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Mobile phone use among patients and health workers to enhance primary healthcare: A qualitative study in rural South Africa



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ABSTRACT

Mobile phones have the potential to improve access to healthcare information and services in low-resourced settings. This study investigated the use of mobile phones among patients with chronic diseases, pregnant women, and health workers to enhance primary healthcare in rural South Africa. Qualitative research was undertaken in Mpumalanga in 2014. Semi structured in-depth interviews were conducted with 113 patients and 43 health workers from seven primary healthcare clinics and one district hospital. Data were thematically analysed. We found that some health workers and patients used their own mobile phones for healthcare, bearing the cost themselves. Patients used their mobile phones to remind themselves to take medication or attend their clinic visits, and they appreciated receiving voice call reminders. Some patients and health workers accessed websites and used social media to gather health information, but lacked web search strategies. The use of the websites and social media was intermittent due to lack of financial ability to afford airtime among these patients and health workers. Many did not know what to search for and where to search. Doctors have developed their own informal mobile health solutions in response to their work needs and lack of resources due to their rurality. Physical and social factors influence the usability of mobile phones for healthcare, and this can shape communication patterns such as poor eyesight. The bottom-up use of mobile phones has been evolving to fill the gaps to augment primary care services in South Africa; however, barriers to access remain, such as poor digital infrastructure and low digital literacy.

1. Introduction

1.1. Mobile health interventions in low- and middle-income countries

Digital technologies such as mobile phones are providing solutions for improving access to healthcare information and services in low- and middle-income countries (LMICs). The use of conventional mobile and wireless technologies to support health objectives is known as mobile health or mHealth (WHO, 2011). The capabilities of digital communication technologies to create, store, retrieve, and transmit information among users may improve and support the delivery of healthcare solutions (Akter and Ray, 2010; Odendaal et al., 2015). The potential of mHealth to be integrated into existing health systems has been widely acknowledged in the literature (Labrique et al., 2013; Ruxwana, 2007; UN, 2012), including in LMIC settings (Mehl and Labrique, 2014; Ruxwana, 2007; UN, 2012). The mobile phone infrastructure is the

most advanced infrastructural development in Africa, far surpassing roads and water, with many rural households having access to mobile phone services but not piped water (WorldBank, 2017).

In rural resource constrained contexts, with shortages of health professionals (Beratarrechea et al., 2017), affordable, effective, and accessible mHealth solutions (Beratarrechea et al., 2014) have been increasingly adopted. A realist review of the use of mHealth for long-term conditions in sub-Saharan Africa indicates that mHealth can address the lack of capacity at the point at which people access healthcare (Opoku et al., 2017). However, mHealth presents many challenges. For example, a qualitative study from South Africa suggests that scaling up mHealth in community-based services is limited by the lack of availability of digital communication technology and privacy of information (Leon et al., 2012). Studies that assessed the feasibility and acceptability of mHealth to support self-management of chronic diseases (Kamis et al., 2015; Leon et al., 2015) in Bolivia and South Africa and

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sexual and reproductive health (Ippoliti and L'Engle, 2017) (mostly from African contexts) agree that mHealth is effective in reaching patients; however, data privacy and phone access are limiting factors.

Lines of evidence of the effectiveness of mHealth solutions in LMICs have been inconsistent in systematic reviews (Bärnighausen et al., 2011; Bloomfield et al., 2014; Catalani et al., 2013; Cole-Lewis and Kershaw, 2010; Fjeldsoe et al., 2009; Free et al., 2013; Krishna et al., 2009; Mbuagbaw et al., 2015; Velthoven et al., 2012; Yasmin et al., 2016). For example, in a review on mHealth for noncommunicable diseases (NCD) in sub-Saharan Africa, Bloomfield et al. (2014) concluded that evidence to support mHealth effectiveness for NCD care is insufficient. Discussions on how few publications have evidenced scalability in low-resourced contexts continue (Hill, 2015; Kumar et al., 2016). In response to the insufficient programmatic evidence of implementation and scale-up of mHealth, Tomlinson et al. (2013) recommended that the mHealth component must be guided using behaviour change theory.

Most published research evaluated mHealth interventions in LMICs that have been designed and implemented as part of a research programme. By contrast, an interview study by Hampshire et al. (2016) described how health workers in Malawi ($n = 18$) and Ghana ($n = 16$) used their phones informally to support healthcare delivery. In doing so, they bore 'the costs of bottom-up mHealth' (Hampshire et al., 2016, 34). The present study focused on this idea of bottom-up mHealth.

