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Research Article

The Use of Mobile Technology among Healthcare providers (HcPs) for improved health outcomes in Sub-Saharan Africa (SSA): A narrative review

Annah Rufu (PhD fellow)[1], Kudakwashe Chitindingu (PhD supervisor)[2]

[1,2]PHD student at Chinhoyi University of Technology Zimbabwe

Abstract:

Aim: In the study literature for mobile technology (MT) usage by frontline healthcare providers (HcPs) in SSA was reviewed to explore opportunities and constraints for improving health outcomes.

Background: Resource-constrained countries engage the services of HcPs as conduits of healthcare service between the health centre and the clients. Despite the increasing number of health MT tools that have been developed to support HcPs, few of these applications have been rigorously evaluated and even fewer have been brought to scale to improve health outcomes.

Methods: In this study, a narrative review of 24 peer-reviewed literature (in English) dated from 2000 to 2018 from health, social science, and computer engineering databases, using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines was done.

Results: HcPs in SSA have used MT with encouraging health outcomes particularly in sexual and reproductive health including HIV. Literature reviewed, indicated that projects are mostly concentrating on improving health governance, learning and implementation of health benchmarks and guidelines. Of the researches that evaluated program outcomes, evidence is that MT is handy to HcPs in improving quality of healthcare, program monitoring capacity and improved service efficiency.

Conclusion: Evidence from grey literature suggests encouraging opportunities for use of MT to improve the quality of health outcomes. A positive trend towards using MT that lead to positive health and programming outcomes through operational improvements and innovative intervention designs has been observed. However, SSA leaders need to address programmatic and research gaps as they advance the use and assessment of mobile technology tools for HcPs.

Keywords: Mobile technology (MT), Electronichealth (eHealth), Mobilehealth (mhealth), Healthcare provider, health outcomes, Sub Saharan Africa.

1. Introduction

Healthcare across the globe is constrained by inadequacies of healthcare providers (Narasimhan *et al.,* 2004). In low-income countries, the human capital shortage is a crisis triggered by the flight of qualified health personnel to greener pastures, poorly funded country health systems, and devastation of major epidemics such as HIV/AIDS, tuberculosis, and malaria (Chen *et al,* 2004). Despite these challenges, Hongoro and McPake, (2004) observed that ordinary citizens, health ministries and global health funders continue to demand quality services in those poor countries. As part of the basket of healthcare strategies, task shifting through engagement of HcPs (World Health Organization, 2010), decentralisation (Price and Walder, 2010), and other community-based health management mechanisms have been activated in resource-constrained settings.

The World Health Organization (2006) asserts that in SSA, HcPs are conduits between formal healthcare systems and local communities, thriving to improve the relevance, acceptability, and accessibility of health services. In health management, HcPs provide critical services that include counselling, conducting client visits, diagnosis and treatment of disease, information gathering, health promotion and referrals for further management. Home visits in particular present opportunities for HcPs to offer services to hard-to-reach populations including adolescents, the very poor and vulnerable community members.

Hongoro and McPake (2004), Price and Walder (2010) and Burket (2006) concur that by engaging HcPs, the healthcare human capital is expanded. Task shifting from specialised and highly trained health personnel to community volunteers, has greatly lowers the cost of service provision while improving productivity of the delivery system overall. The evidence of how effective the HcPs are varies, with some reports indicating reduced ART defaulting, positive behaviour change and closer cost-effective healthcare services when compared to institution-based approaches (Islam et al., 2002). Evidence from some interventions (Lehmann and Sanders, 2007) indicates that in the absence of adequate supportive health policies; supervision and guidance; appropriate regular trainings and enough intervention resources, the quality of service by HcPs will be highly compromised.

