

A user-centred approach to inform the design of a mobile application for STI diagnosis and management.

Voula Gkatzidou
Brunel University
London, UK
Voula.Gkatzidou@brunel.ac.uk

Kate Hone
Brunel University
London, UK
Kate.Hone@brunel.ac.uk

Jo Gibbs
Barts and the London
Queen Mary's University
London, UK
J.Gibbs@qmul.ac.uk

Lorna Sutcliffe
Barts and the London
Queen Mary's University
London, UK
L.J.Sutcliffe@qmul.ac.uk

Syed Tariq Sadiq
St. Georges University
London, UK
SSadiq@sgul.ac.uk

Pam Sonnenberg
University College London
London, UK
P.Sonnenberg@ucl.ac.uk

Claudia Estcourt
Barts and the London
Queen Mary's University
London, UK
C.S.Estcourt@qmul.ac.uk

Mobile, pervasive, and ubiquitous computing technologies have the potential to transform healthcare by providing solutions to diagnose conditions and manage care. This paper describes a patient-centred approach to the design of a mobile application to support self-testing for sexually transmitted infections, providing easy and immediate access to diagnosis, treatment via electronic prescription, and partner notification. This paper presents the results of a series of focus group discussions with young people to explore their perceptions of the proposed system and discusses the emergent design principles that present challenges for user interface design and require consideration prior to the adoption of this mobile-based sexual health care.

User Centred Design. Mobile Health. Design Principles

1. INTRODUCTION

Sexually transmitted infections (STIs) are a major public health issue, with Chlamydia being the most commonly diagnosed sexually transmitted infection (STI) in the UK (Booth et al., 2012). STIs such as HIV, gonorrhoea, chlamydia and syphilis constitute an important public health problem as they do not only impact the health of an individual, but affect the health of communities as a whole and can be costly to treat (Pultorak et al., 2009). Young people in the 16-24 year age group are at high risk of acquiring sexually transmissible infections (Health Protection Agency) and despite the recent sustained or rising STI rates among this population, rates of STI testing still remain low. Significant practical and cultural barriers to engaging young people in routine testing for sexually transmitted infections still remain (Baraitser et al., 2011). There is considerable scope to enhance traditional methods for improving the control of STI transmission and thereby increase access to STI services, reduce time to diagnosis and treatment, and increase the effectiveness of partner notification and STI public health surveillance.

The use of mobile and wireless technologies to support the achievement of health objectives has the potential to transform the face of health service delivery (WHO Report, 2011). The ubiquity of mobile phones combined with their increasing communication capabilities present an opportunity for effectively addressing the individual and the social barriers that limit the uptake of testing for STIs among young people. Recent advances in the development of novel personalised diagnostic technologies (Craw & Balachandran, 2012) have the potential to open up opportunities for more accurate point-of-care STI testing and provision of rapid results that can be electronically linked to clinical care pathways. This work is part of the eSTI² (electronic self-testing Instrument for sexually transmitted Infections) Consortium that is harnessing modern advances in communication and diagnostic technologies to offer the potential for electronic point-of care self-testing and diagnosis for STIs (eSTI²). In simple terms, this involves the handheld eSTI² device communicating with a mobile application to allow the user to receive their results rapidly via their phone and will provide easy and immediate access to treatment through an embedded medical assessment

followed by electronic prescription of appropriate antibiotics for those patients for whom it is safe. The focus of this work is to inform the design and guide the development of an effective and user acceptable mobile application (app) that links STI diagnostics with online patient care pathways.

This paper describes a user-centred approach to capture the functional and non-functional requirements and explore the acceptability of the eSTI² mobile application by gathering feedback on end-users' preferences with regards to their interaction with the app. A series of focus groups with young people has been conducted, making use of experience prototypes (Buchenau & Suri, 2000) to investigate their perceptions and obtain suggestions for improving the application through iterative development prior to formative usability testing of the system. Thematic analysis findings are discussed in the context of design recommendations that contribute to the area of user centred design of mobile-based self-testing, diagnosis and management applications.

