Development of a Novel Tablet-based Approach to Reduce HIV Stigma among Healthcare Staff in India

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Abstract

Although stigma is considered to be one of the major barriers to reducing the AIDS epidemic in India, efforts to reduce stigma have not been sufficiently examined. In response, a partially computer-administered three-session stigma reduction intervention was developed and is currently being tested. This paper describes the technological design, development, implementation, and management of these in-person tablet-administered assessment and intervention sessions that are being used to evaluate the efficacy of this innovative stigma reduction intervention among nursing students and ward attendants in India.

Keywords: HIV, AIDS, stigma, mHealth, informatics, Android, tablet device

Background

Decades have passed since the discovery of HIV, and countless resources have been spent combating this virus. Behavioral techniques that prevent high-risk behavior and improve treatment adherence have been the cornerstone of the multitude of strategies used to prevent transmission of HIV and improve treatment outcomes. However, the stigma associated with HIV and its consequent aftermath continues to hamper progress. The stigma faced by people living with HIV (PLHIV) in healthcare settings has been well documented.[1-3] The consequences of such stigma present hardship to PLHIV and affect their decisions to seek help while also affecting their interactions with family and society.[4-12] This situation poses a significant deterrent in seeking timely intervention and requires interventions that aim to reduce stigma in healthcare settings.[13]

Prior interventions that have been used to increase the willingness of healthcare professionals to provide care for PLHIV have used strategies such as instruction/information and skill building.[14-16] Most interventions to date have been performed using traditional training techniques, such as group discussions, facilitator demonstrations, pair-sharing, workshops, and role playing, all of which are in-person, face-to-face techniques that are time consuming, logistically challenging, and therefore difficult to sustain and to scale.[17-20]

However, in recent years, healthcare research has embraced the use of technology, especially mobile phones and tablet devices, for data collection and delivering interventions.[21-25] Besides offering convenience, these platforms have also demonstrated cost effectiveness over traditional techniques, such as paper and computer transcription, in large studies, in that although the initial investments for the devices were higher, recurring costs were lower. These studies also indicate a preference toward the use of tablet devices over paper by field staff.[26,27]

Some examples of use of technology in healthcare research include the following. In a pilot study of the effectiveness of HIV and sexually transmitted infection prevention among internally displaced populations, a psychoeducational HIV intervention in the form of video-based counseling sessions was delivered by a peer health worker via a tablet device.[28] In another study, researchers used mobile devices to administer an HIV risk assessment tool among men who have sex with men.[29] A study conducted in 2006 used a tablet PC-based counseling tool designed to support medication adherence and secondary HIV prevention among PLHIV participants. The main reason for administering the intervention on tablet devices was the fact that PLHIV reported that they felt less embarrassed talking to a computer than to an individual.[30] Finally, a study compared tablet PC-based learning to in-person, pre-test information comprehension among HIV patients in an emergency department setting. The study demonstrated that video-based learning appeared to be as acceptable as an in-person pre-test information

dissemination medium.[31] These studies have successfully demonstrated that information and communication technology tools can be effectively used in HIV-related and sexually transmitted infection (STI)–related behavioral research.

The current study was designed to evaluate the efficacy of a promising stigma-reduction intervention that was pilot-tested among nursing students.[32] The objective-based assessment and the intervention were adapted from the International Center for Research on Women (ICRW) curriculum that specifically addressed instrumental and symbolic stigma among healthcare professionals.[33] Although this program was originally developed for health professionals, it was found to be acceptable and feasible for multiple types of non–medically trained staff who work in healthcare. The ICRW intervention and assessment was originally a three-day, in-person program.

Our earlier study conducted among doctors, nurses, and ward staff in India confirmed that baseline stigma among health professionals was high and that it was driven by transmission misconceptions, blame, and prejudice.[34] In yet another study that was conducted on nursing students in India, the authors assessed the acceptability and feasibility of a brief stigma-reduction curriculum, using tools from the ICRW toolkit, which targeted the specific drivers seen in our earlier work. The result of this intervention was promising in that it showed a decrease in stigma levels and was also found to be highly acceptable among the study participants.[35] We subsequently built on this successful pilot and extended it by adapting it to be a partially computer-delivered intervention in order to increase the likelihood that it would be scaled up and sustained.

This paper specifically describes the methods that were used to design, build, and implement this innovative, partially tablet-administered stigma-reduction intervention. Participants were being recruited for the study at the time of writing, and the methods and results of the study will be presented in a subsequent paper.

Application Development

This tablet-based assessment and intervention was developed using a five-phase software development life-cycle method, which included identification of user requirements, design and development, evaluation, testing, and implementation. The assessment and intervention modules were bundled into one application.