Braun *et al,* (2013) observed an encouraging mobile

technology development and field-testing of mobile technology for trial-use by HcPs. The move to have HcPs use mobile technology to improve health outcomes is appealing as it allows the HcPs to get expert advice and offer service away from the health centre and reaching out to remote clients. Such a decentralised approach makes services more accessible to clients who will save on productive time and travel costs (Mahmud, Rodriguez and Nesbit, 2010). Mobile technologies influence positively on the efficiency of the HcPs as they will be able to share their time amongst a multiplicity of priorities. The mobile technologies has been catering for HcPs' traditional challenges in service provision, data collection, with limited training opportunities and adequate supervision. Formal healthcare systems in SSA have accepted HcPs as vital links to communities and equipping these frontliners with mobile technology thus deserves further scrutiny. Braun *et al* (2013) acknowledge the mushrooming of heterogeneously designed pilot initiatives in which HcPs are equipped with mobile technology in an effort to improve HIV management outcomes. This review thus, systematically tracks documented evidence to date in which HcPs use mobile tools in order to offer better community-based healthcare services for positive outcomes.

2. Methods

2.1 Search Strategy

A systematic narrative review of published literature (in English) was conducted using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines. The review covered the period January 2000 to June 2018, with emphasis on the HcPs and their use of mobile technology for the delivery of health management. The search was a three-pronged process starting with appreciating the multi-disciplinary evidence of subject matter; where PubMed/Medline, CAB Global Health, Web of Science, and INSPEC databases were searched. Next, the search selected credible institutional databases that included WHO publication database, Health UnBound (HUB) Content Library and Royal Tropical Institute resource database. In order to capture any relevant additional literature, citations within the first reading of journal articles were searched.

2.2 Inclusion and Exclusion Criteria

The terms eHealth and mHealth are widely used in the field of health for the mobile technology. The difference between the two terms needed to be unmasked in order to guide the search. The public health community commonly refers to mHealth as a sub-segment of the field of electronic health (eHealth).

For this study, the search approach suggested by Braun *et al* (2013), which aggregates literature mentioning mHealth and HcPs either in the synopsis or epithet was adopted. To qualify as mHealth, the publications either had to explicitly mention the term 'mHealth', or specify both the term 'health' and any one of the following search terms: handheld computer, mobile phone, cellular phone, mobile device, patient monitoring device, mobile telemedicine, MP3 player, mobile operating system technology, 3G, SMS, text message, IVR, interactive voice response, GPS or global positioning system.

In order to refer to HcPs, articles had to include one of the search terms inferring to HcPs. These healthcare providers included community health worker, frontline health worker, midwife, outreach worker, community health education worker, lay health worker, promotor, village health worker, volunteer health worker, community health distributor, community health surveyor, community health assistant, community health promoter, community health agent, rural health auxiliaries, traditional birth attendant, or health promoter. With such a broad search strategy, **412 articles were** navigated. Repeat citations across sources were picked and eliminated while the inclusion criteria accommodated bibliographies and some credible institutional literature. The full-text article residue was then subjected to intense review with specific focus on those mentioning HcPs' use of mobile technology while discarding those that did not meet the search criteria. Such exclusions ranged from systematic reviews, policy briefs, commentaries and any other summary-type literature. Exclusion of articles lacking full-text helped further trim the search to narrow the focus to articles reporting use of mobile technology by HcPs in SSA. This yielded a final list of **16 articles** (Figure 1).

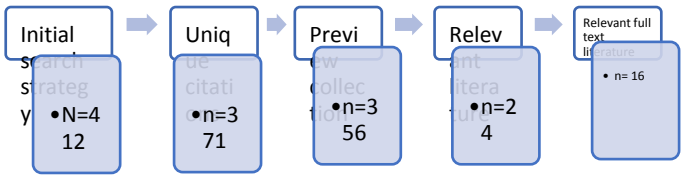

Figure 1: Summary of search strategy

2.3 Data Collection

Braun et al (2013)'s strategy of data collection was adopted to systematically code articles. The characterisation of the literature was packaged to describe the following topics: study design, methods, unit of analysis, number of participants, findings, purpose of technology, mHealth platforms/applications, theoretical framework, location, population served, health issues addressed, information architecture, open source tools, interoperability, engagement/participation of HcPs, strategies for organizational strengthening, outcomes for organisational performance, and conclusions.

2.4 Data Synthesis & Analysis

To provide a conceptual framework for the review and enable

comparison across projects, as suggested by Berman et al (2011), the World Bank's *"Improving the Delivery of Health Services: A Guide to Choosing Strategies"*, commonly used in global health and development to guide programmatic and policy decisions was adopted. A complete summary of all articles in the systematic review is available in the supporting information section (Table 1).