2. BACKGROUND RESEARCH

There are now over 5 billion wireless subscribers (Ofcom, 2012) with two-fifths of UK adults being smartphone users, with take-up being the highest among younger age groups; 66% of those aged 16 to 24, and 60% of those aged 25 to 34 have a smartphone. Age also seems to be a significant factor in app usage with 79% of 18-29 year-olds using mobile apps. An emergent 'app mentality' combined with the advent of ubiquitous computing technologies has influenced the healthcare software market and represents a paradigm shift that provides many opportunities for delivering better patient outcomes. Mobile, pervasive, and ubiquitous computing technologies offer promising solutions to diagnosing conditions, documenting progress, treating and managing care in a patient-centered approach. Literature suggests that there are already in excess of 7,000 documented cases of smartphone health apps (Kailas et al., 2010) and extensive reviews of the use of mobile phone and handheld computing devices in health and clinical practice can be found in literature (Terry, 2010; Free et al., 2010). Mobile health interventions are also increasingly being used for the prevention and care of sexually transmitted infections, with initiatives primarily focusing on promoting prevention messages (Cornelius et al., 2012), facilitating test result notification (Lim et al., 2008) and increasing adherence to clinic appointments (Swenderman & Rotherham Borus, 2010). Despite the increasing popularity of smartphones and applications and the resulting possibilities for phone-based sexual health interventions, recent studies highlighted that sexual health related apps

have failed to attract user attention and positive reviews of target audiences (Ramanathan et al., 2012). A review of current sexual health-related mobile applications available on major online app stores indicates that at the time of writing, there are no fully functional apps that support the user throughout the entire pathway of STI awareness, testing, diagnosis management, medical assessment, prescription, partner notification and health promotion (Muessig et al., 2013). The evidence-base on feasibility and user preferences for mobile health applications is relatively limited and nascent (van der Linden et al., 2011) and there is relatively little literature published on user preferences for sexual health mobile interventions. For this reason, in order to develop novel healthcare applications that use these largely untested technologies, it is important to have a design process that allows a thorough exploration of the capabilities of the novel technologies. This work aims to contribute to the challenge of designing a secure, legitimate, clinically relevant, effective, and user acceptable mobile interface for sexual health management by providing a number of design principles for future mobile-based self-testing, diagnosis and management applications.

3. RESEARCH METHODOLOGY

This work employs a user-centred approach that takes the specific needs of a group of users into account from the onset of designing a system, and works with them throughout the development of the system. A preliminary study to explore young people's perceptions of using electronic self-tests for STIs linked to mobile technology for diagnosis and care was conducted prior to this work (Fuller et al., 2013). Based on these findings, user journeys followed by prototypes of the mobile interface were developed through an iterative and cross-disciplinary reviewing programme, exploring design possibilities for message content, modality and delivery platform. A high fidelity prototype mobile application was developed (using Axure PR software) for use as part of our focus groups to engage young people in discussions about their views in regard to the interface, how the information is presented and the ordering of interaction steps. This first phase will inform the design of a small set of high fidelity prototypes that will be used in controlled usability experiments to compare the efficiency, effectiveness and satisfaction of the final design alternatives. The results of the trials will be used to select the final prototype to be used in future community-based eSTI² trials.

3.1 Focus Groups

Focus groups are a method of 'considerable power, precision and innovation' that can provide 'critically reflective' (Rosenbaum et al., 2002) means of gathering information from target users. The main aim of the focus groups was to elicit user requirements for the eSTI² mobile interface, through the interaction with the prototype interface. Focus groups were conducted with two populations: 16 to 18 and 18 to 24 year olds which are representative of potential users with the highest risk of STI. The focus groups were presented with hypothetical mobile health application features and use scenarios (i.e. for clinical support and self-management purposes).

