

Doctor on DVD: Virtual Health Consultation Using Interactive DVDs

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Abstract—Healthcare facilities in rural areas often lack staff, necessary resources and infrastructure. People in rural areas have to travel long distances to avail basic healthcare facilities. The cost of travel and healthcare consultation in nearby towns is prohibitive for many low-income people. We have anecdotally observed that the penetration of Television (TV) and DVD players in rural areas is higher than smartphones. In this work-in-progress concept note, we advocate an interactive DVD based healthcare decision support system for diagnosis and consultation of common diseases like dysentery, diarrhea, pneumonia etc. on the basis of Integrated Management of Childhood Illness (IMCI) guidelines. The interactive components of the DVD, videos of doctors speaking in local language, graphics, and animations can be used to provide contextual health information in a usable and intuitive manner.

Keywords— *Rural Healthcare; Interactive DVD; Community Health Workers; User Interface Design*

I. INTRODUCTION

Delivery of health services in India is challenged by the large ratio between the number of patients and the number of qualified medical professionals. For most patients, the first contact with the health system is via a Sub-Center (SC), which typically caters to 3000-5000 people and is required to have at least two staff members (one male, one female). SCs are responsible for disseminating information on health practices, running immunization programs, and providing diagnosis and consultation services for diseases like diarrhea, fever, dysentery etc. [1]. However, there are just 146,026 SCs in India [2]. In other words, there is just 1 SC for every 8200 people. In reality, many of these SCs are unmanned and lack the resources to provide effective health services. As a result, people have to travel long distances to visit the nearest primary health center to receive medical services.

The National Rural Health Mission of the government of India has implemented a program called Accredited Social Health Activist (ASHA) to provide easy access to basic healthcare information and services for the rural population [3]. The program has foundations based on *Community Based Monitoring* where local people are responsible for providing health services to their community. ASHAs provide the first contact care to people in rural areas. An ASHA is a village resident in the age group of 25-45 years and has a formal education of at least 8th standard. ASHAs are volunteers and receive compensation on the basis of targets achieved by them. The variable pay component has resulted in low motivation and

high attrition of ASHAs. Although ASHAs are expected to complete 23 days of training, many of them don't finish it. Because of limited experience and incomplete training, diagnosis and consultation services provided by ASHA workers are sometimes imprecise as they either misdiagnose a disease or suggest an incorrect treatment plan. Many times ASHAs are also not aware of the exact number of households they are accountable for. Thus, households that are unaccounted for are unable to take advantage of community based monitoring. Because of the reasons listed above, there is an opportunity to augment healthcare information and service delivery in rural areas by directly providing health information to people in rural regions. However, as many people in rural regions are low-literate and have low income, the information must be accessible to them in an intuitive, usable and cost effective manner.

Recently, researchers have used the interactive capabilities of DVD players (in combination with TVs) to browse large educational websites, like Schools Wikipedia. Such DVDs can be used as a low-cost offline Internet browser for low-income communities where the keys on the remote control of a DVD player can be used for navigating the screens and accessing hyperlinked content [4], [5]. A simple way to understand the interactive capability is by taking the example of a movie DVD consisting of several chapters. A user can navigate to a specific chapter of the movie by pressing an appropriate key on the remote control of the DVD player.

Previous studies have indicated that TVs and DVD players are the primary entertainment devices for people in India [6]. The household penetration of TV in India is 47% [7]. Also, the household penetration of DVD players in India is expected to be 21% by 2013 [8]. In rural areas of India, the household penetration of TV and DVD players is higher than smartphone penetration. We have also observed anecdotally that TV and DVD players are commonly available even in remote rural areas. Moreover, we have seen towns with thriving ecosystems to rent DVD players and DVDs which further increases DVD player penetration. It is worth noting that CDs and DVDs containing health information are easily available in the market, but usually not interactive, not designed for the rural population, contain textual information and do not encode decision support systems for disease diagnosis and consultation.

Commonly-available TVs and DVD players can be leveraged to provide an interactive DVD based medical

decision support system which can be used either by ASHAs or directly by rural people to access health information, diagnose common diseases and access a treatment plan. The diagnostic and consultation decision support system can be built on the basis of IMCI guidelines of the World Health Organization (WHO) using available software and tools [9]. The proposed technology has the potential to train and aid ASHAs in making accurate diagnoses and consultations. Figure 1 contains a mockup of a screen from an interactive healthcare DVD.

