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The state of mHealth development and use by palliative care services in sub-Saharan Africa: a systematic review of the literature

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Keywords: palliative care, sub-Saharan Africa, mobile phone, mHealth

Abstract

Background: Current coverage of palliative care services in sub-Saharan Africa (SSA) remains woefully inadequate, but harnessing mHealth could be one approach to facilitate greater service coverage and engagement with patients with life-limiting progressive disease.

Aims: A systematic literature review to identify the development and use of mHealth in palliative care services in SSA.

Methods: 13 electronic databases from 1990 to 2015 were searched alongside the handsearching of journals and citation searching of included article reference lists. Articles were assessed against inclusion and exclusion criteria and study details extracted and tabulated by two researchers. Studies were plotted against a modified World Health Organization mHealth and ICT framework to classify how they are targeting health systems strengthening.

Results: Of 1110 articles, 5 met the inclusion criteria, describing mHealth use in Nigeria, Uganda, Kenya and Malawi. Descriptive analysis revealed that existing mHealth interventions for palliative care services in SSA are limited in number and are being developed for use at the palliative treatment, guidance and coordination stage of care provision. Levels of detail about the development and structure of interventions are low.

Conclusions: mHealth interventions for palliative care in SSA are limited. This is an opportune time to explore how evidence-based mHealth interventions could form part of evolving palliative care services in the region.

BACKGROUND

Palliative care is emerging across sub-Saharan Africa (SSA) and is now present in 24 of the 51 countries in the region, up from only five in 2004, but less than 5% of people with palliative care needs access supportive care.[1] In 2013, there were an estimated 24.7 million people living with human immunodeficiency virus (HIV) in SSA[2], with 1.1 million deaths due to AIDS.[3] Additionally, in 2012 there were 847,000 new cancer cases (6% of the world total) and 591,000 deaths (7.2% of the world total) across the continent.[4] The demand for palliative care is high and rapid development of palliative care services is urgently needed.[1] Particular attention needs to be given to how palliative care can be provided to patients with cancer in the region. Much of the development of palliative care services in recent years was driven by the needs of adult HIV patients,[5] but recent policies and declarations constitute a new global non-communicable disease (NCD) agenda inclusive of integrated palliative care.[6]

The delivery of palliative care in SSA has utilised innovative approaches, characterised by invention in the face of low resources, inadequate investment, and a focus on community rather than inpatient care.[7 8] Differing methods of service delivery exist, such as roadside care delivered by Hospice Africa Uganda,[9] alongside palliative care services delivered at the specialist, district hospital level, and community level. Recent efforts have focused on mapping such models of palliative care delivery and questioning how to develop and extend their reach.[1] An emphasis on initiatives around education and training continue, with these seen as essential components of the World Health Organization (WHO) public health model for palliative care.[10]

Utilising mHealth technology has been highlighted as an approach to enhancing palliative care services through, for example, rapid access to clinical and social support networks and increasing health communication to patients and their caregivers.[11] mHealth refers to medical and public health practice supported by portable devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices.[12]

Approaches using mHealth have demonstrated the capture of individual and health-related data at low cost,[13] and been successfully used by frontline health care workers for remote data collection and monitoring, and diagnostic and treatment support in several developing countries.[14] Of particular advantage in low-resource settings are the fewer requirements on infrastructure compared to health information systems, making scale-up seemingly more feasible.[15] Condition-specific application of mHealth in this context has included communicable diseases, such as HIV and tuberculosis (e.g. improving medication adherence[16-18] and appointment attendance)[19 20] and NCDs to a much lesser extent.[21]

The rationale for a mHealth focus in SSA health research is underpinned by the increase in mobile phone access regionally, from approximately 5% to 70% during 2000 to 2008, now reaching over 380 million users.[22] Mobile networks in this region reach more people than any other advanced communication technology and access exceeds that of basic services, such as electricity, sanitation and financial services.[23] To help steer efforts in the development of mHealth activities, a recent initiative by the WHO and partners jointly developed the “mHealth and ICT Framework”. [24] The framework describes mHealth activity as constructed around standard health system goals and places intended users and beneficiaries in central focus. The work stems from a need to describe types and uses of

mHealth generally, as explored in the WHO global survey on eHealth.[25] The framework is able to guide mHealth development by encouraging mHealth efforts that are integrated into existing health system functions, rather than as stand-alone solutions. While initially developed in reproductive, maternal, newborn, and child health, there is scope to draw on the basis of the framework to inform other fields of health research.