Table 1: Summary of study scope (Adapted from Braun et al, 2013)

Category	Sub-category	Results (n)	Results (%)
Rural/Urban	Rural	11	68.8
	Urban	5	31.2
Region	S.S. Africa	13	81.3
	Asia	2	12.5
	Latin America	1	6.3
Health Issue addressed	Sexual, Reproductive, Maternal & Child Health	7	38.9
	HIV/AIDS	8	44.4
	TB	2	11.1
	Malaria	1	5.6
Purpose of technology	Data gathering	12	44.4
	Decision support	6	22.2
	Alerts & reminders	5	18.5
	Information on demand	4	14.8

3. Results

3.1 Scope of Research

As summarised in table 1, the study managed to review 16 articles cited in 24 unique researches as some articles described multiple studies. Sub-Saharan Africa projects constituted the bulk of the reports followed by Asia with a handful reported in Latin America. Zimbabwe in particular had a few such studies focusing on use of mobile technology in maternal and child health management. Most projects are implemented in rural settings than urban with a few studies reporting a mix of both. HIV/AIDS, sexual, reproductive, and maternal & child health dominated the issues that were studied. A few cases of malaria and tuberculosis were cited in some studies. The mobile technology is ordinarily used in data gathering, supporting decision-making, reminders and alerts, and medical care information on demand.

3.2 Research Designs and Methods

As presented in table 2, the review showed that assessments related to HcPs and mobile technology had significant differences methodologically and in construct. The bulk of the researches employed quantitative than qualitative methodologies, while a sizeable number of articles used mixed methodologies.

Table 2: Designs and methods of reviewed studies

Category	Sub-category	Result (n)	Result (%)
Research Methods	Quantitative	14	58.3
	Qualitative	8	33.3
	Mixed	2	8.3
Design	Non-Experimental	9	37.5
	Quasi-Experimental	8	33.3
	Experimental	6	25.0

All the studies analysed were published after 2010. Nine reported use of non-experimental design that described the mobile technology in use without necessarily assessing the outcomes of application. Eight studies took the quasi-experimental design that had a control group to draw comparisons between mHealth interventions against the paper-based control projects. Six researches used an experimental design in which the control and intervention participants were randomly selected. Rotheram-Borus *et al* (2011) reported a description of a cluster randomized controlled trial with HcPs to evaluate effects of a health data collection and decision support system on health outcomes of mothers living with HIV. Zurovac et al (2011) described a cluster randomized controlled trial to evaluate effects of alerts and reminders on HcPs adherence to malaria treatment guidelines. Florez-Arango (2011) added a different dimension by describing a randomized crossover study to evaluate use of mobile multimedia for simulated patient interactions to enhance performance of HcPs. Chang et al (2011) also included a mixed methods evaluation of a cluster-randomized trial to evaluate use of mobile technology by peer health workers providing services to HIV infected clients. DeRenzi *et al* (2012) experimented with a series of randomized-control studies investigating use of automated short message services (SMS) to improve HcPs performance when delivering general health services.

Generally, the studies showed a common gravitation towards increased use of experimental research designs. Differences in article reporting standards is attributed to variations in style requirements across the fields of medicine, computer studies and social science.

3.3 Strategies for Strengthening Health Organizations & Systems

The analysis exposed four major strategies linking HcPs performance and their use of mobile technologies. These are categorised as (a) process improvement and technology design, (b) guidelines and standards, (c) training and learning, and (d) governance. Nearly all the studies (n=24) explored process improvement in a bid to minimise human error in workflow. The critical tasks executed by HcPs in data

collection (whether for patient support, monitoring or scientific inquiry) is susceptible to human error yet the information is of significant value in supporting decision-making (Curioso *et al*, 2005) and swift response to identified medical problems (Tomlinson *et al*, 2009). Reviewed literature showed that when equipped with mobile technology tools, HcPs collected more complete, accurate (Bernabe-Ortiz *et al*, 2008) and timely data with less data loss (Tomlinson *et al*, 2009).

