
Center for Newborn Screening, Ethics, and Disability Studies
RTI International, Research Triangle Park, NC, USA

Send all correspondence to:
  Robert Furberg, PhD, MBA
  RTI International
  3040 E. Cornwallis Road
  P.O. Box 12194
  Research Triangle Park, NC 27709-2194
  Voice: (919) 316-3726
  Fax: (919) 541-6621
  E-mail: rfurberg@rti.org
  Skype: robert.furberg
  Twitter: @medicfurby
ABSTRACT

Background
Current challenges in the typical informed consent process indicate the need to develop tailored, supportive interventions for all individuals, especially those with limited decisional capacity. The goal of the tool was to enhance shared decision-making and the decisional capacity for individuals with fragile X syndrome (FXS), the most common inherited form of intellectual disability, who were participating in the informed consent process for a clinical trial.

Objective
The purpose of this paper is to describe the content development, design, and technical implementation of a tablet-based decision support tool.

Methods
Our development process for the decision support tool employed a user-centered, feature-driven design approach. We began with an environmental scan to catalog relevant mobile applications, and we conducted interviews with those diagnosed with FXS and clinicians at fragile X clinics. To develop content for the decision support tool, key concepts and elements were extracted from a real clinical trial consent and re-written using plain language principles.

Results
Iterative testing was used to continuously evaluate and revise the decision support tool content. The tool was finalized in 2016 and contained a series of vignettes, quiz questions, and a sorting activity. A randomized controlled trial was conducted throughout 2017 to compare the efficacy of the decision support tool with a standard verbal presentation of material that mimicked typical informed consent practice.
Conclusion

Those with intellectual disability face several challenges when making healthcare decisions. Resources such as the tablet-base decision support tool provides flexibility to the informed consent process and enhances user’s engagement in making the decision to enroll in a clinical trial.

**Keywords:** Decision support, Informed Consent, Digital Health, Intellectual Disability, Fragile X Syndrome
INTRODUCTION

Digital Health and Decision Support

Digital technologies can serve as a communication bridge between patients, caregivers, and healthcare providers, making information available to users when and where they need it, and allowing users to better communicate their needs and preferences. For those with intellectual and developmental disabilities, technological advances can be utilized to support daily living skills, enhance cognition, and support communication. Further, multimedia formats for information delivery—including interactive, computer-based interventions—may contribute to greater patient understanding of complex information when compared to traditional formats [1-4] and are gaining in popularity [5].

Electronic informed consent employs the use of electronic media (such as web sites, video, or audio) to convey study information and obtain participant’s consent [5]. Researchers are rapidly beginning to see the value of electronic informed consent methods as opposed to traditional paper-based methods.

At present, potential research participants sometimes struggle to comprehend informed consent standards and regulations [6]. One such challenge is a lack of general understanding of the research and important concepts [1,7]. Participants also struggle to understand potential risks and benefits of research [7], and to understand their rights, the treatment they may receive [7], and the purpose of the research for which they are being asked to provide their consent [8,9]. Informed consent documents and informational materials for patients focus more on meeting minimal ethical requirements than facilitating the decision-making process [10]. Audio-visual interventions may have the potential to provide benefits to the informed consent
process by improving participant understanding and satisfaction [11].

Overview of Fragile X Syndrome

Fragile X syndrome (FXS) is the leading inherited type of intellectual disability (ID). Males diagnosed with FXS typically have impairment ranging from mild to severe; females are generally less impaired [12]. This wide range of cognitive skills among those with FXS can result in variable decisional capacity and the ability to make choices [13].

To date, most research on individuals with FXS has been noninvasive, limited to parent surveys and secondary assessment of clinical data [13,14]. Studies such as these typically involve straightforward consent/assent processes or parental consent. However, with advances in understanding the underlying mechanisms of FXS, there has been an increase in the number of clinical trials available for individuals with FXS [13, 15]. Decisions related to enrollment in treatment trials are now more complex than in the past, thus researchers are compelled to consider how best to support decision-making for individuals who present with a range of decisional capacity. Recent technological advances in digital health have the potential to dramatically change the consenting process for those with FXS.