The first step, identification and development of content, was followed closely by collection of functional requirements for the tablet-administered intervention and assessment. The content of the intervention was developed by professionals experienced in psychology, health education, and stigma reduction program development. The ICRW Indian Toolkit, which provided a starting point and exercises that addressed the drivers of stigma identified in our previous research,[36] was selected and modified. Subsequently, videos, illustrations, and interactive virtual walkthroughs were designed, developed, and reviewed by the investigators. Filming and editing of the video sequences was outsourced, and actors performed the various roles depicted in the videos. The videos were also shown to members of the target audience to ensure that the graphics, language, and setting were acceptable and were perceived as interesting and helpful.

A detailed functional requirement analysis was performed before the technical aspects of development were initiated. Some of the functional requirements of the application are as follows:

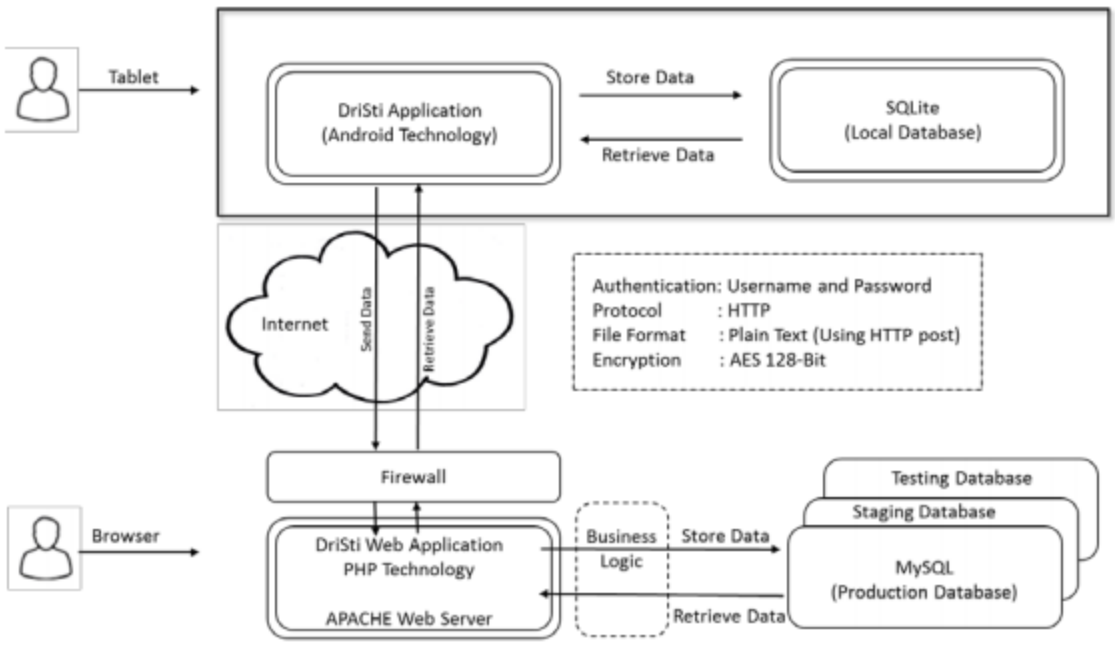
- The intervention and assessment components are to be administered to the end user on a touch-screen tablet device.
- The tablet devices should be interchangeably used by multiple individuals and across multiple study sites.
- The user roles should be configurable so that end users could access either the intervention or the assessment components in order to maintain blinding of the study.
- The application must be capable of delivering the assessment and recording participant responses in the absence of Internet connectivity.
- The application had to be interactive, be content rich, and deliver content in three different languages in order to maintain end-user acceptability.
- The application had to have the ability to securely transfer data to a remote data repository over wireless connections.
- Any updates to the application had to be an automated process.

The application was developed by a team that included in-house medical informaticists and outsourced consultants. The in-house informatics team consisted of a solutions architect, a project manager, project coordinators, a systems analyst, graphic designers, a database administrator, and a quality assurance team. Members of the informatics team, such as the architect, managers, and coordinators, were formally trained clinicians and had extensive experience in designing software solutions in

healthcare. The role of the informatics team was to act as a liaison between the technical teams and the study investigators. They were responsible for working closely with the investigators to understand the functional requirements and expectations of the investigators. On the application design front, the informatics team was responsible for translating the requirements to effectively coordinate the planning, design, development, evaluation, and testing of the application. The informatics team was also responsible for creating computer graphics, such as illustrations and animations, and sizing the media content for use on the tablet device. The team was further responsible for training end users, managing application updates, provisioning and providing access to the application to field staff, managing study data, and troubleshooting and resolving issues with the development team.