1.2. The present study and its context

This paper reports a large qualitative study that investigated how and why patients with chronic disease, pregnant women, and nurses and doctors in the public health system of a rural north eastern part of Mpumalanga province, South Africa used their own mobile phones for healthcare. Although South Africa is a middle-income country, with free healthcare provided at the point of access, health outcomes in the rural areas are poor. This has been attributed to an ineffective national response to the country's burden caused by leading diseases: HIV and AIDS, tuberculosis, hypertension, and diabetes (StatsSA, 2013). The national maternal mortality rate was high in 2014 (133 deaths per 100,000 births) (van Shaik, 2015, 80). Health service management is not always effective (Scott et al., 2012); governance failures (Coovadia et al., 2009) and ongoing health workforce crises (Rispel et al., 2016) are prevalent. Altogether, these problems create barriers to quality healthcare in the rural communities (Ataguba et al., 2011; Goudge et al., 2009). We investigated the use of mobile phones to fill healthcare gaps and augment services. Our research question was as follows:

How are mobile phones being currently used from the bottom-up by patients and health workers to enhance the delivery of primary healthcare within rural South Africa?

Our study had the following objectives:

- To investigate the current uses of mobile phones to enhance health;
- To determine how patients engage with a clinic-initiated mHealth intervention;
- To understand how bottom-up mHealth practices can be developed to improve healthcare in similar rural areas in South Africa in future.

1.3. Patient and health worker initiated use of mHealth in South Africa

In South Africa, 84.2 percent of households own a mobile phone (Gillwald et al., 2012, 49). A study that used a story-based approach with young South African people (8–25 years) to elicit phone use found that many used digital social networks and consulted the Internet through their mobile phones to 'secure effective healthcare' (Hampshire et al., 2015, 90). A qualitative study with 16 South African nurses undertaking an advanced training programme in midwifery found that the

midwives working in a remote area used mobile phones to connect themselves to 'online communities' (Pimmer et al., 2014, 1402). They also established a Facebook group to consult with each other about patient cases and share specialised knowledge (Pimmer et al., 2014). Another qualitative study (van Heerden et al., 2017) on the publicly funded HIV services in KwaZulu-Natal, reported data from 10 female patients living with HIV and 12 community health workers. In focus groups, the community health workers described how they communicated with each other through WhatsApp and used Google to search the Internet for health information (van Heerden et al., 2017, 100).

1.4. Public health service initiated use of mHealth in South Africa

The South African Government is enthusiastic about mHealth to improve healthcare (Agarwal and Labrique, 2014) and has published an mHealth strategy (NDOH, 2015). In 2014, the National Department of Health launched MomConnect to deliver health promotion messages to pregnant women registered for antenatal care. These messages are tailored to their stage of pregnancy and after delivery, until their child is one year old (Peter et al., 2016; Seebregts et al., 2016; Wolff-Piggott and Rivett, 2016), at no cost to the woman (Barron et al., 2016).

1.5. Evaluations of mHealth interventions in South Africa

In a randomised controlled trial undertaken in Cape Town, patients with hypertension were sent reminders and text messages on behavioural change information to their mobile phones for 12 months (Bobrow et al., 2016). A slight reduction in systolic blood pressure was observed in the intervention group at 12 months compared with the control group; however, this change was not statistically significant. A marked improvement was noted in the intervention group's clinic attendance compared with that of the control group. The results of the study's process evaluation suggest that the patients who benefitted the most from the intervention were those with ongoing stressful life situations such as poverty, causing them to take breaks from taking hypertension medication (Leon et al., 2015). Moreover, also in Cape Town, a trial on interactive mobile text messaging with motivational interviewing aimed at enhancing breastfeeding among women living with HIV is underway (Zunza et al., 2017).

In contrast to these intervention studies, we report initiatives undertaken by patients and health workers to use their own mobile phones to fill gaps and augment primary healthcare services.

2. Methods

We conducted an interview study to examine the current use of health-related digital mobile communication among patients and health workers at their first point of access to services in rural South Africa.

2.1. Study setting

Fieldwork was conducted in one district hospital and seven primary healthcare facilities located in or on the borders of the Agincourt sub-district of rural Mpumalanga province, north eastern South Africa (Fig. 1) (Kinsman et al., 2015; Agincourt, 2014b; Sartorius, 2013). The Wits/MRC Agincourt Health and Demographic Surveillance System (HDSS) site runs a Public Engagement Office (PEO). The PEO assisted with access to the community and entry into healthcare facilities.