Decision Making and Fragile X Syndrome

The knowledge base surrounding the decisional capacity of those with ID and FXS is inadequate, and recent reviews conclude that the literature is limited in both scope and focus [14,16]. The few studies that have examined ways to support individuals with ID in the informed consent process have found that the presentation of information is important, given that language skills, memory, and previous decision-making all have an impact on ability to consent [16]. Due to the wide range in decisional capacity, those with ID could participate in the consent
process, but many authors encourage that participation should be determined and supported on an individual case-by-case basis [13,16,17].

The use of digital decision support tools can potentially improve the understanding of clinical trial consents for those with FXS. The purpose of this paper is to describe the content development, design, and technical implementation of a tablet-based decision support tool to enhance shared decision-making and decisional capacity for those with FXS participating in the informed consent process.

METHODS

The user-centered design (UCD) process outlines the design and development life-cycle focused on gaining a deep understanding of a system’s end users. A variety of UCD guidelines are available to inform the development of digital technologies. For example, the international standard 9241-210:2010 [18] provides the requirements and recommendations for human-centered design principles to guide the development of computer-based interactive systems. Several federal resources to support implementation and management of UCD are openly available from the United States Digital Service [19], 18F [20], and usability.gov [21]. Our team leveraged these resources to develop a tablet-based decision support tool. Figure 1 outlines the methodology our project team used to identify and develop content for the tool.
To begin, our team conducted an environmental scan to catalog available tablet-based applications (apps) that focus on health care or were designed for individuals with intellectual and developmental disabilities. Our goal was to evaluate the apps based on UCD principles and determine what features we needed to include when developing the tool. Study staff purchased an iPad and identified 31 apps categorized as: (a) communication apps (n = 10), (b) educational/social skills apps (n = 8), (c) decision support apps (n = 7), (d) clinical trial apps (n = 3), and (e) behavior modification apps (n = 3). Based on our review, we formulated recommendations for key features, outlined in Table 1. Although the recommendations do not encompass all considerations necessary for tool development, they provide a well-rounded initial assessment of features that are either currently used by or with individuals of our target population, or that need to be developed and enhanced to address inequities for a successful informed consent decision support tool.

Table 1. App Key Features
<table>
<thead>
<tr>
<th>Decision Support Tool Feature</th>
<th>Feature Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply clear communication and plain language principles</td>
<td>The tool should reflect clear communication principles (e.g., avoid jargon, uses a low reading level) and be easy to understand</td>
</tr>
<tr>
<td>Ensure appropriateness to sensitivities</td>
<td>Content and presentation elements need to be respectful of particular sensitivities common among individuals with FXS (e.g., heightened sensitivity to light, color, sound)</td>
</tr>
<tr>
<td>Combine animation and real-life images</td>
<td>The combination of animation and real-life images provide engagement while grounding concepts in the real world, and provides tangible orientation to relevant scenarios (e.g., a clinic waiting room)</td>
</tr>
<tr>
<td>Enable customization</td>
<td>Enable customization of the content and delivery to ensure accessibility to a broader audience</td>
</tr>
<tr>
<td>Incorporate active learning</td>
<td>Incorporate active learning principles to facilitate greater engagement and integration of the information</td>
</tr>
<tr>
<td>Assess comprehension</td>
<td>Incorporate existing methods (e.g., the “teach back” method) or develop new ways to assess a user’s comprehension of information received to gauge the effectiveness of the tool</td>
</tr>
<tr>
<td>Support decision-making</td>
<td>Offer simple decision support tools to facilitate reasoning about a decision (e.g., pro/con list) and assessment of preference (e.g., importance of factors) related to that decision.</td>
</tr>
</tbody>
</table>

**Interviews with the Target Population**

As a second step to inform the appropriate features and functionality for the decision support tool, study staff conducted six in-person observation-based interviews with individuals diagnosed with FXS. Participants were given an iPad and rated on their engagement and performance of simple skills, advanced skills, and exploration skills interacting with specific apps. Overall, all participants interacted with the assessment apps and were most engaged with
exploring app hotspots that involved avatars or narration, and least engaged with simplistic app features. Results from these interviews will be published at a later date.