Section II briefly explains the challenges in smartphone, feature phone or tablet based medical decision support systems. Section III elaborates on the proposed concept of using interactive DVDs for providing contextual health information in rural regions. Challenges in using interactive DVDs for rural healthcare are outlined in Section IV. Some open research questions and next steps are detailed in Section V. Conclusions are presented in Section VI.

II. MOBILE DECISION SUPPORT SYSTEMS

In recent years, many researchers and practitioners have developed smartphone, feature phone and tablet based decision support systems so that ASHAs can precisely diagnose a disease and suggest an appropriate treatment plan [10], [11], [12], [13], [14]. Though the above mentioned systems are expected to increase the proficiency of an ASHA, they have some limitations in practice.

The projected number of smartphone subscribers in India by the end of 2013 is 67 million [15]. In other words, only 5% of people in India owns a smartphone. The figures are much lower for rural populations in India. Moreover, it is anecdotally observed that low-literate low-income communities own basic phones or feature phones instead of smartphones. As smartphones and tablets are relatively expensive, putting them in the hands of ASHAs would require a big investment by the government, spanning hardware, training, and maintenance. Even if it is practically feasible for a government or practitioner to give a smartphone or tablet to ASHAs, only ASHAs will have the direct access to the device and health information. Hence, people will have to locate an ASHA or wait for him/her to visit them.

Previous studies have indicated that smartphones and tablets can be too intimidating for ASHAs as these devices are perceived by ASHAs as an expensive device [16]. Most ASHAs have limited education so they may take some time to become confident in operating the device. The possible discomfort with the device and its price may become a hindrance in using it effectively to provide healthcare counseling.

A smartphone, feature phone or tablet based decision support system can operate either in offline mode where the rule engine and rules are coded in a standalone application or in an online mode where the application sends a query to a centralized server through USSD, SMS, GPRS, EDGE or 3G network. In case of the offline mode, there are various challenges in designing the ecosystem to distribute and update the application. On the other hand, the online model doesn't always work as many rural regions in India still have limited or no network connectivity [17]. This is because it is not

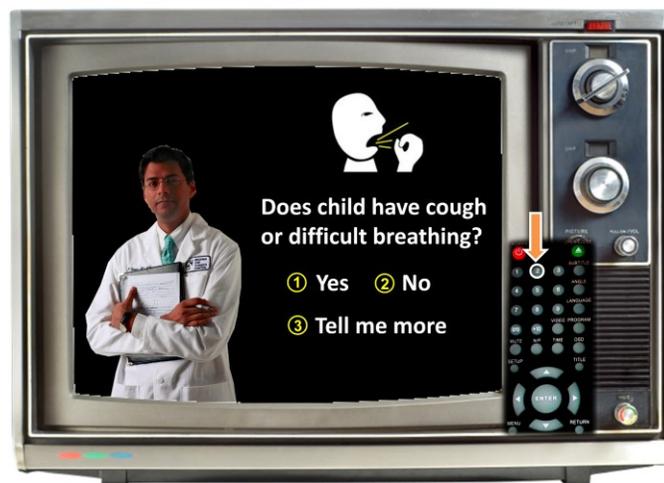


Figure 1: Mockup of a Doctor on DVD
(Photo: Atul Gawande)

economically sustainable for telephony providers to provide voice and data connections in areas with sparse populations and frugal usage of telephony services.

Lastly, phones and tablets are designed for individual use rather than shared use. The form factor of phones and tablets is small and limits the efficacy of disseminating health information to large groups of people.

Because of the above reasons there is a need to explore other modalities to complement the existing efforts of disseminating health information, and diagnosing and providing consultation to people living in rural areas.

III. INTERACTIVE DVDs FOR PROVIDING CONTEXTUAL HEALTH INFORMATION

Various tools are available to map large websites and data on interactive DVDs [9], [18], [19]. These tools leverage the programmable aspects of DVD players, including control flow, basic arithmetic and comparisons, and storage in a limited number of registers. These capabilities enable DVD players to traverse hierarchical decision trees based on inputs from users. They are also able to make decisions by counting symptoms entered by users, or by performing other arithmetic. However, as DVD players lack a random-access memory (such as a stack or a heap), certain complex operations remain out of reach.