Nine focus group discussions (n=49) were conducted as part of the study to inform the design of the eSTI² mobile application. Focus groups were conducted using an a-priori semi-structured interview guide to promote discussion of the content and functionality of the intervention. An animation of the underlying clinical pathway (visual probe) of the eSTI² mobile system was used at the beginning of the focus group sessions to set the context of the discussion and engage the participants. Discussion was conducted until the themes elicited became redundant across groups and no new themes emerged. Participants were queried about the feasibility, acceptability, and attractiveness of potential features of the mobile application, as well as technology-related, security, and privacy issues. Questions also covered topics related to user experience including visual design, information architecture, and structure organisation and labelling of visual components, finding and managing options and interaction design. Recordings from focus groups were transcribed verbatim and subjected to structured review by two members of the research team, using the a priori concepts that guided the interviews. Preliminary thematic analysis (Ryan & Bernard, 2003) was conducted from the qualitative data that included the audio recordings of the focus group interviews and notes taken during the sessions and design principles were derived.

3.2 Participants

The inclusion criteria for the study were fairly relaxed to explore a broad and diverse set of preferences, attitudes and perspectives. For this reason screening criteria for the focus groups were only age (16 to 24 years old) and mobile phone ownership. Participants (n=49) were smartphone users and were recruited from a Higher Education Institution (49%) in London and a Further Education College in an economically disadvantaged area in the North East of England with high prevalence of Chlamydia (51%). Median age of participants was 19 years and most

participants were female (53%); participants were predominantly of white background (65%) with 35% being ethnically diverse. Given the sensitive nature of the subject, participants had the option to select participation in same sex group discussions and research and ethical approval had been granted prior to the study. Overall, nine focus group discussions were conducted, three female-only, three male-only, and three mixed sex groups. All participants owned a smartphone, with 39% using a Blackberry, 35% an HTC, 14% an iPhone phone and 12% a Samsung; only 20% participants had previously used a mobile health application.

4. RESULTS

The objective was to assess the users' perceptions of the initial prototype in order to refine the system before the community trials stage of the research. Preliminary thematic analysis of the focus group discussions has identified a number of emergent themes that are consistent with the research objectives, such as design recommendations, technology preferences, interaction, access modality, privacy, security, confidentiality and legitimacy. During the focus group sessions, participants expressed general enthusiasm towards the concept of self-managing their sexual health through the mobile application.

Salient themes in the discussions varied significantly across the two user populations. Discussions with the younger age group (16 to 18) focused on issues of cost and technology which were regarded as the biggest barriers to acceptance. Discussions with the older age group (19 to 25) focused on privacy and confidentiality which were regarded as the biggest barriers to use. Despite different focal points, there was a fair degree of overlap in discussion with several conflicting needs being identified by both user groups. A number of major themes emerged which pose design challenges to the user interface of the mobile app; these are presented in the following sections.

4.1 Legitimacy and Trust

Legitimacy was a concern to the majority of the participants who saw the design and the content of the application as cues to determine the legitimacy of the service. During focus group discussions, participants have expressed their overall satisfaction with respect to the content being 'clear' with a 'serious tone', which established the application as a professional and credible medical resource. Participants unanimously agreed that the inclusion of a NHS endorsement or affiliations with Sexual Health Centres will engender further trust in

the service and will establish the online medical consultation as 'credible'. Similar to findings from relevant studies (Garett et al., 2011) we have found that design can increase the acceptability and trust of online medical consultations. Nevertheless, in terms of UI requirements, participants also desired the inclusion of a symbol-based 'subtle' logo and suggested the use of 'ambiguous' terminology for the name of the service, avoiding nomenclature such as 'STIs' and 'sexual health', which are in conflict with the premise of a professional, legitimate and health related medical application interface.

4.2 Security

Participants did not express any concerns regarding the security of the application in terms of data transfer and storage, or potential network threats. Security concerns primarily manifested as concerns over the confidentiality of sensitive data. Furthermore, data encryption, that is traditionally considered a security concern, was only mentioned in the context of privacy, with participants expressing a preference for encrypted electronic prescription (QR or barcode) as opposed to non-encrypted content in a text message.