Interviews with Clinicians

To establish a better understanding of the context within which the decision support tool would be used, study staff conducted three in-depth interviews with clinician stakeholders who have consented participants with FXS into clinical trials. From the interviews, it was unclear if there is a standard or maximum reading level for consent forms. One FXS clinical trial research manager stated their consent forms were written for an 8th grade reading level, and the other two clinics noted that their forms include simple questions (possibly at a 2nd or 3rd grade reading level) to prompt a yes/no response from the patient. It was also the consensus that most individuals with FXS don’t understand much of the information presented to them; however, they are able to understand that they will be taking a new medication, and they are able to understand the risks and benefits of that new medication. Although none of the clinicians regularly used tablets as part of the informed consent process, one clinician emphasized that keeping the participant happy and engaged is the greatest challenge, and they welcomed anything to make the process easier.

Content Development

Content development began with a review of informed consent forms from previously conducted FXS clinical trials. Although the tool focused on a hypothetical trial, the actual consent forms were used as a guide to extract key concepts and elements that would also be needed in our tool (e.g. randomization, blinding, and placebo, as well as concepts that anecdotally are difficult to comprehend and typically explained with medical terminology and
jargon). These concepts and elements were then re-written using plain language principles and incorporating other recommendations we identified in the environmental scan. We used a matrix to crosswalk Institutional Review Board (IRB) requirements and the clinical trial consent content with language in the decision support tool to ensure all mandatory elements of informed consent disclosure were addressed. Table 2 illustrates a sample of how these elements were mapped. Members of the RTI IRB were consulted to validate this process.

To aid in the development of closed-ended quiz questions for the tool, we adapted the MacArthur Competence Assessment Tool for Clinical Research (MacCAT-CR), which is the main measure of decisional capacity in individuals with FXS [22]. Finally, a sorting activity was developed to identify the perceived reasons (both positive and negative) an individual may consent to participate in a clinical trial.

**Table 2. Sample: Decision Support Tool Content Mapping**

<table>
<thead>
<tr>
<th>IRB Element</th>
<th>Real Clinical Trial Consent</th>
<th>Hypothetical Clinical Trial Consent</th>
<th>Decision Support Tool Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of risks or discomforts to subject.</td>
<td>Risks are possible side (adverse) effects from the study drug, other drugs, taking the blood pressure or taking blood.</td>
<td>The new medication is generally considered to be very safe, but one purpose of the study is to determine whether any serious side effects occur. The most common side effects expected are fatigue and a mild headache.</td>
<td>You might not like some parts of the study. If you get the real pills, you might feel a little sick or tired. You also might not like getting your blood drawn.</td>
</tr>
</tbody>
</table>
IRB Element | Real Clinical Trial Consent | Hypothetical Clinical Trial Consent | Decision Support Tool Content
---|---|---|---
Description of voluntary compensation and treatment if the subject is injured related to the research. Applicable for research posing greater than minimal risks. | Each study subject will receive $200 per study visit when you have to stay overnight and $120 for other visits to the study center, to compensate for your time. | $25 will be given for each study visit and $10 for each phone call | You will get $25 after each visit. Your name and information about you will be kept private.

As the next step in our development process, we created audio-visual components to accompany the content of the tool. The Disability Act of 2005 [23] defines universal design of a digital product as a process of creating systems so that they may be used by any person. The approach stresses user-awareness and emphasizes designs that can be used by as many people as possible while minimizing the need to adapt the product to support particular users, especially those with disabilities or limited function. To develop the imagery and interaction model for the decision support tool, a graphic design artist created draft storyboards of initial content, audio, and user interface that adhered to the principles of universal design. We sought feedback on the storyboard from the project consultants, stakeholders, individuals with FXS and their family members on the draft content. The study team undertook a collaborative and iterative process of refining and ultimately finalizing the content for the decision support tool.

RESULTS

The results section focuses on testing the decision support tool style and content developed through the UCD process described in the Methods section. Figure 2 outlines our
project team’s iterative process that will be discussed in the Results section, used by the project team to test and refine the decision support tool.

**Figure 2. Decision Support Tool Testing**

![Decision Support Tool Testing](image)

**Initial Concept Testing**

We sought input from individuals with FXS on the three stylistic options for the decision support tool. We displayed a sample of each graphic style (simplistic, cartoon, and graphic novel, as shown in Figure 3), and asked participants to vote on which style they most preferred. One hundred and four participants provided input on their preferred graphic style. Most, 45% (n = 47) preferred the cartoon style, 37% (n = 38) preferred the simplistic style, and the remaining 18% (n = 19) preferred the graphic novel style.