The HDSS site covers 420 km², encompassing 32 villages, with approximately 16,000 households (Kahn et al., 2012). The area is broadly representative of the most marginalised rural communities in South Africa. Unemployment rates remain high; therefore, economic 'out migration' to cities for labour is common (Collinson et al., 2007, 3). Many of the village households are densely settled, remote, and underserved by government services. However, two-thirds of households

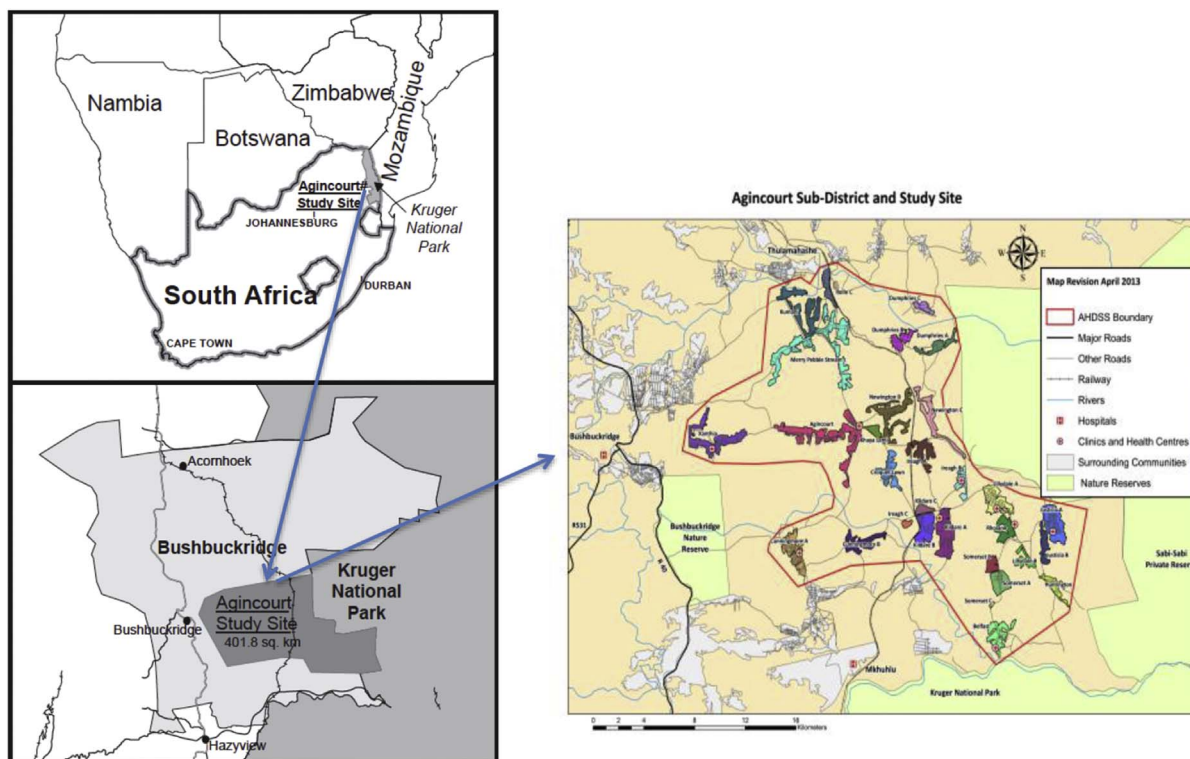


Fig. 1. Map of the Agincourt HDSS field site and its geographic location within Mpumalanga, South Africa.

have access to running water and prepaid electricity (Maredza et al., 2013). The mobile phone penetration is approximately 93 percent of the households. Mobile phone signals and the third-generation (3G) network are strong in the study area (Agincourt, 2014a).

2.2. Access to healthcare facilities

The lead author (JAW) is a white South African woman trained in qualitative research methods. To prepare for fieldwork, JAW spent three months becoming familiar with the field site prior to data collection and learning basic Xitsonga—the language of the Shangaan people and the most commonly spoken local language in the study site. Four primary healthcare facilities were purposively recruited to represent the geographical and demographic diversity of the community within and on the boundary of the HDSS by using the publically available HDSS data. The two clinics near the boundary of the HDSS had less research experience. The district hospital is located on the periphery of the study site. Permission to undertake research in each facility was obtained from the facility manager prior to recruitment. The study was advertised on posters displayed in English and Xitsonga in the public waiting areas in each health facility. We recruited patients with chronic disease, women attending antenatal care, and government employed professional health workers.

2.3. Recruitment for patient interviews

To recruit patients with chronic disease, we sampled consecutively from the chronic disease queue in each of the four facilities, stratifying by age group (18–24, 25–50, and 50 + years). To recruit pregnant women, we consecutively sampled from the antenatal queue at the same four clinics, stratifying by gestational age and parity. Recruitment was undertaken over 10 consecutive weekdays over a two-week period at each health facility. One fieldworker trained in qualitative methods was employed to assist with recruitment by introducing the study in Xitsonga to all the patients in the queue. In doing so, she was accompanied by a nurse.