4.3 Privacy

Privacy issues were considerably more salient to participants than security. Password protections, notifications within the application only, immediate data transfer off the mobile phone, and data encryption ameliorated privacy concerns. Participants unanimously agreed on the need for password protection for accessing the application as they described it as a necessary feature due to the sensitive nature of the data that would be collected. Participants agreed that a username and password or a 4-digit passcode would provide a sufficiently secure login mechanism but highlighted privacy issues in regards to system notifications. Although participants understood the need to receive information from the application, they consistently voiced concerns with regard to system notifications. The participants' major concern regarding receiving text notifications from the system was privacy, especially relating to test results and partner notification. As a result, the overall discussion suggested that participants preferred to receive and store all the notifications within the application, rather than on email or text.

4.3. Confidentiality

Almost all participants recognised the value of anonymity offered on the app (as it does not require for the users to disclose their names) with the majority of them accepting the rationale for disclosing their personal data. Participants drew

parallels with a face-to-face visit to the doctors and both user groups were comfortable with the amount of personal data that they had to disclose both for the registration with the service and for the online clinical assessment sections of the application. Confidentiality concerns that were raised focused on the inclusion of a confidentiality policy to explicitly explain how the data will be used. Participants highlighted that the inclusion of disclaimers when collecting 'sensitive' information (which they identified as their postcode and sexual history information) would alleviate the perceived confidentiality barriers.

4.4 Personalisation

Participants had diverse preferences for devices and modalities for their interaction with the mobile application and the accompanying self-testing device. In terms of access modality, when given the option to access the system on their smart phone or on a desktop computer, most participants felt it would be inconvenient to have to access a computer or log on to a website, and wanted all or most of their interaction to take place directly on the smart phone. Overall, preferences in regards to access modality, results notifications, e-prescription modality and partner notification method varied significantly within the sample population. Individualisation and granular control over functionality (referred to as 'customisation') emerged as one of the key features and design principles to both increase the attractiveness and acceptability of the eSTI² mobile interface and alleviate privacy concerns.

4.5 Context of use

Participants were asked what the context of use of the mobile app would be and the majority of them agreed that they would access the system on their mobile (rather than on a desk top). They also highlighted that they estimated that their interaction with the system would be in short chunks of time. When asked whether they would download and install the app or access it over the Internet, participants' replies were varied. The majority of them highlighted a preference for an app that would require download and installation (native app), as opposed to an app that they would access through their web browser (web app). Nevertheless, the participants also highlighted a one-off context of use, with deleting the app after they have got their results and treatment.

5. FINDINGS & DISCUSSION

Overall, the results of this study demonstrate that technology is not regarded as a barrier to the use of our novel mobile-based STI care pathways by the two particular age groups. Design aspects of

the resultant app emerged through the user-centered design process. However, careful design is required to ensure that the design principles deriving from the focus group discussions can be applied in order to promote acceptance and ultimately adoption of mobile health interventions in the future.

Privacy from friends and relatives was arguably the greatest concern expressed by participants, despite all considerations that have been incorporated within the application's design. Issues of privacy and preventing friends and family inadvertently seeing system notifications/text messages is paramount. The design principles for privacy from friends and relatives were to (1) ensure that interactions with the system would be password protected (2) use non-descript wording on logo and name of the application (3) make the interactions/notifications from the system discrete. Although other studies have found that text messaging, and especially multi-media messaging, has been found to be attractive to groups of mobile users (Cornelius et al., 2006; Ramanathan et al., 2012) our participants suggested that receiving text messages from the service presents a privacy concern to them.

Even though privacy was vital for the participants, security was not deemed as a potential barrier to use- with participants inherently trusting new technology and being unaware of potential security threats. They were concerned with their social privacy when using the application, rather their institutional privacy. In other words, they were more concerned about controlling access to personal information, rather than how the service might use that information or how securely it will be transferred and stored. The design principles for data confidentiality and security include 1) inclusion of a comprehensive and comprehensible confidentiality and security policy to alleviate concerns over data storage and sharing.