An interactive healthcare decision support system can be mapped on DVDs using prior tools and IMCI guidelines. The diagnosis and consultation rules to be encoded in proposed DVDs are standard procedures endorsed by WHO guidelines. Once these rules are mapped to a decision tree, the proposed DVD can be used to diagnose common diseases like dysentery, diarrhea, pneumonia etc. and suggest appropriate treatment plans. Moreover, the DVD can also be used to disseminate contextual health information in an interactive and persuasive way. On playing the proposed DVD, various videos and interactive content will be presented to provide contextual health information to users. In addition, a user can also go to a disease diagnosis module to undergo a preliminary diagnosis. A set of multiple choice questions will be presented to the user by means of videos and graphics. The person operating the

DVD player will be able to answer the questions by pressing numeric keys on the remote control of the DVD player. The system will analyze the response for the current question and present the next question accordingly. When all the questions are answered, the system will have traversed down a hierarchical menu to a node that identifies the disease. The decision tree will also enable assessment of the severity of a disease and suggest an appropriate treatment plan on the basis of IMCI guidelines.

A. User Interaction

In India, the rural literacy rate is 67%. However, only 58% women in rural India are literate [7]. Thus, another important focus is to make the interactive healthcare DVD usable for low-literate people. This can be achieved either by augmenting text-based questions with graphics and animations explaining the text or by completely replacing texts with videos and graphics [20]. To instill more trust in the technology and to make the interaction more intuitive, we propose to play recordings of a doctor (or an actor speaking messages approved by a doctor) in a local language. The recording of the doctor can be supplemented by appropriate graphics to explain the questions to the user.

Let's understand the difference between the interaction of a patient with an ASHA equipped with a flipchart or a mobile based decision support system, and the interaction of a patient with the interactive healthcare DVD. According to the IMCI guidelines, one of the questions which an ASHA should ask to diagnose pneumonia in a child of age 2 months to 5 years is: *Does the child have cough or difficult breathing*. If the answer is yes, the follow-up question is: *For how long*. The phone application or flipchart guides ASHA to assess some other physiological factors like *Count the breaths in one minute*, *Look for chest indrawing*, *Look and listen for Stridor*, *Look and listen for Wheeze* etc. On the basis of the answers to the questions and assessment of physiological factors, a flow chart helps an ASHA to diagnose the disease, measure severity level and suggest a treatment plan.

In case of interactive healthcare DVD, an ASHA or a person with limited healthcare expertise will play the proposed DVD. On playing the DVD, a video recording of a doctor will be played on TV screen. The doctor will ask questions in a tone and body language similar to what he uses while interacting with patients in a clinic. For example, on playing the DVD, the doctor will ask the following question: *Hello! Hmm, does the child have cough or difficult breathing?* The user will be asked by the doctor on the DVD to press 1 on the remote of the DVD player if the child has a cough or press 2 if the answer is negative. If the user presses 1, the doctor will ask the user to count the number of breaths in one minute. The doctor will explain by showing a video how a user should count the number of breaths a child is taking in one minute. A user will have an option to use additional graphics and animations for understanding the breath measuring process. The doctor will ask to input the number of breaths by pressing keys on the remote control of the DVD player. Once the input is provided, the doctor will ask the user to look for chest indrawing. Similar to the previous step, the doctor will explain the process by videos, graphics, and animations on how to observe chest

indrawing. The doctor will ask the user to press 1 if chest indrawing is observed or press 2 if chest indrawing is not observed. The doctor will then explain what Stridor is and how to look and listen for it. The answer to the question will again be inputted by pressing buttons on the remote control. Finally, the doctor will explain what a wheeze is and how to look and listen for it. Users optionally will be able to view a video of a person demonstrating how to check for a wheeze. The doctor will ask the user to input the appropriate key to submit the information. Once all inputs are obtained, the decision support system on the DVD will analyze the inputs to classify the disease, its severity level and will suggest a treatment plan accordingly. For example, in case of a patient suffering from diarrhea, if the decision support system on the DVD detects stage I diarrhea, the doctor on the DVD will consult the patient to drink oral rehydration solution every three hours. Some videos on how to prepare a home-made sugar and salt solution will also be shown. If the decision support system detects stage II diarrhea then the doctor will consult the patient to take an anti-diarrheal drug. If stage III diarrhea is detected, the doctor will consult the patient to visit a doctor or nearest medical facility at earliest. These consultations are the standard treatment plans mentioned in IMCI guidelines once a disease is diagnosed. The DVD will have different recordings of the doctor saved in advance for each possible branch of the decision tree.