All patients older than 18 years in the chronic disease or antenatal queues were invited to participate. If JAW or the fieldworker had doubts about the ability of a patient to participate in the interview due to their mental or physical health, they consulted the managerial nurse to determine whether the patient should be excluded from the study. Before the interview commenced, participants were given 30 min or longer, after they had agreed to take part, to read the study information leaflet. Patient interviews were conducted by JAW and the fieldworker in a private consulting room at each health facility during the time they were waiting to see the nurse. We ensured that at least 10 people were ahead of them in the queue; thus, the interview did not interfere with their consultation slot. If a patient was near the front of the queue and wanted to participate, they were interviewed after their consultation.

A month after all patients with chronic disease had been interviewed, a mobile phone intervention for hypertension was initiated in four HDSS village clinics, three of which were different from the clinics sampled for this study. Two lay health workers per clinic were employed in the trial to phone patients each month to remind them to attend the clinic to collect their medication (Thorogood et al., 2014). Clinic nurses were consulted about the intervention and its implementation but had no direct role in delivery of the intervention. We considered this intervention as an opportunity for us to recruit patients for interview, who we knew had experience of receiving a mobile phone call reminder from a clinic. On the days that the patients receiving the intervention were booked to attend the clinic, we consecutively sampled patients for interview from the chronic disease queue of three of the intervention clinics. We excluded one intervention clinic where we had already interviewed patients to ensure that we did not recruit the same patients. We also excluded patients who had not received the intervention for at least two months. We stratified the recruited patients by age group (18–24, 25–50, 50 + years).

2.4. Recruitment for health worker interviews

We arranged a meeting with the primary care facility managerial nurse and hospital manager to seek permission to interview the nursing

staff and doctors during their work breaks or before or after their shifts. The sampling of nurses was purposive for a diversity of duration in the work role and type of experience. Nurses were recruited at the same four clinics as were the patients. In each clinic, five to eight nurses were interviewed, constituting almost all the nurses of each clinic. The doctors were each given a printed letter inviting them to participate. For those that agreed, an interview was arranged for a time convenient to them. Health worker interviews were conducted by JAW in a private room at the clinic or hospital, and in two cases, over the telephone.

2.5. Data collection

The semi structured interviews were conducted over a period of six months (January–June 2014).

During the familiarisation period, the topics in the interview guide were determined a priori based on a scoping review of the literature and informal discussions with nurses and community members in a local village. This village was not included in the study. The interviews were designed to ask the participants about themselves and their experiences of healthcare and then focused on what they used mobile phones for, particularly in relation to healthcare or clinic activity. For example, questions for patients included the following: *Can you give me examples of when you use your phone? Are there times when you do not have airtime? Tell me about your experiences of using the Internet. Do you need help using your mobile phone? Can you describe instances when you have used your phone for a health-related purpose?* Questions for health workers included the following: *Tell me about the use of your mobile phone at work. Tell me about your use of computers at work, if any. What are some of the challenges of your job? How may digital technology be a benefit or disbenefit to your everyday work tasks?* For a complete interview guide, see [Appendix 1](#). We adapted the interview guide for each study group during the data collection process. For example, we reworded questions to sound more culturally relevant with the aid of the fieldworker's local knowledge. As the research progressed, JAW probed issues in greater depth during the interviews, drawing on insights gained from earlier interviews.

At the start of each interview, the purpose of the study was described to the participant before consent was requested (see ethics section below). All interviews were audio recorded. For patient interviews, a multilingual local South African female fieldworker acted as an interpreter. JAW asked the questions and then followed up on what was being said throughout the interview. This process became easier as time progressed. Patient interviews were conducted in the South African language that the participant was most comfortable with (we had anticipated that this was likely to be Xitsonga). The health worker interviews were conducted in English. Participants were informed that JAW was not a clinician but studying for a postgraduate degree. No interaction had occurred between JAW and any of the participants before the interview.

The fieldworker transcribed and translated all patient interviews into English, shortly after data collection. The transcripts were discussed with JAW. To review the accuracy of the fieldworker's translations, an independent Shangaan translator transcribed 10 percent of all patient interviews conducted in Xitsonga. This translation was compared with that of the fieldworker's transcripts. JAW transcribed all health worker interviews.

During and after all interviews, JAW took field notes to supplement the interview transcription and made reflective notes. These documents were used in combination during the analysis. The research team discussed factors that might influence the interpretations of data during data collection and analysis to avoid generating preconceived notions.

2.6. Data management

All paper copies of information on participants were stored in a locked filing cabinet and destroyed at the end of the study. Audio

recordings were password protected and destroyed after transcription. At the point of transcription, a study identification number was assigned to each participant and all identifiers were removed from the data. Digitally stored transcripts were password protected. In reporting the quotations in the results, we have ensured participants cannot be identified from the quotations. We report quotations with the participant identifier, participant sex, and age group.