Customisation was also deemed critical, as preferences on access modality, results notifications, e-prescription modality and partner notification method varied significantly within our sample population. Therefore, in order to enable broad adaptability of the mobile application, such features should have the ability to be tailored to users' needs and preferences. The design principle for customisation was to provide a personalization feature (user profile, authentication preferences, system notifications preferences, features (e-prescription modalities). Although a certain degree of user customisation has been built into the design of the mobile application to accommodate the varying user preferences- there seems to be a

design tension between the need for user customisation and the 'one-off, fast interaction' context of use of the app as described by the participants. Good design of defaults is essential to err on the side of caution and provide a balanced solution between zero-configuration and counter-productive personalisation. For this reason, the eSTI² app will allow the user to optionally set their profile as part of the normal flow of the interaction (while registering with the service and waiting for their test results).

The design principles to engender trust and establish the credibility of the app that derived from the focus group discussion were: 1) To design the intervention (content, language tone and interface) that is validated by clinicians and human factors experts, clinicians to ensure the app follows established medical guidelines and 2) to integrate the mobile app with existing National Health Service clinical care practices by allowing user data to be packaged, stored and optionally shared securely as a electronic health record. In order to address these principles, the NHS branding and logo affiliations with local sexual health clinics have been incorporated in the eSTI² mobile interface, offering support (health advisor staffed helpline fast appointment booking functions) for users to that choose to drop off from their 'online' mobile care pathway and continue their treatment 'offline'.

The design principle regarding the choice of technology that emerged from the discussions was to focus design on system goals and user preferences rather than technological advances and features. Even though an emergent app mentality is evident in the healthcare software market, dictating the development of native (platform specific) apps – our prospective users opted for a platform-independent solution that does not require download and installation and fits in with their preferred context of one-off use. For this reason, according to the users' preferences we are currently developing a HTML5-based web app that is device-agnostic, platform independent and does not require installation on the users mobile phone.

6. CONCLUSIONS & FURTHER WORK

The study was limited to a two-site small convenience sample with no control group, which limits our ability to explore the extent to which the findings reported so far will generalise to a wider population. Future work includes iterations of the eSTI² mobile interface prior to the development of the final prototype for use in future community-based trials.

Understanding healthcare problems from a technological, social and medical perspective in order to design mobile applications that successfully integrate within current healthcare practices is a complex process. Although this study is limited to the design of the eSTI² application, a number of the principles identified are relevant for the design of mobile health apps. Our work hopes to pave way for a greater focus on user-centred approaches to the design of mobile health interventions for sexual health care. The design principles presented in this paper aim to stimulate conversation and encourage creative collaboration across human-computer interaction, pervasive and ubiquitous computing, clinical, biomedical engineering, public health and health economic sciences. This paper argues that successful mobile-based healthcare interventions should reflect collaborative efforts between researchers, HCI practitioners, health professionals, and key stakeholders and apply user-centred methodological approaches to promote acceptance and adoption in the future.