Integration of mHealth into palliative care has been seen across the USA and Europe, with reported benefits including supported pain management[26] and improved communication between patients and health professionals.[27] With emerging evidence for the benefits of mHealth and the widespread use of mobile phones in SSA, the need to harness new technologies, while respecting cultural traditions, has been highlighted as one possible approach to extending the reach and provision of palliative care while maintaining quality.[11] Two recent systematic reviews have documented mHealth development in SSA; one provides guidance on mHealth development informed by earlier research,[28] the other provides a strategic framework to highlight evidence gaps around mHealth.[21] Neither provides a focus on mHealth as part of palliative care provision in the region. Consolidation of existing literature on the development and use of mHealth through a systematic search of the literature can be used to provide guidance to future research initiatives. By further contextualising findings using the WHO mHealth and ICT Framework, identified studies can be understood in terms of how they might support health systems strengthening in SSA palliative care.

AIM

Our aim was to conduct a systematic review to identify the development and use of mHealth in palliative care services in SSA.

METHODS

A systematic review of research literature was undertaken to identify the use of mHealth approaches in SSA palliative care. The review took a broad definition of mHealth use across palliative care in this setting, with interpretation of findings orientated towards identifying and reporting the development and use of mHealth interventions. The review was undertaken in six stages: (1) development of search strategy; (2) generation of inclusion and exclusion criteria; (3) literature searching; (4) assessment of relevance of identified literature; (5) data extraction and tabulation; (6) overview of existing literature and descriptive analysis.

MeSH headings and keywords were identified (outlined in Appendix A) and relevant databases selected and searched in consultation with a healthcare information specialist at the University of Leeds (outlined in Table 1). Inclusion of disease group terms was included to broaden the database searches and complement the mHealth, SSA and terminal / palliative care components. Potentially relevant references from bibliographies and citation indices were identified and abstracts assessed against selection criteria. The search was carried out during April 2015.

Table 1: Overview of databases search and terms used in the literature review

| Databases (searching for literature published between 1990 and March 2015) | Search terms |
|--|---|
| Embase, MEDLINE, Global Health, Cochrane library | <i>Extending MeSH and keyword terms based</i> |

| | |
|---|---|
| (including CENTRAL), WHO pan African clinical trials registry and the U.S. National Institutes of Health clinical trials database were searched. Libraries searched included WHO (IRIS and Afrolib), African Index Medicus, Eldis, 3ie (International Initiative for Impact Evaluation), British Library for Development Studies, JOLIS (World Bank Group and International Monetary Fund) and the Campbell International Development Group | <i>on (example from MEDLINE in Appendix 1): mHealth / mobile phones (exp Computers, Handheld/; exp Cell Phones/; (mobile adj3 telephone\$).ab,ti) and sub-Saharan Africa (exp "Africa South of the Sahara"/) and palliative care (exp Terminally Ill/; exp Palliative Care/; Neoplasm/ or Tuberculosis/ or Human immunodeficiency virus/ or Acquired immune deficiency syndrome).</i> |
| Hand-searching occurred in <i>Journal of Medical Internet Research, International Journal of Medical Informatics, Journal of Health Informatics in Developing Countries, Technology and Health Care, Current Opinion in Supportive and Palliative Care, BMJ Supportive and Palliative Care, Journal of Pain and Symptom Management, Supportive Care in Cancer, Palliative Medicine</i> and <i>BMC Palliative Care</i> . | <i>Keyword terms used: mHealth, mobile phone and sub-Saharan Africa</i> |

Inclusion criteria were developed through consensus by the research team. To be included, articles had to describe research on the design, development, testing or evaluation of mHealth approaches by health professionals in support of patients with life-limiting progressive illness, or by the patients themselves to support or interact with their care provision. The patient population was intentionally broad to capture mHealth use across disease groups accessing palliative care. To be considered a mHealth intervention, interaction with a mobile device by health professionals or patients to communicate either directly or indirectly with palliative care providers had to be documented. Intervention development or use was limited to SSA.