2.7. Data analysis

We developed an initial coding framework from the interview guide, adding new codes as necessary. The data was coded by two members of the research team (JAW, FG) in QRS International Nvivo version 10 software. Other authors (JG, XGO) reviewed a random selection of transcripts from both participant groups. We performed line-by-line coding. Codes were then reviewed and categorised into themes ([Braun and Clarke, 2006](#); [Crowe et al., 2017](#)). The research team met five times to refine themes until consensus was reached that all themes represented the breadth and depth of the data.

In reporting this study, we have applied the 32-item Consolidated criteria for Reporting Qualitative research (COREQ) checklist for in-depth interviews ([Tong et al., 2007](#)).

2.8. Feedback to the health facilities

After completion of data collection and initial analysis, we presented results to the managerial nurses of all seven participating clinics and then to a group of hospital doctors (of which half of these doctors had participated in the study).

2.9. Ethical considerations

The consent form was read out loud to all the patients by the fieldworker. Written informed consent and separate permission to audio record the interview was voluntarily given by all participants prior to the interview by signature or inked thumbprint, if the respondent was illiterate. The participants were given an information leaflet in Shangaan or English to take home. This included a telephone number to phone if at any time, they wanted to withdraw their data from the study. Ethical clearance was given by the University of Warwick Biomedical and Scientific Research Ethics Subcommittee (REGO-2013-082), the University of the Witwatersrand Medical Human Research Ethics Committee (M130411), and the Department of Health Mpumalanga Provincial Health Research Committee.

3. Results

3.1. Study participants and their general use of mobile phones and computers

We interviewed 69 patients with chronic disease aged 18–88 years, of which 53 were women (from all seven clinics) and 44 were pregnant women aged 18–37 years (from four of the clinics). Among the 69 patients with chronic disease, HIV/AIDS was the most common condition (63%), followed by hypertension (39%), diabetes (13%), and epilepsy (6%). One-third of the 69 patients required treatment for more than one long-term condition. At the time of interview, the mean gestational age of the pregnant women was six months. All interviewed patients were Black South Africans, Swazis, or Mozambicans permanently residing locally. The languages spoken at interview were Xitsonga (67%), English (14%), isiXhosa (4%), SiSwati (4%), isiZulu (2%), and dual language (9%).

We interviewed 32 nurses and 11 doctors. All were employees of South African Department of Health. Out of these 32 nurses, 10 had nursed for 10 years or less, and 22 nurses had worked as a nurse for more than 10 years.

All those invited for an interview consented for participation. Patient interviews lasted 25–35 min. One patient with tuberculosis was considered by a nurse to be too unwell for interview after she gave her consent. The fieldworker's transcriptions were found to be very accurate when compared with those of the independent transcriber. The interviews with nurses lasted 25–40 min and those with doctors lasted approximately 40–60 min.

All the 113 interviewed patients owned their own mobile phones, but only half of them owned a phone capable of connecting to the Internet, as opposed to basic phones with limited functions. None of the patients owned a touchscreen smartphone. Most interviewed nurses owned phones that could enable them access to the Internet, and three nurses owned basic phones. One newly qualified nurse shared a mobile tablet device at home. We did not find any differences in the use of mobile phones and Internet use between nurses in clinics in the HDSS site and those outside the site boundary. All but three doctors owned a smartphone; those who did not, explained that they were nearing retirement.

Doctors and most nurses used their personal phones socially, for making phone calls, sending text messages, or using WhatsApp. The nurses were more familiar with mobile phones than they were with computers.

Many patients explained that they simply could not afford to regularly buy airtime for making calls, often waiting until they had received their monthly government social security grant to purchase airtime credit.

'Yes, it [airtime] is very important and I need it but it's just that I don't have money.' (Pregnant woman ID: 1240, age 18–24)

All the doctors and only 30 percent of the patients and nurses had airtime credit to make phone calls and send text messages at the time of interview.

Of the 56 patients who had phones that could connect to the Internet, only 31 patients had ever used the Internet on their phones. Of those 31, only 10 patients considered themselves regular website or phone application users. However, many of them suggested that they used social media when they could afford to buy data. All doctors and a quarter of all nurses reported using the Internet at least once a week. For most patients and nurses, web literacy levels were either non-existent or very rudimentary.

3.2. Health-related use of mobile phones by patients and health workers

A total of 40 percent of the patients, 60 percent of the nurses, and all the doctors reported using their mobile phones more than once per week for health-related purposes. Among the 69 patients with chronic disease, 18 (13 female, 5 male) of those patients all with hypertension participated in the trial and had received two phone call reminders. These were at monthly intervals received from a lay health worker to remind them to attend the clinic to collect their medication.