The outsourced contractors primarily consisted of software developers with experience in designing mobile applications on the Android platform. The Android application was developed using the Android software development kit, which is a free tool to develop Android applications. The web application was developed using PHP (Hypertext Preprocessor) technology, also an open-source tool, to create the web pages, back-end logic, and processes. The database on the tablet device was SQLite, an open-source database engine, and the database on the server side was MySQL, an open-source database management system. The use of free and open-source applications helped to keep the development costs low. Figure 1 describes the high-level architecture of the application.

Figure 1: Architecture of the DriSti Application, Databases, and Communication



The development and quality assurance team followed standard practices such as unit testing, black-box testing, and regression testing. The application was also subjected to functional testing and end-user acceptance testing by field staff and study coordinators. Any issues identified by the study team were addressed and retested before the field study began.

The intervention and assessment were bundled into a single application developed on the Android operating system, version 4.4.2 KitKat, and deployed on Samsung Galaxy Note 10.1 (2014 edition) tablet devices. Bundling of the assessment and the intervention into one application provided the advantage of allowing multiple users to interchangeably use the device for both assessments and interventions based on their roles. However, bundling the two components also made the application fairly large, and therefore media compression tools were used to decrease the size of the media content while maintaining its quality.

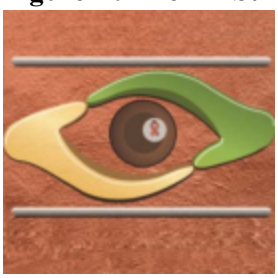
The user interface was designed with attention to its appearance, ease of use, and navigation. In addition to user-level access, an administrative level of access was designed to help monitor and manage data transfer and other activities, such as managing follow-up of study participants and viewing and exporting raw files containing study data. Testing and evaluation of the content accuracy, functionality, and data upload process were performed with the standard methods described above and were reviewed.

Study Design

Ethical approval was obtained from the Institutional Ethics Committee of St. John's National Academy of Health Sciences in Bangalore and the Committee on Human Research at the University of California, San Francisco (UCSF).

The study was called DriSti, an acronym for *Drive against Stigma*. DriSti is also a Sanskrit word meaning "to focus and see the world as it really is." The study logo (see Figure 2) was therefore designed to look like a human eye. The hands and the equal sign symbolize that we are all equal. The logo was conceptualized and designed by the graphics and animations team of St. John's Research Institute (SJRI), which is part of St. John's National Academy of Health Sciences, India. The application thus developed was also named DriSti.

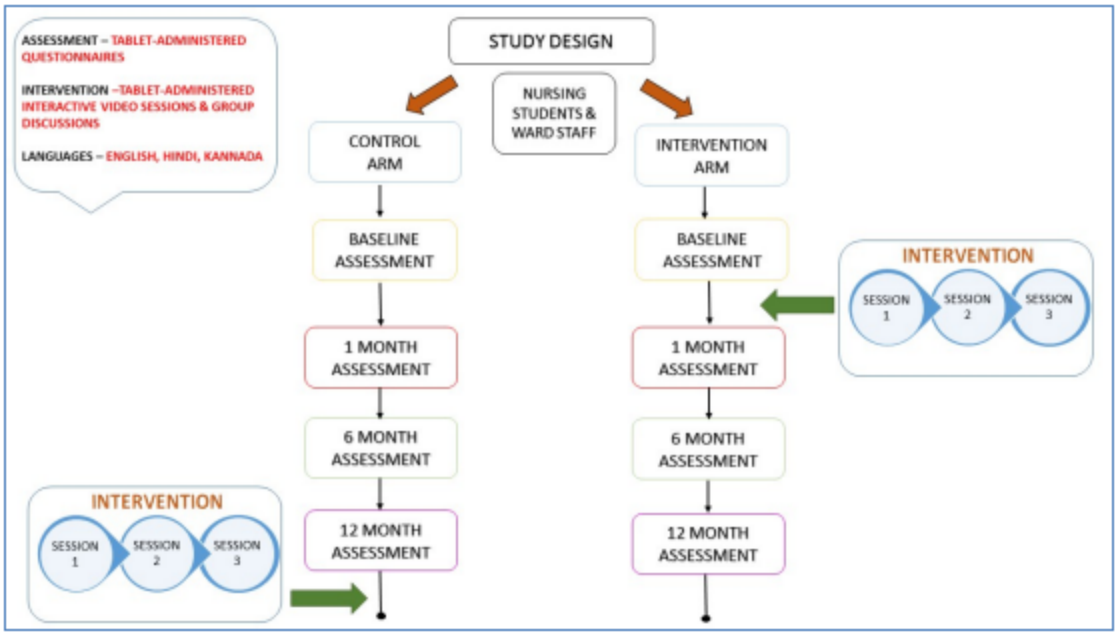
Figure 2: The DriSti Logo



The DriSti study is a cluster randomized controlled trial (cRCT) covering 24 sites in India. The study participants include second- and third-year nursing students who are enrolled in the undergraduate nursing degree program and hospital ward attendants. The ward attendants are helpers on the hospital floors. They usually assist in performing manual tasks, such as transporting patients, moving patient samples, running errands (e.g., replenishing patients' bedside supplies and transporting paperwork), attending to patients' personal hygiene, and assisting with activities such as ambulating, turning, or positioning patients. Ward attendants are typically educated up to the tenth grade.