Study staff also conducted in-depth, in-person interviews with nine individuals with FXS to seek feedback on an early iteration of the tool’s content. Interviews focused mainly on learning whether the images, text, and narration captured the clinical trial component as...
intended. Interviewers also asked the participants their opinions about the graphics used, suggestions for improvement, and whether the text and narration were understandable. Lower-functioning males with FXS expressed a preference for the cartoon graphic style; however, higher-functioning participants preferred the simplistic style, and that design was ultimately selected in order to appeal to these users.

Our interviews also revealed scenes that required modification and enhancements to increase comprehension among individuals with FXS. For one scene, we tested the comprehension of the clinical trial concept placebo with an animation showing that some pills will contain medicine and others will not. Although participants liked animation, they had difficulty grasping the concept. Participants also had difficulty understanding the concept of blinding, and that no one will know who will receive the trial drug. Similarly, participants were also confused by the concept of randomization, particularly regarding who decides which trial participant receives the drug versus the placebo. Participants had an easier time understanding more concrete concepts such as trial procedures (e.g., providing a urine sample or having blood drawn), and they were able to easily navigate through the different screens on the iPad and liked the narration and animations included throughout the tool.
Figure 3. Decision Support Tool Graphic Styles

<table>
<thead>
<tr>
<th>Simplistic</th>
<th>Cartoon</th>
<th>Graphic Novel</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Simplistic" /></td>
<td><img src="image2.png" alt="Cartoon" /></td>
<td><img src="image3.png" alt="Graphic Novel" /></td>
</tr>
</tbody>
</table>

Decision Support Tool Content

In fall of 2015, we completed a draft of the tool composed of a series of six vignettes or interactive narratives), close-ended multiple-choice quiz questions, and a sorting activity. Each vignette discusses a separate component of the consent using plain language: study purpose, study involvement, how the study will work, study benefits, study risks, and withdrawing from the study. To evaluate each user’s understanding of the content, multiple choice questions follow each vignette. Before answering the multiple-choice questions, users are given the option to re-watch the vignette. If answered incorrectly, the vignette will automatically replay for the user one time and the multiple-choice question will be presented again. A sorting activity is also used to facilitate a self-directed values clarification of the perceived reasons an
individual may choose to participate or not participate in a clinical trial. Users are provided with seven features of study participation (e.g. “I would have to see my doctor several times” or “I might feel better”) and asked to sort each feature as a reason to be or not be in the study. Participants are required to sort a minimum of two features.

Pre-Testing and Finalizing the Decision Support Tool

We conducted incremental field testing on each component of the draft decision support tool: the vignettes, the quiz questions, and the sorting activity. On completion of the initial series of vignettes and in parallel with development of the quiz items, we pretested each component of the application. We collected feedback from pretesting in a subsequent version while the quiz component was fielded; input on the quiz was implemented during development of the sorting activity until the final decision support tool was assembled. The complete decision support tool underwent beta testing and internal software quality assurance testing to exercise the compiled decision support tool, verify skip logic, and confirm capture of accurate scoring metrics and session analytics. We completed the final version of the decision support tool in 2016.

Experimental Study

A two-arm randomized controlled trial (RCT) was initiated in 2016 to compare the efficacy of the decision support tool with a standard verbal presentation of the consent material that mimicked typical consent practice. Participants were randomized to receive the tablet-based decision support tool or the verbal script and paper consent. The RCT protocol and outcomes will be published at a later date.

DISCUSSION
Health Technologies to Support Complex Decision Making

The movement to empower patients through health technology to support complex decision making is gaining momentum. As the number of clinical trials targeted toward those with FXS increase, the goal of involving participants in the decision-making process will become more important. Further, although those with ID face challenges in making health decisions, those without such impairments are not immune to similar struggles.

Health literacy is defined as an individual's ability to obtain, process, and understand health information, and use it to make health-related decisions [24]. Low health literacy has been shown to be a systemic issue in the general population. The National Assessment of Adult Literacy [25] found that only 12 percent of U.S. adults had proficient health literacy. This evidence illuminates deficits that lie within the majority of individuals seeking care from health care providers and are considering participation in clinical trials. Our decision support tool speaks to the potential benefits an interactive tool can provide for those making trial participation, regardless of cognitive ability.