From the interview data, we identified three themes: Digital innovation by health workers, patient use of mobile phones to support management of chronic disease; and health information gathering using the Internet by patients and health workers. We present data from the patients and health workers together for each theme.

3.3. Digital innovation by health workers

Nurses and doctors were not provided mobile phones for use in their clinical or administrative work; however, they informally used their personal phones in the work place. Four nurses mentioned making calls at least once per month for clinical emergencies. These nurses explained that this was not a problem because they were concerned about their patients. However, they were not pleased with using their own airtime for this communication.

'Eh, I feel pity for the patient and for the community.' (Nurse ID: 1271, female)

'I am spending my own money, so it is not OK.' (Nurse ID: 1296, female)

Nurses who regularly used the Internet on their phones to access the Web or applications were also more interested in gaining computer skills for use in their work than those with no prior experience of using the Internet.

'We are using pens and books to write monthly statistics, but if we had computer, we would just go and retrieve the information to see how many under-fives [children] we saw.' (Nurse ID: 1290, female)

However, other nurses talked about how busy their jobs were and how there was 'no time for computers' (Nurse ID: 1276, female). Many of the interviewed nurses said that they were unable to use a computer and blamed this on their own 'laziness' (Nurse ID: 1292, female), rather than lack of formal computer skills training.

Within the district hospital, no Wi-Fi was available for health workers' use. As a result, a syndicate of three doctors applied for a charitable grant to install a private computer and broadband system in the hospital to enable Internet access for all doctors who signed up for Internet use. Other hospital staff could request access to this private Wi-Fi.

'There is almost no wireless Internet for the hospital itself. I mean, I have hospital managers wanting to join [the private Wi-Fi] because they don't have it. We bought a computer in the doctor's tea room so that's always connected to the Internet.' (Doctor ID: 1262, female)

Eight of the doctors used their personal mobile phones for work. They routinely retrieved blood test results from the laboratory through a website directly to their phones instead of waiting for the results to be printed out. Doctors also communicated with each another via WhatsApp groups. This enabled them to coordinate care, check which other doctors were on shift at a given time, or ask general administration-related questions. They used the built-in cameras of their phones to photograph electrocardiograms or X-ray images. These digital photographs were then sent to remote specialist doctors for diagnosis, advice, and support. They explained that this process facilitated their own decision-making because they rapidly obtained expert feedback.

'I will take pictures of the X-rays and send them to whoever is on [duty] at the tertiary hospital, they will read the pictures and that is how we will communicate.' (Doctor ID: 1267, male)

One of the interviewed doctors designed an application called 'Thumela (2016)'. The Thumela system held the on-call rotas of the doctors at regional hospitals providing specialist care. This enabled the doctors to contact each other directly to speed up patient referrals between facilities and thus obtain time to treat. They preferred this method than relying on the hospital telephone operator system.

'The very first step in the process is just to know who to call, or who to communicate with' (Doctor ID: 1261, male)

Another doctor in this study also developed an application, 'Vula Mobile' (Vula, 2016). This application enables community health workers who are at a patient's home to decide whether the patient with an eye problem requires a referral to a hospital doctor.

'The app has a questionnaire about [the patient's] eyes, using a chat system ... a bit like WhatsApp, that connects you to a specialist, who is on call. It's only two megabytes large, so it is easy to download, especially in rural areas.' (Doctor ID: 12147, male)

3.4. Patient use of mobile phones to support management of chronic disease

Over half of the interviewed patients used their mobile phones to help themselves manage their own chronic disease treatment. Patients discussed setting reminders and alarms, using the phone's clock, and asking treatment supporters (friends or family members) to phone or send a text message to remind them to take their medication or to attend their monthly clinic appointment.

'When I looked at the time on my phone and find that it's eight [pm], I know that I have to take my treatment.' (Patient ID: 1250, female, age 18–24)

Many older patients described how their poor eyesight made it difficult for them to physically see their mobile phone screens. They often obtained assistance from other people, usually grandchildren, with phone use. None of these people wore optical spectacles.

'My eyes are very poor, I cannot see clearly. I can see that there is something written on the [phone] screen but I don't see anything.' (Patient ID: 1217, female, age 70–79)

The patients who had purposively received mobile phone calls from the lay health workers to remind them to attend the clinic to collect their medication were pleased to receive the calls. One patient described how 'we like that style, that system of working.' (Patient ID: 126, male, age 50–59). The patients were not accustomed to any communication from the clinic between their appointments. A few of them reported initial ambivalence towards receiving the calls because they believed that their own reminder system already worked favourably for them or they considered themselves adherent to collecting medication regularly. One patient described how the phone call motivated her to continue with her treatment.

