HHS Public Access

Author manuscript

Am J Med Sci. Author manuscript; available in PMC 2017 December 13.

Published in final edited form as:

Am J Med Sci. 2017 December ; 354(6): 573–580. doi:10.1016/j.amjms.2017.08.005.

Assessing Mobile Health Capacity and Task Shifting Strategies to Improve Hypertension Among Ghanaian Stroke Survivors

Michelle Nichols, PhD, RN,
Medical University of South Carolina, College of Nursing, Charleston, South Carolina

Sarfo Fred Stephen, MD,
Department of Medicine, Neurology Unit, Kwame Nkrumah University of Science & Technology, Kumasi, Ghana

Arti Singh, MD,
KNUST Hospital, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

Suparna Qanungo, PhD,
Medical University of South Carolina, College of Nursing, Charleston, South Carolina

Frank Treiber, PhD,
Medical University of South Carolina, College of Nursing, Charleston, South Carolina

Bruce Ovbiagele, MD,
Department of Neurology, Medical University of South Carolina, Charleston, South Carolina

Raelle Saulson, MPH,
Department of Neurology, Medical University of South Carolina, Charleston, South Carolina

Sachin Patel, MS, and
Medical University of South Carolina, College of Nursing, Charleston, South Carolina

Carolyn Jenkins, DrPH, RN
Medical University of South Carolina, College of Nursing, Charleston, South Carolina

Abstract

Background—There has been a tremendous surge in stroke prevalence in sub-Saharan Africa. Hypertension (HTN), the most potent, modifiable risk factor for stroke, is a particular challenge in sub-Saharan Africa. Culturally sensitive, efficacious HTN control programs that are timely and sustainable are needed, especially among stroke survivors. Mobile health technology and task-shifting offer promising approaches to address this need.

Methods—Using a concurrent triangulation design, we collected data from stroke survivors, caregivers, community leaders, clinicians and hospital personnel to explore the barriers, facilitators and perceptions toward mHealth related to HTN management among poststroke survivors in

Correspondence: Michelle Nichols, PhD, RN, Medical University of South Carolina, College of Nursing, 99 Jonathan Lucas St, MSC 160, Charleston, SC 29425. (nicholmg@musc.edu).

The authors have no conflicts of interest to disclose.

Ghana. Exploration included perceptions of a nurse-led navigational model to facilitate care delivery and willingness of stroke survivors and caregivers to use mobile health technology.

Results—Two hundred stroke survivors completed study surveys while focus groups (n = 4) were conducted with stroke survivors, caregivers and community leaders (n = 28). Key informant interviews were completed with clinicians and hospital personnel (n = 10). A total of 93% of survey respondents had HTN (60% uncontrolled). Findings support mHealth strategies for poststroke care delivery and HTN management and for task-shifting through a nurse-led model. 76% of survey and 78.6% of focus group participants have access to mobile phones, 90% express comfort in using mobile phones and conveyed assurance that task-shifting through a nurse-led model could facilitate management of HTN. Findings also identified barriers to care delivery and medication adherence across all levels of the social ecological model.

Conclusions—Participants strongly supported enhanced care delivery through mobile health and were receptive toward a nurse-led navigational model.

Key Indexing Terms

Stroke; Mobile health; Hypertension; Task-shifting; Nurse led

Introduction

There has been tremendous surge in stroke prevalence over the past 4 decades in low- and middle-income countries (LMIC), including sub-Saharan Africa (SSA).[1,2] This scenario has been engendered by profound escalations in rates of traditional vascular risk factors such as hypertension (HTN), dyslipidemia and diabetes mellitus among adult populations in SSA.[3] HTN is the most potent modifiable risk factor for incident and recurrent strokes.[4-6] Differences in the levels of awareness and control of vascular risk factors, particularly HTN between populations in LMIC and high-income countries, may account for the diverging secular trends in stroke incidence and prevalence in these 2 settings over the past 40 years.

Unfortunately, the burden of stroke in SSA,[7,8] is projected to increase substantially over the next several decades,[9] a situation likely to be compounded by the low prevalence of awareness, treatment and control of HTN in SSA.[10,11] Achieving and sustaining blood pressure (BP) control is a particular challenge in SSA.[7,12] Key factors responsible for uncontrolled HTN are medication nonadherence, failure to intensify therapy in a timely manner (i.e., therapeutic inertia) and treatment resistant HTN [13-16] However, systematic reviews of randomized control trials have indicated that BP self-monitoring, medication reminder tactics and use of case managers each improve adherence, therapeutic inertia and BP levels.[17-20]

Occurrence of prior stroke is the strongest predictor of future stroke, with this risk being greatest during first 3-month poststroke.[21] Initiation of prevention strategies are most effective when implemented early, monitored frequently and maintained long term after an index stroke.[22,23] Thus, culturally sensitive, efficacious BP control programs, which are acceptable, feasible, timely and sustainable are needed, especially among hypertensive stroke survivors, the group at highest risk for future stroke.[24] Mobile health (mHealth)

technology offers a promising approach to address this need.[25,26] Most adults in SSA own a cell phone (~ 73%),[27,28] smart phone ownership is burgeoning (~25%)[29] and mHealth has produced promising results in chronic disease (i.e., HIV) management in SSA.[30-32] However, the potential for mHealth for the management of vascular risk factors among stroke survivors has not been explored within the African context.

The aims of our study were to explore the barriers, facilitators and recommended mHealth intervention strategies to control HTN in poststroke survivors. Specifically, we sought to assess stroke survivors willingness to use mHealth services for stroke and HTN care, to identify what educational and training needs they would have, and explore what types of technical support was readily available. We assessed the demographics, self-reported medication adherence and attitudes of 200 stroke survivors toward mobile phone for remote monitoring for chronic disease management and then assessed perceptions and willingness of stroke survivors to participate in research studies to evaluate feasibility of mHealth for HTN control.