Papers were excluded that: i) provided no description of a mHealth intervention; ii) described systems that were not designed for, or known to be used to enhance care for, patients with advanced or life-limiting progressive illness; and iii) discussed palliative care services, but not involving the use of mHealth technology by patients or health professionals.

Titles and abstracts were screened for relevant articles by MA (lead author), for which full text reports were sought and assessed against the inclusion/exclusion criteria to identify eligibility for the descriptive analysis. Details of the study identification and selection process are shown in the Figure 1 flowchart, developed using PRISMA guidelines.[29] Data were extracted from eligible studies by MA into a tabulated form and checked by a second reviewer (RAP).

Following data extraction, the WHO mHealth and ICT framework[24] was used as the basis for plotting the uses of mHealth described in the included articles. The initial framework was developed for reproductive, maternal, newborn, and child health and was adapted for palliative care. Content of the WHO mHealth and ICT framework was modified to include a care pathway tailored for palliative care provision in SSA.[1] A draft version of the adapted framework was shared with seven palliative care organisations from Rwanda, Kenya and Uganda for comment. Following iterative revisions, the framework was agreed, creating a tool with which the research team could discuss and plot the intended use of mHealth interventions while charting them against a palliative care pathway representing service provision in SSA.

RESULTS

The database searches yielded a total of 1110 citations after duplicates were removed. As charted in Figure 1, following record screening and full text assessment, five articles were included in the review.[11 30-33] Our assessment of titles and abstracts identified no non-English papers that met the inclusion criteria. A summary of the included articles is provided in Table 2.

Regions and use of mHealth interventions

Articles discussed mHealth interventions from four SSA countries; Nigeria,[32–33] Uganda,[31] Kenya,[30] and a study reporting across Kenya and Malawi.[11] Only one intervention[33] involved palliative care patients in a mHealth intervention. The remainder involved caretakers of palliative care patients[11–31] and health professionals.[30–32] Most articles referred to mHealth interventions supporting cancer care,[30–33] with one outlining their use in the care of HIV and AIDS patients.[11]

Figure 2 outlines the included studies, plotted against the modified mHealth strategic framework. All mHealth development is occurring at the palliative treatment, guidance and coordination stage of provision. No mHealth interventions are being developed around earlier stages (diagnosis, referral and needs identification), terminal care, or as part of bereavement care. Three of the included articles detail patient-to-provider communication. In three studies,[11–32–33] patients or their caregivers were provided with the mobile phone number of a palliative care professional and were able to contact them as required for support.

Two articles outlined interventions requiring supporting infrastructure (such as software that could be used to support automated text messaging) and structured processes for interaction with end users (such as scheduling text message contact). The first, with use defined as provider training and education, described use of text messages to a mobile phone as part of an educational intervention designed to enhance training undertaken by palliative care professionals.[30] The second, used for client education and behaviour change communication, involved caretakers of Burkitt lymphoma patients receiving reminders of appointments and information to support treatment adherence.[31]

Despite describing three uses of mHealth in palliative care services, there was a lack of detail around infrastructure requirements, platforms used to deliver interventions and hardware and software details across all articles. There was also an absence of reporting of costs relating to intervention delivery (e.g. cost of text messages, equipment and infrastructure requirements, staffing costs). In all articles, the reporting of mHealth as part of service delivery was not reported. For example, for patient-to-provider communication, there is a lack of clarity on processes followed by health professionals receiving calls from patients, intended and options for responding, or how mHealth forms part of routine practice. However, one study referred to planned routine documentation by health professionals of discussions held with patients or their caregivers over the phone.[33] Similarly, in two articles, there was no reporting on a clear process of when and why patients might make contact with health professionals.[11 32]

Intended location of use of mHealth interventions

The intended location of use (where a patient, caregiver or health professional is expected to use their mobile phone as part of the intervention) provides an indication of the planned structure of interventions. For all studies the intended location of use for patients and their caregivers was flexible, with an assumption of location in the community setting. For health professionals, one intervention required health professionals to update information from calls into a database,[33] potentially limiting location flexibility. All other studies involving health professionals[11 30 32] were flexible about location of use.