B. Comparison with Phones and Tablets

The form factor of TV is much larger than that of mobile phones and tablets. Moreover, the sound quality of a TV is significantly better than that of phones and tablets. Because of these reasons, a TV-DVD seems to be a better option to disseminate health information and educate health workers. Moreover, a TV-DVD can also be used to play interactive content for enhancing users' participation. Researchers have found that intermediated interactions with technology through digitally skilled users can offer benefits to low-literate, low-income, novice technology users [13]. Unlike phones and tablets, TV is designed for shared use and thus reaps the benefits of intermediated interactions as well. An interactive DVD-based healthcare technology will be more intuitive, accessible and usable than a smartphone or tablet based solution as homes in rural areas are often equipped with a TV and DVD player. Moreover, the learning curve for using TV and DVD players is very low because people in rural India use TV and DVD players as their primary entertainment device.

C. Health Education and Awareness

Multimedia content related to health education can be coupled with interactive DVDs to increase awareness and literacy. The interactive component of DVDs can be exploited to design quizzes and games. Such DVDs can enable any household with a TV and DVD to access primary health care information provided by WHO.

D. Cost

Though the production cost to record video clips of a doctor speaking in local language, design interactive graphics and create interactive DVDs would be high, the operational cost of

writing DVDs and dispatching them to sub centers and primary health care centers would be quite low. Moreover, the existing thriving DVD distribution ecosystems can be used to distribute the proposed DVDs to remote rural areas of India.

IV. CHALLENGES

Though using interactive DVDs for providing contextual healthcare information in rural areas sounds promising, it has its own challenges.

A. Perception

People may have a perception that only a human (doctor or medical practitioner or community health worker or a trusted friend or a family member) can diagnose a disease and not a DVD. People may also feel hesitant in taking important healthcare recommendations from a medium of entertainment. This perception may result in limited usage of DVDs as a primary tool for diagnosis and consultation.

B. Power Outages

Many villages in developing countries have access to electricity only for a few hours in a day. Because of intermittent power outages, the adoption of a DVD based solution will be more limited than smartphone or tablet based solutions as phones and tablets run on battery and can be charged whenever electricity is available. Though portable DVD players are available in the market, it is unlikely that the target demographic will have access to and preference for them.

C. Updating Rules and Information in DVD

It is logistically impossible to update the rules and information once they are encoded in a DVD, unless one sends a replacement disc. The task is relatively easy for a smartphone or feature phone application which communicates to a central rule server. Any update can be incorporated by changing the rules in the central server or by pushing application updates. However, phones or tablets are no better than DVD if a standalone offline application is running on them.

D. Epidemic Alerts

It is challenging to find a solution to send epidemic alerts by ASHAs to a central authority. In case of a smartphone or feature phone application, information entered by ASHAs can be automatically analyzed at a server to predict epidemic outbreak. Once an epidemic outbreak is expected, epidemic alerts can be sent by text messages or automated voice calls to all ASHAs in a region. In case of a DVD based decision support system, it is impossible to automatically collect data for analyzing epidemic outbreaks. However, ASHAs can always manually call a central number or send a text message to inform authorities about any possibility of an epidemic outbreak.

V. NEXT STEPS

In this section, we are listing some open research questions which must be explored to understand and evaluate the efficacy of proposed solution:

- Would people use DVDs as a diagnosis and consultation tool?
- Would ASHAs like to use interactive DVDs to supplement the processes used in daily operations?
- Would ASHAs prefer a flipchart, smartphone application or an interactive DVD?
- Would people prefer printed material to an interactive DVD as a medium to access health information?
- Would people prefer a printed material or a smartphone application rather than interactive DVD as a diagnosis and consultation tool?
- Would interaction with the doctor on the DVD affect adoption of health practices and recommendations?
- Would low-literate community health workers and other users comfortably navigate the decision support system by pressing buttons on the remote control?
- Would animations, graphics and interactive features of the DVD improve the user experience and thus information absorption by users?

In order to answer these questions, we propose doing a few field studies to get feedback on usability aspects of the proposed DVD. It will be particularly useful to employ the principles of user centered design and participatory design while interviewing doctors, ASHAs, patients, and low-income low-literate rural users to improve the design of the system, and inform the feasibility of the proposed technology. The field study will also help us understand the complex social and psychological dynamics of adoption of TV-DVD technology. It will also be interesting to understand how asynchronous video interactions through recorded video clips of a doctor impacts the adoption of health practices suggested in the DVD.