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7. REFERENCES

- Baraitser, P, Alexander, S & Sheringham, J 2011, 'Chlamydia trachomatis screening in young women.' *Curr Opin Obstet Gynecol*, vol. 23, pp.315-20.
- Booth, A, Harris, P, Goyder, E and Norman, P 2012, 'Beliefs about chlamydia testing amongst young people living in relatively deprived areas.' *J Public Health*.
- Buchenau, M & Fulton Suri J 2000, 'Experience prototyping', In *Proceedings of Design of Interactive Systems* (pp. 424-433). New York: ACM Press
- Cornelius, J, Cato, M, Toth, J, Bard, P, Moore, M and White, A (2012), 'Following the trail of an HIV-prevention Web site enhanced for mobile cell phone text messaging delivery.' *J Assoc Nurses AIDS Care*, vol. 23, pp. 255-259.
- Craw, P. & Balachandran, W 2012, 'Isothermal nucleic acid amplification technologies for point-of-care diagnostics: a critical review.' *Lab Chip*, vol. 12, pp. 2469-2486, 2012.
- eSTI², Electronic Self-Testing Instruments for Sexually Transmitted Infections. Available online: <http://www.esti2.org.uk> [Retrieved 04/3/2013].
- Free, C, Phillips, G, Felix, L, Galli, L, Patel, V & Edwards, P 2010, 'Effectiveness of M-health technologies for improving health and health services: a systematic review protocol.' *BMC Research Notes* 2010 vol. 3, pp. 250-257.
- Fuller, S, Aicken, C, Sutcliffe, L, Estcourt C, Gkatzidou, V, Hone, K, Sonnenberg, P, Oakeshott, P, Sadiq S, Shahmanesh, M 2013, 'What are young people's perceptions of using electronic self-tests for STIs linked to mobile technology for diagnosis and care (eSTI²)?' *STI & AIDS World Congress*, Vienna.
- Garrett C, Kirkman M, Chen M, Cummings R, Fuller C, Hocking J 2012, 'Clients' views on a piloted telemedicine sexual health service for rural youth.' *Sex Health*. Vol 9(2):192-3.
- Kailas, A, Chong C, Watanabe, F 2010, 'From mobile phones to personal wellness dashboards.' *IEEE Pulse*. 2010. pp. 57-63.
- Lim, E, Haar, J & Morgan, J 2008. Can text messaging results reduce time to treatment of Chlamydia trachomatis? *Sex Transm Infect*, vol. 84, pp. 63-64.
- Muessig, K, Pike, E, LeGrand, S & Hightow-Weidman, L 2013, 'Mobile Phone Applications for the Care and Prevention of HIV and Other Sexually Transmitted Diseases: A Review.' *J Med Internet Res*, vol. 15(1).
- OFCOM Communication Report 2012, Available online: http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr12/CMR_UK_2012.pdf [Retrieved 19/2/2013].
- Pultorak, E, Wong, W & Rabin, C 2009, 'Economic burden of sexually transmitted infections: incidence and direct medical cost of chlamydia, gonorrhoea, and syphilis among Illinois adolescents and young adults, 2005-2006.' *Sex Transm Dis*, vol. 36, pp. 629-636
- Ramanathan, N, Swendeman, D, Comulada, W, Estrin, D., Rotheram-Borus, M 2012, 'Identifying preferences for mobile health applications for self-monitoring and self-management: Focus group findings from HIV-positive persons and young mothers.' *Int. J. Med. Inform.*
- Rosenbaum, S, G. Cockton, G, Coyne, K, Muller, M and Rauch, T 2002, 'Focus groups in HCI: wealth of information or waste of resources?'. In *CHI '02 Extended Abstracts on Human Factors in Computing Systems* (CHI EA '02). ACM, New York, NY, USA, 702-703.
- Ryan, G & Bernard, H 2003, 'Techniques to identify themes', *Field Methods* 15 (1), pp.85.
- Swendeman, D & Rotheram-Borus, M 2010, 'Innovation in sexually transmitted disease and HIV prevention: internet and mobile phone delivery vehicles for global diffusion'. *Curr Opin Psychiatry*, vol. 23, pp. 139-144.
- The Health Protection Agency, 'Sexually Transmitted Infections and Young People 2008 Report.'
- WHO World Health Organisation 2011, 'm-Health: New horizons for health through mobile technologies: second global survey on eHealth.'
- Terry, M 2010, 'Medical apps for smartphones.' *Telemed J E Health*, vol. 16, pp. 17-22, 2010.
- van der Linden, J, Rogers, Y, Crissman, T & Dalglish, M (2011). 'Technology inspired design for pervasive healthcare.' In *Workshop on User-Centered Design of Pervasive Healthcare Applications*. Proceedings of Pervasive Healthcare Conference, Ireland.