In nearly a third of the reviewed literature (n=8), mobile technology was used to comply with health services guidelines and standards at project level. The studies reported, to be more pronounced through supporting key decision-making processes coupled with scheduled alerts and reminders (Baun *et al*, 2013). The success of out-patient malaria case management of Kenyan government health centres, as reported by Jones COH (2012), that embarked on text messaging, improved drug administration in the short and medium terms post intervention. Post intervention interviews showed highly satisfied clients.

Education and training are critical tasks in supporting the work of HcPs. Almost a quarter (n=6) of the studies narrated the use of mobile technology to support such tasks. Florez-Arango *et al*, (2011) and Lemay *et a*l, (2011) observed that the mHealth tools closed the geographical divide between the Health Centre-HcPs -client by using multimedia platforms to spread credible clinical information timely. Mobile technology connected the HcPs into a professional web, with Health Centres as well as with their clients by enhancing sharing of accurate clinical advice and information in real-time. In 2011, a K4Health project piloted an SMS based networking platform for HcPs to promote sharing of accurate HIV/AIDS messages and reproductive health information. Evaluation results of that pilot reviewed that active HcPs on the SMS platform had higher chances of contacting their clinical supervisors for on the ground support. Such close working relationships greatly improved quality of obstetric emergency care according to Lemay *et al* (2011).

The use of mobile technology, as reviewed by 21% of the studies (n=5), demonstrated improved governance especially in supporting and supervising of HcPs even from their remote field bases. Svoronos *et al* (2010) described how a CommCare maternal healthcare intervention in Tanzania remotely used SMS platform to remind and alert mid-wives about past and due client visits. The mobile technology improved the level of alertness and increased timely home visits to expecting mothers compared to midwives who did not receive such text messages. The follow-up calls from the clinical supervisor to the HcPs greatly reduced delays to client visits by as much as 86% according to Svoronos *et al* (2010). Feedback from both HcPs and their supervisors, as shown in DeRenz *et al* (2012) study, reviewed that the SMS reminder and alert platform was highly accepted and applied with great satisfaction despite distance between supervisor and supervisee. Mobile phone reminders are an effective intervention to improve retention to HIV care (Jong *et al*, 2017).

While studies have exposed many examples of improved supervision because of HcPs using mobile technology, few cases have been reported in which HcPs demonstrate leadership in intervention design. Mahmud *et al* (2010) cited a Malawi pilot TB intervention in which HcPs helped researchers in designing a mobile application for enhancing client adherence reporting, clinical queries and appointment alerts. Svoronos *et al* (2010) shared experiences from a maternal health intervention in Tanzania in which HcPs spent in excess of four months assisting researchers craft and pilot a mobile Application for community-based maternal and childcare services. In both pilot cases, the studies concluded how HcPs can be instrumental in participating in designing home-grown innovative technology that was compatible with the field realities.

3.4 Health Organization & System Outcomes

Literature supported notions that mobile technology when properly used has potential to improve HcPs work performance outcomes notably: the zeal for continuous learning, service utilisation and efficiency, and quality of care with the latter being the frequently measured attribute (n=19). Researchers concur that HcPs despite their general low literacy levels and training, form the spine of health care delivery in resource-constrained setting. Thus, Florez-Arango *et al* (2011) argue, introducing mobile technology to enhance the work of such lowly educated HcPs through multimedia devices reduced errors in making on-site clinical decisions when they are guided by standard clinical protocols.

Despite the lack of consensus among authors on how best to measure efficiency, the Malawi case study in which HcPs relied on SMS texting to discharge some of their duties added interesting outcomes to the body of knowledge. Mahmud et al (2010) observed that HcPs reported reduced working hours and the reduced motorised visits saved on operational costs that in turn almost doubled the client coverage by HcPs.

Learning as a positive outcome is acknowledged by almost a fifth (n=7) of the reviewed literature. Through increased exposure and use of the mobile technology, HcPs develop more self-confidence in the delivery of their services. Lee, Chib and Kim (2011) reported improved self-efficacy in maternal health services by HcPs. In an earlier study by Chib *et al* (2008), traditional birth attendants acknowledged improved maternal health care to patients because of their exposure to timely mobile –based information.