Stage of development of mHealth interventions

Overall, the research studies report early stages of intervention development, with feasibility and exploratory work being reported. A mix of research designs and methodologies were used, including case studies,[11] interviews,[31] questionnaires,[30] questionnaires combined with interviews,[32] and descriptive data analysis.[33] Benefits of mHealth interventions identified in the early piloting and exploratory work included: increases to the geographical coverage for accessing patients;[33] making appointment booking and reminders easier to perform;[33] increasing contact between visits to assess change[33] and monitoring symptoms;[32] improving sharing of information with patients' relatives;[32] enabling easier contact with competent healthcare professionals;[11] and allowing health professionals to ensure caregivers provide more effective and efficient care.[32]

Table 2: Overview of included articles

| No. in Figure 2 | Reference | Country of mHealth use | Target population | Study sample population | Study design and methodology | Goal of mHealth use / system | Aim of article | Mode(s) of technology used to gather patient data | Process of patient system | Information provided to recipient | Information provided to health professional | Symptom focus | Intended location of use by patient | Intended location of use by health professional | Findings |
|-----------------|--|------------------------|--|---|---|--|---|--|---|---|---|---------------|-------------------------------------|---|--|
| 1 | Grant, L., Brown, J., Leng, M., Bettega, N. & Murray, S. A. 2011. Palliative care making a difference in rural Uganda, Kenya and Malawi: Three rapid evaluation field studies. <i>BMC Palliative Care</i> , 10. | Kenya and Malawi | Carers of palliative care patients | Carers of patients with mostly AIDS and cancer (undisclosed number of participants) | Rapid evaluation methodology | To empower families to feel secure in their role as carers for palliative care patients – carers can call volunteers or nurses to discuss care | To report findings of three rapid evaluation studies of palliative care programmes carried out in Uganda, Kenya and Malawi. | N/A | Carer or patient encouraged to “flash” (calling a number, allowing it to ring, but hanging up before it is connected) a nurse or volunteer. This ensured that the nurse or volunteer bears the cost of the call rather than a patient. Subsequent voice calls would be held between patient and nurse, or patient and volunteer | Advice and assistance around care and decision making support provided in discussion over phone | N/A | N/A | Community | Flexible | Many health workers, even in remote areas, are at the cutting edge of adapting new technologies to meet local needs. Mobile phones are used to facilitate communication between families, volunteers and programme staff to provide a sophisticated form of tele-health. They are relatively inexpensive, but airtime is costly, so the projects encourage families and volunteers to “flash” a nurse on their cellphones. Even in homes with no running water or electricity, mobile phones permitted health communication and support. |
| 2 | Low, D., Nabakooza, S., Ndagire, M., Gerds, S. & Sessle, E. 2014. Using text messaging to improve appointment adherence among Burkitt lymphoma patients in Uganda. <i>Journal of Investigative Medicine</i> , 62 (1), 176. | Uganda | Caretakers of Burkitt lymphoma patients | Caretakers of Burkitt lymphoma patients (undisclosed number of participants) | Informal interviews to assess interest and capacity to receive and respond to text message followed by piloting of text message reminder system | To increase appointment adherence and rapport with patients in oncologic setting | To report on preliminary exploration of mobile phone use in oncologic setting in Uganda | N/A | Electronic data triggers release of text messages to Caretakers of Burkitt lymphoma patients. Text message content was chosen through earlier consultation with patients. Text messages are sent in place of case managers contacting each patient or their caretaker. | Reminders of appointments and information about treatment adherence | N/A | N/A | Community | Flexible | Text messaging can be used in resource-limited, oncologic settings to potentially increase appointment adherence and improve rapport with patients. With growing mobile penetration, this work also suggests that other m-health programs should be considered, including pictures and diagnostic techniques. |
| 3 | Nwagwu, W. E., Adegunwa, G. O. & Soyannwo, O. A. 2013. ICT and collaborative management of terminal cancer patients at the University College Hospital, Ibadan, | Nigeria | Health professionals involved in the management of patients with advanced cancer | 50 medical doctors in three units / departments which provide care to patients with advanced cancer at University | Questionnaire with a follow-up interview | | Present results of questionnaire and interviews into the use of information and communication technology in the care of patients with advanced cancer | Predominantly mobile phones used to contact patients and the relatives of patients. However, email, land line, | Variation in use of ICT with patients and patient relatives by health professionals | N/A | N/A | N/A | Community and hospital-based | Flexible | Doctors reported using mobile phones to communicate with their patients and patient relatives. Relations/families of patients reported using a wider range of technologies to communicate with doctors. Mobile phones fit the working environment in |