Figure 3 depicts the study design. The control group receives only the assessments during the study period and receives a delayed administration of the intervention after the 12-month follow-up assessment.

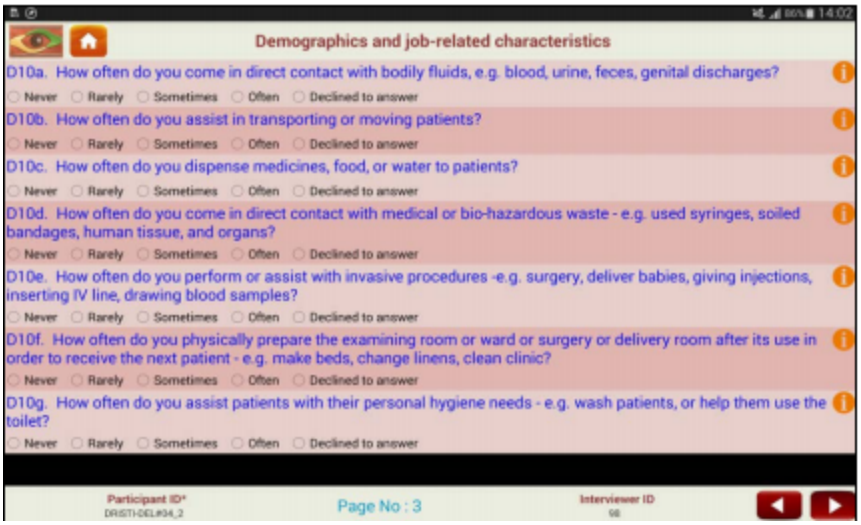
Figure 3: Study Design



Assessment

The tablet-based assessment consists of an interviewer-administered assessment containing 165 questions for ward attendants and 171 questions for nursing students (Figure 4). The assessments are offered at baseline, at 1 month, at 6 months, and at the end of 12 months for both the control and intervention groups. The system generates a unique ID for each participant, which is linked to all assessment and intervention cycles of the participant during the course of the study. The assessment evaluates the pre- and post-intervention status of the participants' knowledge regarding instrumental stigma, transmission knowledge, symbolic stigma, their endorsement of coercive policies, and intent to discriminate. The questions in the assessment are the same for both the intervention and control groups and in the pre- and post-intervention sessions. However, there are minor variations between the questions for nursing students and those for ward attendants. The participants have the right to refrain from answering questions if they wish to. The assessment consists of multiple-choice questions, and free-text boxes are provided for additional responses where necessary. To avoid question omission by the interviewer, a check system prevents the interviewer from proceeding to the next step if a question has been omitted. After completion of the assessment, participant data are stored locally on the tablet. The application allows offline data collection to account for the fact that the study sites may not have reliable Internet connectivity. Data transfers are done periodically with the use of a data synchronization module.

Figure 4: An Example of the Tablet-Administered Assessment



Intervention

The intervention consists of three sessions, of which the first two are tablet administered and the third is a group session. In this paper, we describe only the intervention sessions that are tablet administered. The sessions are scheduled according to the timelines specified in the study protocol and are conducted at a time convenient to the participants and at their respective institutions. A baseline assessment, followed by post-intervention assessments at 1 month, 6 months, and 12 months, are administered by an interviewer using a tablet device. The assessments and intervention for the nursing students and ward attendants are identical in content except for the specific examples, which are chosen to be relevant to the different tasks and responsibilities of ward attendants and nursing students. As noted, the assessment and intervention are bundled into a single application deployed on the tablet devices.

In addition to English, the intervention and assessment are available in two other Indian languages, Hindi and Kannada, to cover the likely language preferences of the participants. A storyboard and script for the entire intervention were developed by the team on the basis of the stigma drivers identified in our previous research.[37] The script and assessment forms were translated and back translated, and any discrepancies were resolved by a third person not involved with the study. The language of the participant's choice is used for the assessment and intervention sessions. The device also allows the user to toggle between languages at any point during the tablet-administered session.

The tablet-administered intervention sessions are split into two sessions of approximately 70 minutes and 30 minutes, which participants can take on separate occasions. The goal of the first session is to introduce the concept of stigma to the study participants. The objectives and approach of this session are described in Table 1.