VI. CONCLUSIONS

TVs are designed for shared use and have a larger form factor and better sound quality than phones and tablets. It may be possible to leverage the interactive capabilities of DVDs to effectively disseminate health information to low-income, low-literate, rural populations in an intuitive, usable and cost effective manner. Moreover, a healthcare decision support system can be mapped on an interactive DVD to provide a reliable tool for identifying common diseases and suggesting preventive actions. The decision support system rules can be coded in an interactive DVD on the basis of the IMCI guidelines which are used to train community health workers. There are various advantages of using interactive DVDs for rural healthcare. The interactive components and interaction with the doctor on the DVD could make the user experience intuitive. The video of a doctor could instill trust. The DVD could provide a health information dissemination tool, and a disease diagnosis and consultation tool to every household equipped with TV and DVD player in rural areas. The technology could also be used to decrease the reliance on ASHAs and also aid their efforts by increasing the accuracy of their diagnosis and consultation.

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REFERENCES

- [1] “Number of Sub-Centres, Primary Health Centres and Community Health Centres Established During Five Year Plans.”
- [2] “Rural Health Statistics in India 2012,” 2012.
- [3] “National Rural Health Mission.” [Online]. Available: <http://www.nrh.gov.in/>.
- [4] G. Paruthi and W. Thies, “Utilizing DVD players as low-cost offline internet browsers,” in *Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11*, 2011, p. 955.
- [5] K. Gaikwad, G. Paruthi, and W. Thies, “Interactive DVDs as a Platform for Education,” in *Information and Communication Technologies for Development (ICTD)*, 2010, vol. 2013.
- [6] N. Sambasivan, E. Cutrell, K. Toyama, and B. Nardi, “Intermediated technology use in developing communities,” in *Proceedings of the 28th international conference on Human factors in computing systems - CHI '10*, 2010, p. 2583.
- [7] “CensusInfo India 2011.” [Online]. Available: <http://www.devinfolive.info/censusinfodashboard/>.
- [8] “Screen Digest, Market Research Report,” 2010.
- [9] “DVD Author.” [Online]. Available: <http://dvdauthor.sourceforge.net/>.
- [10] Y. Anokwa, N. Ribeka, T. Parikh, G. Borriello, and M. C. Were, “Design of a phone-based clinical decision support system for resource-limited settings,” *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development - ICTD '12*, p. 13, 2012.
- [11] B. DeRenzi, N. Lesh, and T. Parikh, “E-IMCI: Improving pediatric health care in low-income countries,” in *Proceedings of the 26th international conference on Human factors in computing systems - CHI 2008*, 2008, pp. 753–762.
- [12] M. M. Haque, F. Kawsar, S. I. Ahamed, R. Love, R. Dowla, D. Roe, S. M. Hossain, and R. Selim, “Findings of e-ESAS : A Mobile Based Symptom Monitoring System for Breast Cancer Patients in Rural Bangladesh,” pp. 899–908, 2012.
- [13] N. Kuntagod and C. Mukherjee, “Mobile decision support system for outreach health worker,” *2011 IEEE 13th International Conference on e-Health Networking, Applications and Services*, pp. 56–59, Jun. 2011.
- [14] S. Paul, “Health Innovation Trends in India.” [Online]. Available: <http://www.accenture.com/in-en/Pages/service-health-innovation-trends-india.aspx>.
- [15] M. Meeker and L. Wu, “2013 Internet Trends.” .
- [16] I. Medhi, S. N. N. Gautama, and K. Toyama, “A comparison of mobile money-transfer UIs for non-literate and semi-literate users,” in *Proceedings of the 27th international conference on Human factors in computing systems - CHI 09*, 2009, p. 1741.
- [17] A. Chandele, Z. Koradia, V. Ribeiro, A. Seth, S. Triukose, S. Ardon, and A. Mahanti, “2G/3G network measurements in rural areas of India,” in *Proceedings of the 3rd ACM Symposium on Computing for Development - ACM DEV '13*, 2013, p. 1.
- [18] S. Ittan, G. Paruthi, and W. Thies, “Mapping Large Educational Websites to Interactive DVDs,” in *IEEE International Conference on Technology for Education (T4E 2012)*, 2012.
- [19] “Sonic Scenarist.” [Online]. Available: http://en.wikipedia.org/wiki/Sonic_Scenarist.
- [20] I. Medhi, S. Patnaik, E. Brunskill, S. N. N. Gautama, W. Thies, and K. Toyama, “Designing mobile interfaces for novice and low-literacy users,” *ACM Transactions on Computer-Human Interaction*, vol. 18, no. 1, pp. 1–28, Apr. 2011.