| | | | | | | | | | | | | | | | |
|---|--|---------|----------------------------|--|--|--|--|---|---|---------------------|---|--|-----------|----------|---|
| | Nigeria. <i>Health and Technology</i> , 3, 309-325. | | | College Hospital, Ibadan, Nigeria | | | | electronic health information systems, instant messaging and blogs were also used to a lesser extent. | | | | | | | the palliative care where nurses and doctors move around constantly and collaborate extensively. |
| 4 | Obuya, S., Agawo, W. A., John, L. A., Liru, M., Odada, P. & Were, P. 2014. The role of a physician in palliative care of cancer patients admitted in a Western Kenya county hospital. <i>Asia-Pacific Journal of Clinical Oncology</i> , 10, 107. | Kenya | Palliative care physicians | 24 physicians, clinical officers and nurses providing care to terminally ill patients | Pre- and post-test questionnaire s to evaluate an education intervention for health professionals | To form part of education intervention. SMS text messages reminders were sent relating to symptom control, accessibility to drugs (and other provisions used in symptom management), bereavement and psychosocial support. The SMS reminders accompanied twice weekly lectures occurring over six weeks. | To report on outcomes from education intervention with palliative care health professionals in Kenya | N/A | N/A | N/A | Reminder texts relating to educational biweekly lectures occurring over a six week period | N/A | N/A | Flexible | Despite being in a resource challenged environment, short term discussions, lectures and even sort text messages can be useful in empowering health care providers in providing care. |
| 5 | Odigie, V. I., Yusufu, L. M., Dawotola, D. A., Ejagwulu, F., Abur, P., Mai, A., Ukwanya, Y., Garba, E. S., Rotibi, B. B. & Odigie, E. C. 2012. The mobile phone as a tool in improving cancer care in Nigeria. <i>Psycho-Oncology</i> , 21, 332-5. | Nigeria | Patients with cancer | 1176 patients with breast cancer or endocrine cancer. Patients were also recruited from orthopaedic oncology and general surgical oncology patients. | Descriptive analysis of data captured from patient contact with health professional using a mobile phone alongside findings from structured interviews with patients about their experience of using mobile phones as part of their care | Patients were provided with the mobile phone number of their oncologist. They were advised to call about their medical care and seek advice at any time in the language most comfortable to them | Provide overview of use of mobile phones with cancer patients in Nigeria | Mobile phone | Patient contacts oncologist to seek advice about their condition. Health professional provides advice and documents details about the call. | Advice on condition | Details about patients condition and advice being sought | Any issues arising relating to condition | Community | Flexible | At 24 months, 97.6% (1132 patients) had sustained their follow-up appointment. 97.6% found the use of the phone worthwhile and preferred the phone to traveling long distance to hospital/clinic. The patients also felt that they had not been forgotten by their doctors and were been taken care of outside the hospital/clinic. Mobile phones found to improve communication between health professionals and patients. |

DISCUSSION

This systematic literature search outlined existing mHealth interventions developed for palliative care provision in SSA. The use of interventions included patient-to-provider communication, patient education and behaviour change communication, and palliative care provider training and education. The exploratory development identified in all articles reflects the early stage of development for mHealth interventions in palliative care services;[26 34] a reflection of broader development of mHealth in SSA.[28] While the benefits of mobile phone use are reported in the included studies, their effectiveness at enhancing – and impact upon – palliative care services has not been explored systematically.