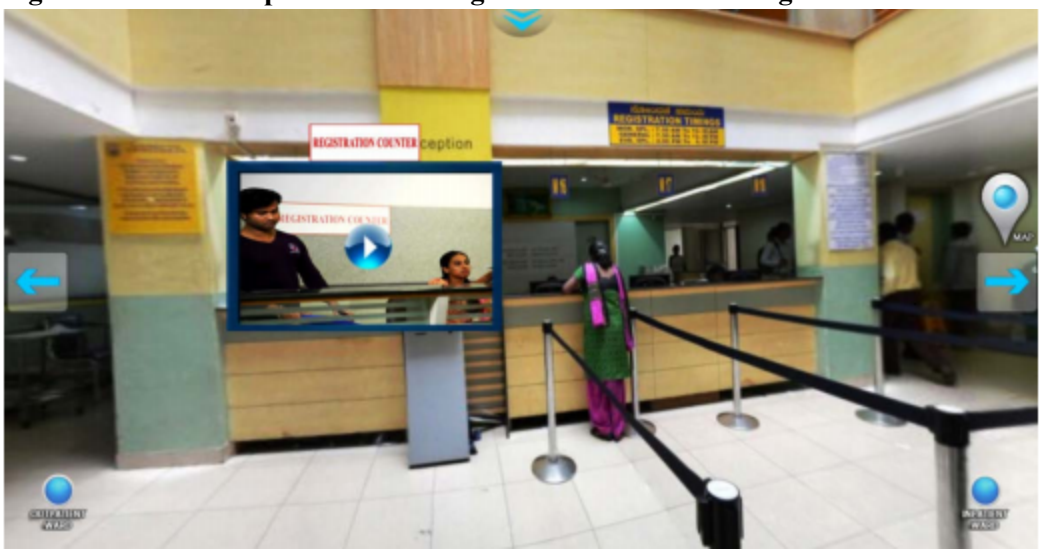
Table 1: Objectives of Session 1 and Multimedia Content Used for the Intervention
Abbreviation: **PLHIV, people living with HIV.**

Objectives	Multimedia Content
Objective 1: Defining stigma	An introductory video and a short video depicting stigma in a home setting are shown. Pictures of stigmatized and nonstigmatized groups are presented. Participant identifies stigmatized groups. The pictures that are touched turn gray. A video providing feedback is shown. Self-reflective questions are presented; a blank screen appears for few seconds during this time for participant to note his or her thoughts.
Objective 2: Identify locations where HIV-related stigma is high	A unique 360-degree virtual walk-through of the layout of the hospital setting is presented. Embedded in various locations are two inpatient videos and 12 outpatient videos showing stigma. The participant (nurse or ward attendant) explores any of the locations where stigma could possibly occur by touching the desired video. Software ensures that the participant watches the required number of videos: one inpatient and three outpatient. After each video, a self-reflective question is presented, followed by few interactive questions.
Objective 3: Exploring beliefs/attitudes about PLHIV and other marginalized populations	Statements exploring beliefs are presented along with a set of four facial illustrations that indicate strongly agree, agree, disagree, and strongly disagree. Participants touch the ones that they think are correct. A video discussing various beliefs and attitudes is shown.
Objective 4: Effect of stigma on HIV epidemic	Three videos are presented by PLHIV. A few questions relating to the effect of stigma on PLHIV are interspersed.

The participants are required to view the video segments and are given an opportunity to reflect on the scenes that they witnessed. Participants are also guided through an interactive question-and-answer module consisting of multiple choice questions linked to the ICRW fact sheets.

Objective 2 includes an innovative 360-degree interactive virtual walk-through in a hospital setting with navigation cues (see Figure 5), in which the participants are encouraged to identify locations within a hospital where PLHIV and other marginalized groups are likely to face stigma. This module of the tablet-administered intervention showcases locations within a hospital where participants in our prior research indicated that they had experienced stigma and discrimination. We decided to implement this approach, which is similar to that of Google Street View, because it can be used to indicate a location on a map as well as to provide a panoramic 360-degree view, thereby enhancing user engagement and the overall user experience.

Figure 5: Screen Capture of 360-Degree Virtual Walk-through



The walk-through depicts a virtual layout of a healthcare facility and various locations where patients interact with healthcare personnel and receive care. Examples of these locations include the medical record department, patient registration counter, outpatient department waiting area, pharmacy, emergency room, antenatal clinic, and the labor and delivery ward. During the virtual walk-through, participants are asked to select a location within the hospital on the tablet's touchscreen interface where, per the participant's experience, the likelihood of the occurrence of stigma is high. Touching the location icon with either the fingers or a stylus presents a novel 360-degree layout of that location within the hospital. Embedded within this layout of the location is a short video vignette that depicts how stigma typically occurs and what PLHIV experience as a consequence of living with HIV. After the video, the participants are requested to answer a few multiple-choice questions, which help to reaffirm their understanding of HIV stigma.