Discussion and Recommendations

This review acknowledged the growing interest in mHealth-based HcPs interventions as demonstrated by the project types and quantum since year 2000. The turn of 2010 ushered in more explorations that are experimental with results showing that more HcPs are accessing mobile technology for positive health outcomes especially in the sectors of maternal and childcare, sexual and reproductive health services including HIV management in resource-constrained settings, especially Sub-Saharan Africa. The potential for HcPs to increasingly use mobile technology in the discharge of their duties as a

conduit between higher level healthcare institutions and local communities is widely acknowledged in literature.

Some constraints especially in technical, policy framework and social elements however, remain. The bulk of the reviewed literature were small isolated pilot projects that are limited in scope or information for scalability of the mobile technology use by HcPs in large-scale mHealth-based strategies. National policies are largely missing to support the HcPs in the electronic health interventions (Bhutta *et al*, 2010). According to Health Metrics Network, World Health Organization (2008), clinical standards suitable for sharing on open electronic platforms that address the total health information-sharing package need to be considered. Ngabo *et al* (2012) assert that political will has to back-up the pilot project achievements as demonstrated by a Rwanda project in which SMS alert system was successful in pregnancy monitoring that greatly reduced maternal mortality.

Studies exposed the usefulness of mobile technology in improving processes and foster compliance with clinical guidelines and benchmarks. Mobile technology was demonstrated to be viable in enhancing learning and skills transfer, governance and collective working culture. Efforts still have to be made to document more success stories of HcPs as champions of mobile technology design and use in HIV interventions. Despite such opportunities evidenced in literature, HcPs involvement in mobile technology application design has largely remained accidental rather than planned. The tendency for top-down engagement has perpetuated HcPs as mere implementers of laid down policies, benchmarks and protocol though with minimum assistance from the parent clinicians. Even more scanty evidence exists on how organisational cultures turned around with the introduction of mHealth tools for improved performance outcomes. Conway's (1968) question of "How do Committees invent?" puts health delivery system under the spotlight even half a century later as it certainly will challenge communication channels that healthcare centres use let alone design. The formal fit of HcPs within the technology health delivery system on its own remains an even bigger task more than technology design and use.

While literature has provided evidence of increasing use of mobile technology by HcPs for their community-based duties and accessing learning opportunities in their work, yardsticks for performance measurement and outcomes remain hazy. This is especially in terms of access, quality, service utilisation and sustaining the outcomes. Therefore need for more research on the subject.

Our study findings have a number of mobile technology gaps. First, SSA health leaders need to address programmatic and research gaps as they advance the use and assessment of mobile technology tools for HcPs.

Second, more work is needed for more qualitative studies on mobile technology.

Third, to have Healthcare provider planned design mobile application, implement and evaluate mobile technology.

Limitations

This study is limited by the scope of the literature search, which included only articles in English collected through scholarly and organizational databases. Admittedly, a lot may be happening in the field but goes unreported even in conferences and unpublished reports. Other negative outcomes are likely to be undocumented yet useful in providing lessons for future designs and applications. The trimmed review of 16 articles however, gives insights into the potential of HcPs as frontline healthcare providers in using mobile technology in their duties. The varied methodologies, designs and unit of analysis typical of such dynamic field made meta-analysis not viable.

6. Conclusions

Evidence is growing in literature of how mobile technology improves HcPs effectiveness in poor countries. HcPs have used mHealth tools in easing their tasks especially in facilitating reliable health data collection and quality health care services with minimum standards and protocol adherence errors. Mobile phone reminders are an effective intervention to improve retention to HIV care. Women with HIV living in resource limited settings benefit significantly from the intervention. Also, mobile phone reminders using text messages are as effective as phone calls to improve retention to HIV care. More studies have focused on quantitative elements with increased effort still required in descriptive qualitative inquiries that will enhance more user-friendly mHealth tools designed with input from the HcPs. The potential for HcPs using mHealth tools is undoubtedly huge but literature also suggests the backing of appropriate policies and implementation modalities for even greater impact.

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