'It reminds and encourages me to come to the clinic. When they call me, it makes me motivated to come to take the treatment.' (Patient ID: 1222, female, age 30–39)

3.5. Health information gathering using the Internet

Several interviewed patients had an experience of gathering information on their disease through their mobile phone by communicating with other patients, both acquaintances and strangers, via social media such as WhatsApp and Facebook. Five of those patients also found health information on the Web. However, many patients and nurses stated that they did not have the skills to search the Web for health information by using their phones and often did not have any data to access the Internet.

Doctors and nurses who used the Internet for work reported using search engines on their phones such as Google, to access clinical information on diseases or prescription drugs. A few nurses reported accessing the digital versions of government clinical guidelines.

'To check, when I want to understand the diseases of my clients [patients], I just search ... but not always because it is expensive.' (Nurse ID: 1273, female)

A nurse suggested that searching the Web is useful because rural areas typically have no libraries and the paper copy of clinical guidelines was often unavailable at the facility.

'So, you can Google and find one thing that you cannot find in the books ... we do not have libraries here that are well equipped, so the Internet for Google searching for health seeking is good.' (Nurse ID: 1292, female)

A total of six patients younger than 25 years owned an Internet-enabled phone. They accessed browsers, such as Opera or Google, to search for specific information on websites about their health. They also used several social media platforms to improve their comprehension of

illness or medication by asking questions. Among the 30–39 year old patients, four used social media to obtain information on their health problems. Among social media platforms, WhatsApp was most popular for discussing health concerns and giving and obtaining advice.

'I do talk to my friends ... we do chat about our treatment and some will say, "When I came here I was left with 3 CD4 count but now I am fine". Then we ask, "Why do you stay for a long time without testing?" and so on. We do advise each other.' (Patient ID: 1244, female, age 30–39)

These younger patients described how they were becoming more informed and aware of their disease by using their phones to actively seek relevant information.

'I use my phone to research about diabetes. What kind of food are you supposed to eat and how to prevent it and stay healthy all the time.' (Patient ID: 12129, male, age 18–24)

A younger patient spoke about how she shared information with others who were without Internet access.

'It is important because we are learning things there [on the phone] and you are able to share with other people who are unable to go to Internet.' (Pregnant woman ID: 12132, age 30–39)

However, these younger patients used very basic strategies for choosing what information to read:

'When I go to Google, I will write a question and then the answer will come out. I choose any answer, then read it.' (Pregnant woman ID: 1259, age 18–24)

Many patients and health workers repeatedly suggested that they were unsure of where to search for the information they required. Patients also discussed their inability to read or understand websites written in English.

'I prefer Shangaan because it's my mother tongue and there are other words that I will not understand if it is in English.' (Patient ID: 1225, female, age 60–69)

4. Discussion

Health workers and patients have been developing their own digital communication solutions to fill gaps and augment healthcare by using their own mobile phones and buying their own airtime and data to engage in activities. Doctors were the most active users among health workers in initiating innovation in digital communication for health. They used their own resources or leveraged resources from donors. Their motivation was to improve healthcare access by using their smartphones to fill gaps in service and speed up processes such as referrals and receiving laboratory test results. Nurses lacked the financial resources for using their own mobile phones extensively for clinic practices; however, they still used them despite finding the cost of doing so a burden. Healthcare provider organisations cannot afford resources for health workers to use digital communication despite the potential benefits and desire to use it. Among patients, the younger patients were most engaged in using the Internet and social media to learn more about their health, even if this was ad hoc. Many older patients struggled to read the text on their phone screens but did use the alarm and phone call facilities to help them to remember their medication and clinic appointments. Older patients were mostly pleased to receive phone calls from the lay health workers at their clinic to remind them to attend the clinic to collect their medication, because it made them feel cared for by the health system.

Our findings agree with the technology-augmented Capability Approach (Haenssger and Prochista, 2017a; Sen, 1990, 1999). In the context of poor and remote rural communities with challenging healthcare access, mobile phones are a logical solution to improve

service access. Phones are technical objects that enable change in ‘care seeking’ and care providing practices, leading to increased capability (Haenssger and Proochista, 2017b, 288). For example, patients and health workers can find health information that they can use to improve health; doctors can speed up care processes to benefit patients. Mobile phones provided many of the participants in this study, the freedom to use their initiative, which in turn led to an increased capability of gaining or providing ‘effective healthcare’ (Anstey-Watkins, 2016, 4). However, social factors also influence the usability of mobile phones for healthcare, and this can shape communication patterns (Haenssger and Proochista, 2017a). In our study, the nurses were unable to harness the use of mobile phones as much as the doctors did because they were poorly paid and had poorer digital literacy. Younger patients who were familiar with the use of mobile phones were more active in using digital channels for gaining health information than older patients who relied on the radio. Our study data suggest that physical factors such as poor eyesight also influence the use of mobile phones. However, the physical factors being a barrier may in turn be attributed to social factors. In the context of this study, a key influencing social factor is the poor provision of eye care in South Africa (Lecuona and Cook, 2011).