The study participants have to select at least three outpatient locations and one inpatient location before moving on to the next session. Figure 6 shows a screen capture of the user interface to select the locations within the hospital. The software ensures that the participants meet this criterion before proceeding to objective 3.

Figure 6: Screen Capture of Navigation Options to Select the Location in the Virtual Walk-through Module

The second intervention session is designed to reduce instrumental stigma and includes four objectives. The objectives and approach of this session are described in Table 2.

Table 2: Objectives of Session 2 and Multimedia Content Used for the Intervention

Objectives	Multimedia Content

Objective 1: Summarize the basic points of Session 1	Narrator video summarizes the Session 1 points. Vulnerable groups who are commonly stigmatized in the society (transgender people, sex workers, people who inject drugs, men who have sex with men, and migrant workers) are discussed. The virtual walk-through layout is shown again with pictures and signboards; the participant is instructed to touch the picture or signboard of the locations that surprised him or her the most.
Objective 2: HIV transmission: routes and misconceptions	Statements with pictures about HIV transmission are presented. When each picture is touched, a related video plays, followed by explanation of HIV transmission routes and misconceptions.
Objective 3: How transmission fears influence our behavior	Pictures depict four different procedures the nurse or ward attendant may perform in a healthcare setting are shown (in different settings for nursing students and ward attendants). Each picture is followed by four facial illustrations representing no fear, mild fear, moderate fear, and severe fear. Participants are instructed to think about how fearful or worried they would be to perform this procedure on a HIV-positive patient. This step is followed by a video showing two nurses or ward attendants sharing feelings and experiences regarding the situation. A video summarizing the objective is shown.
Objective 4: Standard precautions	Video on standard precautions is shown. Four videos are shown, each having two scenarios. The first scenario is the original scenario, showing an excerpt of a video from session 1. The second scenario displays the correct set of practices demonstrated by a nurse or ward attendant. A video summarizing the objective is shown.

All of the videos and interactive illustrations related to the assessment and intervention sessions were designed and developed in-house exclusively for this study and were edited on the basis of feedback from medical professionals. We called for applications from video and filmmaking professionals to shoot the videos and provide direction to the overall continuity and flow of the video vignettes. Selection of the video production vendor was based on factors such as years of experience in the industry, experience working on healthcare-related subject areas, experience filming and editing videos in English and Indian languages, nature and quality of filming gear, and price quotes.

The cast of the video vignettes were all either professional actors or study staff members, with the exception of three people who were openly living with HIV.

Outcome Measures

The efficacy of the intervention on nursing students and ward attendants will be evaluated on the basis of the changes in the behavioral manifestations of HIV-related stigma, instrumental stigma, and symbolic stigma such as intention to discriminate; endorsement of coercive policies; fears and misconceptions of casual transmission; and negative attitudes toward marginalized and vulnerable groups. Other outcome measures related specifically to the tablet-based intervention, such as cost-effectiveness, low error rate, effectiveness in monitoring of the interview and the interviewers, respondent comfort, user satisfaction, and prompt generation of accurate reports, will also be evaluated.

Data Management

Participant responses are stored in a local database on all tablets. Daily manual synchronization schedules have been set up for the study teams to wirelessly transfer the assessments and intervention study data from the tablet devices to a centralized server via cell phone networks or Wi-Fi. Figure 7 illustrates the process of data synchronization from multiple devices and study sites to a centralized server. Data synchronization is a two-step, push-and-pull process. The first step is a data push whereby the tablet device sends information stored on its local database to be merged with the central database, located within the data center of the research institute, which receives data from all of the tablet devices. After the data are synchronized successfully, the application on the tablet displays a short summary that confirms the transfer of data to the server (see Figure 8).

Figure 7: Data Synchronization from Multiple Devices and Study Sites to a Centralized Server