Digital Tools in the Informed Consent Process

The informed consent process is primed to leverage digital health resources given recent changes to the Common Rule that promote increasing understanding and engagement of research participants in the consent and research process. Interactive electronic informed consent material provides more adaptable content than traditional paper-based materials. The digital decision support tool can be deployed in a variety of settings, such as inpatient and outpatient clinics, hospitals, research facilities, or at home. The latter enables a prospective trial participant to learn about the trial in a familiar and comfortable setting without perceiving
potential undue pressure from medical or research personnel. The ability to go through the consent process at home also fosters shared decision-making, as family members or those important to the individual can more easily review and openly discuss the information together. Additionally, the ability to use the tool at home provides convenience and reduces the need for travel to a clinic or physician’s office, which may be difficult for some individuals due to living situation, financial status, trial location, or health issues.

Agile Development Works for NIH-Sponsored Studies

Agile software development is a group of methods in which requirements and solutions evolve through collaboration between self-organizing, cross-functional teams [26]. It promotes adaptive planning, evolutionary development, early delivery, and continuous improvement, enabling rapid and flexible response to change. Feature-driven development (FDD) is an iterative and incremental software development process [27]. It is a lightweight, agile method for developing software that blends several industry-recognized best practices into a cohesive whole. These practices are driven from a client-valued functionality (feature) perspective to deliver tangible, working software repeatedly and in a timely manner.

Our development process for the decision support tool was consistent with an agile, feature-driven process. This can deliver value and yield a more efficient, responsive product, all while conforming to mandatory research processes such as evidence reviews, stakeholder engagement, regulatory compliance, and protection of human subjects.

Involvement of an Interdisciplinary Team

The principle of “team science” addresses barriers associated with intervention development and implementation through engagement of an interdisciplinary team. This tactic
brings together a variety of researchers with specialized expertise, approaches, and methodologies to solve complex problems [28]. The effectiveness of team science is evident in the evolution of multi-university research teams, which often produce higher-impact research when compared to individual investigators [29]. Our project utilized a team science approach to sustain member's involvement and inform each phase of development for the decision support tool.

A team science approach is especially critical when considering digital health interventions, which require input and coordination from information technologists, researchers, and healthcare professionals [28]. In line with the team science approach, development and implementation of the tablet-based decision support tool integrated input from a number diverse of sources. Contributors consisted of clinicians, clinical implementation specialists, communication scientists, regulatory compliance experts, graphic designers, programmers, and field interview staff. We approached development of the tool as an integrated team and remained integrated through completion of the randomized controlled trial.

CONCLUSION

Central to the success of this project were the team's recognition of the importance of a user-centered approach, stakeholder engagement and input, appreciation of interdisciplinarity, and willingness to explore and adapt commercial software methods and management techniques. The process and experiences described here may provide a model for other digital health design and development initiatives seeking to create more interactive and accessible decision support resources. Future research is needed on the impact of decision support tools
in obtaining electronic informed consent and their influence on shared decision-making and user’s decisional capacity.

ACKNOWLEDGMENTS
Funding for this work was provided by the Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health under Award Number R01HD071987. The content of this article is the responsibility of the authors and does not reflect the view of RTI International.

CONFLICTS OF INTEREST
The authors have no conflicts of interest to declare.
REFERENCES


WebCite Link: http://www.webcitation.org/6yGDxBqNX (accessed 2018-03-28)


WebCite Link: http://www.webcitation.org/6yGEGloS5 (accessed 2018-03-28)

20. 18F. 18F partners with federal agencies to improve the user experience of government.
   Original URL: https://18f.gsa.gov/
   WebCite Link: http://www.webcitation.org/6yGEWUb5U (accessed 2018-03-28)

    WebCite Link: http://www.webcitation.org/6yGEevq9p (accessed 2018-03-28)


    Introduction. In National Library of Medicine Current Bibliographies in Medicine:
    and Human Services; 2000.

25. Kirsch IS, Jungeblut A, Jenkins L, Kolstad A. Adult Literacy in America: A First Look at
    the Results of the National Adult Literacy Survey (NALS). Washington, DC: National