The visual framework outlined in this review was adapted from the WHO mHealth and ICT Framework as a way of categorising mHealth interventions in palliative care in SSA. The framework highlights the many possible applications of mHealth to support delivery of care at the different stages of palliative care provision. For example, the development of interventions is currently reported only at the stage of palliative treatment, guidance and coordination. There is scope to consider the role of mHealth to support earlier stages (diagnosis, referral and identification), terminal care and bereavement care. The utility of the framework is twofold; to inform and guide discussions by palliative care providers of opportunities for mHealth development, but also to chart and record where development has taken place. The latter approach is being fostered by the African Palliative Care Association mHealth Research Network, who are engaging with palliative care providers across SSA to chart where they are exploring mHealth initiatives. This approach enables the sharing of experiences where mHealth has been implemented into practice. The initiative is

aligned with the WHO mHealth agenda, where the focus is on reducing resource wastage and programme duplication.[35] This is of added significance in palliative care research in SSA, where research capacity is limited and evidence generation is urgently needed.[36]

For palliative care in SSA, while intervention development is at an early stage, there is an opportunity to develop a structured approach to evidence generation. While the review was limited by low numbers of studies and limited reporting of mHealth interventions, it identifies an opportunity for structured development with opportunities to learn from other mHealth developments in the region. An option could be to leverage mHealth technologies that have successfully targeted other health conditions rather than reinventing tools.[37] Focus should also be given to how interventions are measured and evaluated. While much promise is aligned with mHealth interventions, there is a notable lack of rigorous research in the context of developing countries.[38] Ensuring that intervention development is well-planned, measured and evaluated is crucial to advancing evidence. In particular, consideration should be given to the targeted change expected to arise from mHealth. Technology alone will not provide a solution to pressing demands on palliative care in SSA, but it may open up opportunities for more dynamic and expansive services. Understanding how mHealth is planned to supplement or facilitate components of services is an important consideration for evaluation.

The potential of mHealth in supporting the development of existing palliative care services should also be considered. While existing provision of services has historically focused on HIV and cancer, the remit of palliative care in SSA is evolving. In 2014, the 67th World Health Assembly adopted a resolution on strengthening palliative as a component of integrated treatment throughout the life course, which included advanced NCDs such as heart failure

and chronic obstructive pulmonary disease.[39] As a consequence, services will need to consider how logistically to manage meaningful relationships with patients potentially requiring longer periods of engagement. The potential role of mHealth in facilitating these relationships has been highlighted, such as supporting medication adherence and communicating supplementary health information.[6]

CONCLUSION

This is an opportune time to consider the potential for mHealth to support palliative care services in SSA; a time of developing greater understanding about how different models of palliative care work within different health systems.[1] While mHealth development is at an early stage, exploration of ways to enhance current service provision can take place, supported by documentation on the framework. But mHealth development should also be mindful of existing evidence from other conditions, particularly NCDs. This may inform how interventions can be developed to align with the changing composition of patients with palliative care needs, likely with increasing chronic care requirements, during the development of palliative care services in coming years.

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Conflict of Interest Statement

The authors declare no conflict of interest.

Competing Interest: None declared.

Appendix A: Search strategy

Database: Ovid MEDLINE(R) <1990 to April Week 1 2015>

Search Strategy:

-
- 1 exp Computers, Handheld/ (2422)
 - 2 (computer\$ adj4 handheld).ab,ti. (399)
 - 3 (computer\$ adj4 hand-held).ab,ti. (280)
 - 4 (computer\$ adj4 palm\$).ab,ti. (176)
 - 5 (computer\$ adj4 pocket).ab,ti. (121)
 - 6 (computer\$ adj4 mobile).ab,ti. (248)
 - 7 (Pocket-PC\$ or PocketPC\$).ab,ti. (50)
 - 8 (Pocket adj computer\$).ab,ti. (87)
 - 9 (Palm adj4 PDA\$).ab,ti. (24)
 - 10 (PDA\$ adj5 computer\$).ab,ti. (90)
 - 11 (Personal adj digital adj assistant\$).ab,ti. (832)
 - 12 (PDA\$ adj5 phone\$).ab,ti. (57)
 - 13 (PDA\$ adj5 telephone\$).ab,ti. (8)
 - 14 (Tablet adj computer\$).ab,ti. (155)
 - 15 (Tablet adj PC\$).ab,ti. (116)
 - 16 (Palm-Pilot\$ or Palmpilot\$).ab,ti. (42)
 - 17 (Palm adj (Pre or Treo or Centro)).ab,ti. (3)
 - 18 (smartbook\$ or smart-book\$).ab,ti. (1)
 - 19 ((ultra-mobile or ultramobile) and (PC\$ or personal computer\$)).ab,ti. (10)
 - 20 ((ultra-portable or ultraportable) and (PC\$ or personal computer\$)).ab,ti. (2)
 - 21 (enterprise adj digital adj assistant).ab,ti. (0)
 - 22 (EDA\$ adj4 computer\$).ab,ti. (3)
 - 23 exp Cell Phones/ (5456)
 - 24 (cellular adj3 phone\$).ab,ti. (580)
 - 25 (mobile adj3 phone\$).ab,ti. (2853)
 - 26 (mobile adj3 telephone\$).ab,ti. (380)
 - 27 (cellular adj3 telephone\$).ab,ti. (342)
 - 28 (cell adj3 phone\$).ab,ti. (1144)
 - 29 (cell adj3 telephone\$).ab,ti. (22)
 - 30 (smartphone\$ or smart-phone\$).ab,ti. (1036)
 - 31 (blackberr\$ or black-berr\$).ab,ti. (369)
 - 32 (google adj3 phone\$).ab,ti. (1)
 - 33 (nexus adj one adj3 phone\$).ab,ti. (0)
 - 34 (application adj software).ab,ti. (149)
 - 35 (MMS or multimedia messaging service).ab,ti. (3237)
 - 36 (SMS or short messaging service\$).ab,ti. (2930)
 - 37 (text\$ adj message\$).ab,ti. (646)
 - 38 exp MP3-Player/ (134)
 - 39 MP3 player\$.ab,ti. (74)
 - 40 MP4 player\$.ab,ti. (1)
 - 41 (MP3 or MP4).ab,ti. (401)
 - 42 (portable adj2 media adj2 player\$).ab,ti. (14)
 - 43 (iphone\$ or i-phone\$).ab,ti. (234)
 - 44 (ipod\$ or i-pod\$).ab,ti. (308)
 - 45 (podcast\$ or pod-cast\$).ab,ti. (237)

- 46 exp Medical Informatics/ (338240)
- 47 exp Medical Informatics Applications/ (332313)
- 48 exp Audiovisual Aids/ (87326)
- 49 exp Multimedia/ (1517)
- 50 exp Public Health Informatics/ (1038)
- 51 exp User-Computer Interface/ (29037)
- 52 exp Interactive Tutorial/ (225)
- 53 ((mobile adj health) not van\$ not unit\$).ab,ti. (329)
- 54 (mhealth or m-health).ab,ti. (280)
- 55 (elearning or e-learning).ab,ti. (1116)
- 56 exp Electronic Mail/ (1934)
- 57 (electronic adj3 mail\$).ab,ti. (712)
- 58 (electronic adj3 messag\$).ab,ti. (181)
- 59 (email\$ or e-mail\$).ab,ti. (7178)
- 60 exp Hypermedia/ (389)
- 61 exp Video Games/ (2429)
- 62 (computer adj2 gam\$).ab,ti. (968)
- 63 (video adj2 gam\$).ab,ti. (1553)
- 64 (electronic adj2 gam\$).ab,ti. (173)
- 65 (playstation adj1 portable).ab,ti. (0)
- 66 (Sony adj1 PSP).ab,ti. (1)
- 67 (gameboy adj (advance or micro)).ab,ti. (1)
- 68 Nintendo DS\$.ab,ti. (8)
- 69 Gamepark.ab,ti. (0)
- 70 Gizmando.ab,ti. (0)
- 71 (Tapwave adj zodiac).ab,ti. (0)
- 72 exp Video Recording/ (31313)
- 73 (video or videos).ab,ti. (50329)
- 74 exp Computer Graphics/ (23068)
- 75 exp Internet/ (53437)
- 76 internet.ab,ti. (26757)
- 77 ("world wide web" or world-wide-web or "world-wide web" or "worldwide web" or website\$ or web-site\$).ab,ti. (17879)
- 78 (WAP or "wireless application protocol").ab,ti. (543)
- 79 online.ab,ti. (35550)
- 80 (on?-line not one line).ti,ab. (18500)
- 81 web?based.ab,ti. (14)
- 82 web-based.ab,ti. (13702)
- 83 bluetooth.ab,ti. (265)
- 84 (web adj3 technolog\$).ab,ti. (858)
- 85 (chat?room\$ or chat-room).ab,ti. (132)
- 86 (blog\$ or web-log\$ or weblog\$).ab,ti. (718)
- 87 exp Blogging/ (590)
- 88 (bulletin adj board\$).ab,ti. (280)
- 89 (message adj board\$).ab,ti. (101)
- 90 (interactive adj5 health adj5 communicat\$).ab,ti. (68)
- 91 (interactive adj3 televis\$).ab,ti. (99)
- 92 (interactive adj3 TV).ab,ti. (20)
- 93 (interactive adj4 technolog\$).ab,ti. (434)
- 94 (interactive adj7 multimedia).ab,ti. (365)
- 95 (interactive adj3 software).ab,ti. (396)