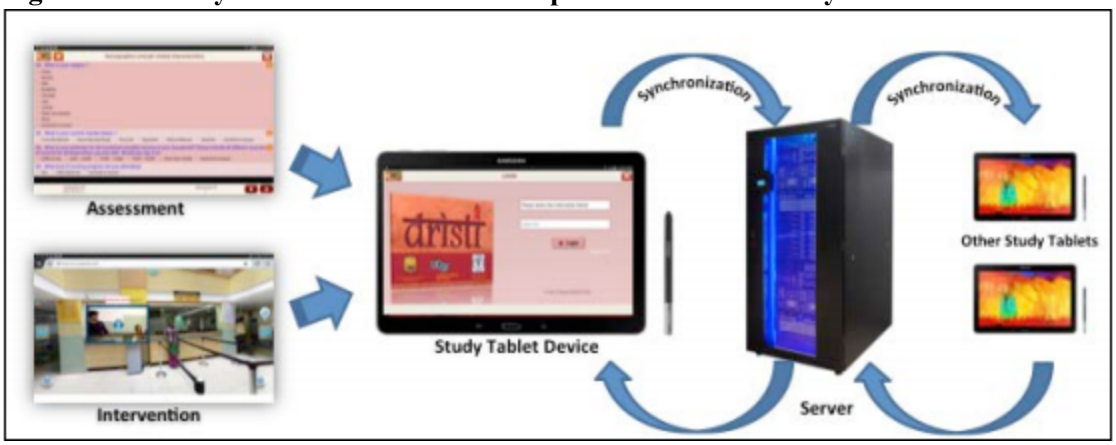
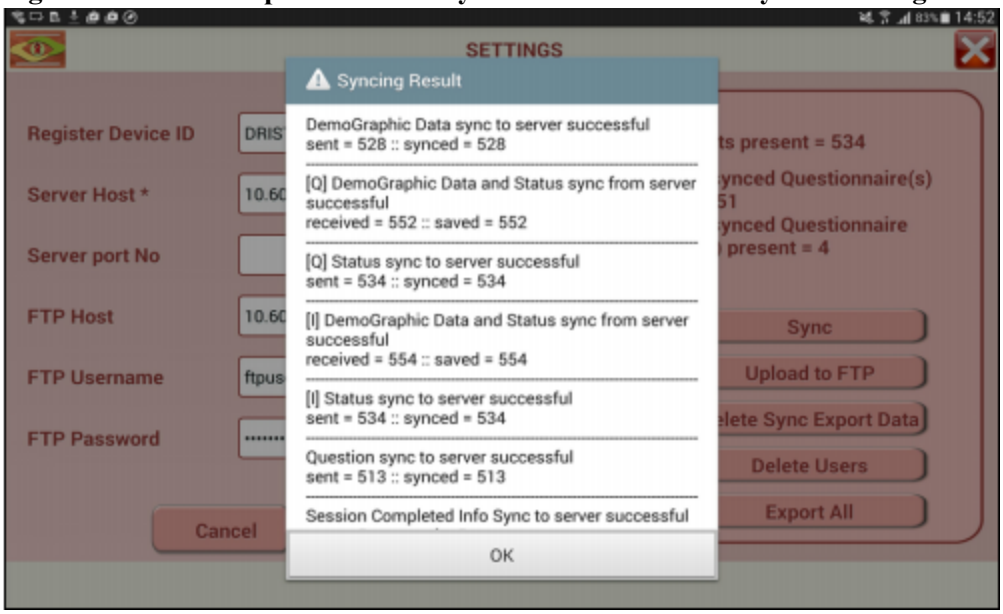


Figure 8: Screen Capture of Data Synchronization Summary Confirming Data Transfer



In case of connectivity failure during data transfer, the tablet stops the synchronization. After the connectivity resumes, the synchronization process can be restarted by the study team. The second step is a pull process wherein the device receives participant status updates from the other devices.

The device-agnostic strategy used in the design of the system enables the study team to administer the intervention or assessment on any tablet device that has the application installed.

A web-based application that includes modules for user management, study participant management, and report generation has also been developed. This module also provides automated application-related updates to all devices. The user management module handles the privileges granted to the users based on their roles as assessment or intervention staff; for example, the assessment staff cannot access the intervention modules on the tablet devices, thereby maintaining the blinding process among the study team. A reporting module was created to generate reports for authorized users to track the study progress.

De-identified data from these reports are uploaded to a secure server at SJRI and shared with UCSF. These data are accessible to the investigative staff of UCSF and SJRI.

Challenges

Field staff are trained to use the Android application and to report any technical issues that occur in the field. For example, if an error message is encountered on the tablet during any of the sessions, they have been trained to capture a screenshot of the error and report it to technical support via e-mail.

Two of the 26 tablet devices deployed in the field malfunctioned over a period of 20 months. The cause of the malfunction on one of the devices was software corruption, and the other malfunction was due to an inadvertent resetting of the device by an end user. Malfunctioning tablets were returned to the study site in Bangalore and a replacement tablet with the preloaded application was issued so as to not hamper the progress of the study. The malfunctioning devices were restored to the original default settings and the application was reinstalled, and no further errors have occurred.

Issues in data collection, such as data entry errors, were reported to the informatics team, who would run audited updates to deactivate the incorrect data elements, thereby segregating the incorrect data from the clean data within the study database. At times, field staff at the remote sites were unable to synchronize the data because of poor Internet connectivity. In such cases, the team would wait until the next day to synchronize the data. They were also trained to set up a Wi-Fi hot spot using a mobile phone if all else failed. The informatics team also had a call-in number to address any questions or troubleshoot any issues related to the tablet device or the application during working hours.