Phone call and text message reminders in healthcare have been shown to increase the likelihood of attending clinic appointments (Guy et al., 2012), especially in LMIC settings (Beratarrechea et al., 2014; Percac-Lima et al., 2016). Digital communication can create an interpersonal relationship (Hennen, 1975) between the health worker and the patient in low-resourced environments (Hoffman et al., 2010; Leon et al., 2015). This relationship can contribute to improved understanding and concordance with treatment (Sturmberg, 2003).

Poorer and less educated populations have been shown to have reduced access to health information on the Web than those with more wealth and with a higher education level (Clarke et al., 2016). A lack of online search skills and the unreliability of health information on the Web also reduces access (Clarke et al., 2016). The patients in our study were disadvantaged and lacked web searching strategies. Patients who use their phones to find health information on the Web require a level of (self-taught) web literacy (Neter and Brainin, 2012). Inexperience with reading website content can lead to retrieval of inaccurate or irrelevant information (Lee et al., 2014). Although studies have found that mistrust of websites is common among patients (Miller and Bell, 2012; Sillence et al., 2007), we did not find this in our study, maybe because patients in our study did not have sufficient opportunities or experience of websites to develop any mistrust.

4.1. Study strengths and limitations

This was a large interview study and included patients and health workers with and without experience of using their mobile phones for retrieving health-related data. Data were collected from patients by a fieldworker and JAW, which ensured consistency in the interviews. JAW probed for a greater depth of data based on the analysis of early interviews. We did not verify the transcripts with participants because their home addresses were not recorded, and the literacy levels of the patients were low. All participants were from one locality. A greater variety of experience may have been gained from interviewing participants in other localities. However, being innovative with digital communication for health in rural and remote areas is imperative (Opoku et al., 2017); therefore, our data are likely to be relatively rich. The age of each health worker was not directly asked because this may have been culturally disrespectful to older nurses. This information may have been useful to understand why and how they use a certain technology and their level of experience in doing so.

4.2. Implications for policy and practice

To improve health and healthcare access, there is potential to harness bottom-up digital initiatives of patients and health workers. Our

study identified barriers to bottom-up initiatives; these barriers can be addressed through a change in policy and increase in resources. The barriers include the following:

- Lack of accessible digital infrastructure;
- Low digital literacy (Quaglio et al., 2016);
- Lack of health information available in local languages.

Nationally and internationally, several initiatives are available to address these barriers. For example, one of South Africa's leading telecommunications companies, MTN, offers the free use of Twitter (online news and social networking service) for up to 500 megabytes per day, per customer (MTN, 2017). This could be extended to evidence-based health websites. The number of free public Wi-Fi hotspots is growing in urban centres of South Africa (WCG, 2017). These are also required in the rural areas. Free downloads of applications are available for health workers, such as guides to essential medicines. Other clinical guidelines are being designed by The Open Medicine Project (OMP, 2017) supported by the South African National Department of Health. Many health workers are likely to initially require training and support to equip them to use these digital resources effectively.

5. Conclusion

The use of mobile phones in poor, remote rural areas of South Africa provides opportunities and capabilities to improve healthcare access and delivery. Patients, nurses, and doctors are taking initiatives to improve healthcare provision and enhance primary care services by using their mobile phones. They have been using their own resources for this purpose and not waiting for healthcare organisations to make provisions. Health workers are motivated to self-initiate in response to the needs they encounter in their daily work. These informal initiatives are making a difference to patients locally; however, these approaches lack regulation in terms of data privacy and security. Nevertheless, these bottom-up solutions are filling gaps in healthcare provision, which would otherwise remain unfilled.

Authors' contributions

JAW led the study and this paper, supported throughout by supervisors, FG, XGO and JG. All authors provided feedback on the drafts, and have read and approved the final manuscript.

Conflicts of interest

The study authors declare no competing interests.

Additional information

The mHealth intervention described in this paper was part of the Nkateko trial called ‘*Treating hypertension in rural South Africa: A clinic-based lay health-worker to enhance integrated chronic care*’ (Trial registration number: ISRCTN12128227). Thorogood M, Goudge J, Bertram M, Chirwa T, Eldridge S, Gomez-Olive FX, et al. The Nkateko health service trial to improve hypertension management in rural South Africa: study protocol for a randomised controlled trial. *Trials*. 2014; 15(1):435.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.socscimed.2018.01.011>.

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