- 96 (e-health\$ or ehealth\$).ab,ti. (1651)
- 97 (electronic adj health).ab,ti. (4454)
- 98 (consumer adj1 health adj1 informatic\$).ab,ti. (75)
- 99 (virtual adj reality).ab,ti. (4101)
- 100 (virtual adj learning).ab,ti. (167)
- 101 (surf adj4 web\$).ab,ti. (11)
- 102 (surfing adj4 web\$).ab,ti. (42)
- 103 exp "Africa South of the Sahara"/ or exp Africa/ (190101)
- 104 Africa.ti,ab,in. (89273)
- 105 (((angola\$ or benin or Botswana or burkina faso or Burundi or Cameroon or cape verde or Cabo Verde or central african republic or chad\$ or comoros or congo or cote d'ivoire or ivory coast or eritrea or Ethiopia\$ or gabon or gambia\$ or Ghana or guinea or guinea-bissau or kenya\$ or lesotho or Liberia\$ or madagascar or Malawi\$ or mali or mauritania or mauritius or mozambique or namibia or niger or Nigeria\$ or Rwanda\$ or sao tome) and principe) or Senegal\$ or seychelles or "sierra leone" or Somalia\$ or south Africa\$ or south sudan or sudan\$ or swaziland or Tanzania\$ or togo\$ or Uganda\$ or Zambia\$ or Zimbabwe\$).ti,ab,in. (89655)
- 106 exp Terminally Ill/ (5480)
- 107 exp Terminal Care/ (41694)
- 108 exp Euthanasia/ (13582)
- 109 exp Hospice Care/ (4754)
- 110 exp Hospices/ (4391)
- 111 exp Palliative Care/ (41484)
- 112 "end of life".tw. (11435)
- 113 (terminal* adj3 (care or ill*)).tw. (6984)
- 114 (palliative adj3 (care or medicine or service*)).tw. (15152)
- 115 (dying adj3 patient*).tw. (5037)
- 116 (death adj3 (near or impending)).tw. (1108)
- 117 "terminal stage*".tw. (2682)
- 118 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80 or 81 or 82 or 83 or 84 or 85 or 86 or 87 or 88 or 89 or 90 or 91 or 92 or 93 or 94 or 95 or 96 or 97 or 98 or 99 or 100 or 101 or 102 (605998)
- 119 103 or 104 or 105 (243311)
- 120 106 or 107 or 108 or 109 or 110 or 111 or 112 or 113 or 114 or 115 or 116 or 117 (90764)
- 121 118 and 119 and 120 (22)
- 122 Neoplasm/ or Tuberculosis/ or Human immunodeficiency virus/ or Acquired immune deficiency syndrome.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier] (383430)
- 123 118 and 119 and 120 and 122 (2)
- 124 120 or 122 (463250)
- 125 118 and 119 and 124 (176)

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Figure 1: PRISMA flow diagram for literature search

Figure 2: A visual framework of mHealth use reported by palliative care services in SSA.