Discussion

The launch of the formative part of this multicenter cRCT among nursing staff and ward attendants in India suggests that this technology is an acceptable and feasible method for delivering an intervention. The knowledge to be gained will assist researchers, policy makers, and hospital and nursing school administrators in the development and implementation of HIV stigma reduction programs for Indian health professionals. Reducing HIV stigma in this population can decrease current barriers to testing, encourage patients to seek treatment, and improve adherence by encouraging patients to return regularly to healthcare facilities for their medication refills.

Given the cross-cultural similarities in the attitudes, behaviors, and underlying factors related to stigma,[38-44] which were also found in our earlier studies,[45,46] we suggest that the evidence generated by this study is likely to make a significant contribution to the science of stigma reduction using tablet devices. The method can be adapted and tested in other global settings with similar patterns of HIV stigma.

We also hope that this study will provide a scalable framework for the conduct and evaluation of the use of mobile technologies in providing media-rich interventions as well as assessments on a single platform in settings with limited resources. The tablet-based application is novel in that both the intervention and assessment can be administered via the same device and also in that the application does not require Internet connectivity except when the data need to be synchronized. This setup has a huge impact by reducing the cost for data services and thereby reducing the operational costs of the study. The entire application, including the media content in three different languages, required approximately 6.9 gigabytes (GB), while the tablet had an internal storage of 32 GB, which left plenty of room for unimpeded performance. Because the intervention is media-rich, all tablet devices deployed in the field have all media components and the application preloaded. Additional tablet devices with the application preloaded are available on standby, which ensures that no delays result from the need to replace nonfunctioning or failed devices. Updates to the application are pushed automatically to all devices that are connected to any WiFi or cellular network. Whenever an update is made, the tablet displays a pop-up message when the app is launched. Acknowledging this prompt installs the update while preserving all the study data that is stored locally on the device prior to data synchronization.

Also unique on the operational front is that the duration of the intervention was substantially reduced from the original three days to just a few hours. Finally, this targeted intervention can be readily administered to the study participants in relative comfort and privacy. We intend to collect feedback from the study participants regarding what they liked and did not like about the application in order to learn about their preferences and make improvements that may increase acceptability of the application among study participants.

The study will help evaluate the efficacy of this intervention in reducing behavioral manifestations of HIV stigma among healthcare providers and improve their interaction skills. In addition, the study offers the opportunity to evaluate the benefit of the use of media-rich mobile technologies in resource-constrained settings.

If these intervention strategies and the methods of administering them are shown to effectively reduce stigma, they could be adapted and used in other Indian healthcare settings and also in other global settings where similar patterns of HIV stigma have been identified. They could also be scaled into national programs aimed at training healthcare professionals to combat

stigma. Finally, this approach could also be adapted to include a gamut of other chronic health conditions for which targeted behavioral interventions are required.

Notes

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Trial Status

Participants are currently being recruited for the study.

Competing Interests

The authors declare that they have no competing interests, either financial or nonfinancial in nature.

Funding Statement

DriSti has been funded by the US National Institute of Mental Health (NIMH), National Institutes of Health (NIH), grant 5R01MH09325702 (M. L. Ekstrand, PI).

Author Contributions

K.R., D.D., and T.R. contributed to the design and development of the application, as well as preparation and review of the manuscript. K.S. contributed to the study design and the development and adaptation of the intervention content and reviewed the manuscript. R.K. and D.R. coordinated much of the filming efforts, contributed to pilot testing, performed quality checks, and reviewed the manuscript. M.E. conceptualized the overall study and contributed to the development and adaptation of the intervention content and preparation of the manuscript. M.E.A. reviewed and provided input on the manuscript. L.N. contributed to the development of the intervention content and reviewed and provided input on the manuscript. All authors agree with the manuscript's results and conclusions.

Acknowledgments

We would like to acknowledge our consultants Dr. Shalini Bharat from the Tata Institute of Social Sciences in Mumbai and the late Dr. Jayashree Ramakrishna from the National Institute for Mental Health and Neurosciences in Bangalore for their contribution during the consultation workshop held in Bangalore. We would like to acknowledge support from Siju Thomas, Dr. Aruna Kapanee, Matilda Pereira, and the staff of the Chetana study in the video and application development and data management. We would like to acknowledge Vaibhav Gupta and Deepak Sharma from Moksha Digital Private Limited in Bangalore for their efforts in the development of the application.

Article citation:
Dass, Dhinagaran; Raj, Tony; Rakesh, Divya; Kishore, Radhika; Srinivasan, Krishnamachari; Nyblade, Laura; Ekstrand-Abueg, Matthew; Ekstrand, Maria L. "Development of a Novel Tablet-based Approach to Reduce HIV Stigma among Healthcare Staff in India" *Perspectives in Health Information Management* (Spring, April 2017).