Methods

Theoretical Framework

Investigators used the social ecological model (SEM) to frame the data collection and data analysis.[33] The SEM considers the larger environment context and how it influences an individual's life. Through this social ecological lens, factors such as physical, interpersonal, cultural, community and organizational influences, among others, are evaluated to consider the context within which one lives and the reciprocal nature of environment on health, health behaviors and health outcomes.[33]

Study Design and Setting

This study was approved by the Committee on Human Research Publication and Ethics (CHRPE) of the School of Medical Sciences, Kwame Nkrumah University of Science and Technology (KNUST), and the Komfo Anokye Teaching Hospital, Kumasi, Ghana. The study was conducted at the Neurology Clinic of the Komfo Anokye Teaching Hospital, a tertiary medical center and the Kwame Nkrumah University of Science & Technology Hospital, both in Kumasi, Ghana. Kumasi is the second largest city in Ghana with an estimated population of 2 million inhabitants.[34] The Neurology clinic, established in 2011 by one of the investigators (F.S.S.), serves an estimated population of 10 million people and receives referrals for adults >16 years with neurologic disorders from 6 of the 10 administrative regions of Ghana.[35]

This study used a concurrent triangulation design, to enhance exploration of the aforementioned research objectives.[36] Our study concurrently collected quantitative data via survey instruments described below and qualitative data through key informant interviews (KIIs) and focus groups (FGs). Within a concurrent triangulation design, quantitative and qualitative data are collected and analyzed separately and then data are compared and combined to cross-validate findings.[36] Simultaneously collecting both quantitative and qualitative data regarding HTN among stroke survivors, their caregivers and key

stakeholders, allows the research team to best understand the needs, priorities and resources available to further design interventional studies to meet this pressing clinical need.

Quantitative Methods

A total of 234 consecutive stroke survivors attending the Neurology service were approached for the quantitative survey, of which 200 were enrolled into the study after obtaining informed consent. Thirty-four stroke survivors with aphasia without a proxy were excluded. Demographic information, including age, gender, educational status, vascular risk factor profile, stroke type and stroke severity, was assessed using National Institute of Health Stroke Scale (NIHSS). Trained research assistants collected functional status, assessed using Barthel's index, and Modified Rankin scale through interview of stroke survivors or their proxy. Stroke type was determined using a computerized scan (CAT) of the brain within 10 days of stroke onset and classified as ischemic or hemorrhagic. Those who had clinical features suggestive of stroke but who did not have a CAT scan were classified as undetermined. The NIHSS is a validated instrument used to assess stroke severity with a score range of 0-42.

Measurements and Definitions

The weight of study subjects was measured in kilograms using a scale with patient standing at the anatomical position on a scale and the height in centimeters was measured using a stadiometer with patient standing in the anatomical position in front of the stadiometer. The weight and height measurements were used to calculate the body mass index. Subjects with body mass index ≥30 kg/m^2 were classified as obese.[37]

BP was measured thrice on the upper left arm using a validated automatic sphygmomanometer, with at least 5 minutes of rest between the second and third readings and results were averaged for analysis. HTN was diagnosed if the patient was on antihypertensive medications over the last 15 consecutive days or if the patient had a systolic or diastolic BP of 140 or 90 mm Hg, respectfully.

Participants were considered to have diabetes mellitus if they were on hypoglycemic medications or if their fasting blood glucose levels were 4 126 mg/dL or HBA1C > 6.5%.[38] Dyslipidemia was defined as a high total cholesterol >200 mg/dL or LDL-cholesterol >130 mg/dL, triglyceride >150 mg/dl or HDL-cholesterol <40 mg/dL for women and <50 mg/dL for men or previous use of statin for dyslipidemia.[39] Cardiac disease including myocardial infarction, rheumatic valvular heart disease and prosthetic heart valve, atrial fibrillation or flutter was based on self-reported history, clinical examination, review of baseline electrocardiogram or echocardiography result at enrollment into care at the neurology clinic.

Current smoking status and alcohol intake were ascertained through report from either the patient or a reliable relative. A high alcohol intake was defined as ≥14 U per week for women, ≥21 U per week for men. Physical activity status of participants was assessed using the International Physical Activity Questionnaire. Responders who reported spending more than half the day on their feet or were involved in daily exercises were classified as physically active. Those who spent less than half of the day on their feet or led a sedentary life were classed as physically inactive as has previously been applied.

Remote BP Monitoring—Each enrolled participant was then given a verbal description of mHealth and shown a video demonstration of the procedural steps using BP monitoring and medication reminder system that included the use of a wireless Bluetooth-enabled BP monitor that would be used to take the participant's BP and pulse every 3 days in the morning and evening; use of a smart phone with an application that automatically acquired and presented audio and visual results of the BP readings and forwarded encrypted BP data from the phone to a secure server; and a text or phone message sent to the phone to remind the participant to take their medications. Adherence with medication would be tracked in real time and would trigger the delivery of motivational and social reinforcement messages via text, e-mail or phone the following day based upon degree of adherence. Following the video demonstration of the prototype system, the participant was then asked to complete the mHealth-related survey and medication adherence scale.

mHealth-Related Survey—A 10-item survey evaluated participants' attitudes toward mHealth and telemedicine-based remote monitoring. Nine items were scored on a 5-point Likert scale ranging from “strongly disagree” to “strongly agree” whereas 1 item had only 2 choices (Yes or No). The items were adapted from a questionnaire used to assess patients' attitudes toward mobile phone based remote monitoring for chronic illness. Cronbach α for internal consistency in the current sample for the 9 items was 0.87.

Medication Adherence Scale—A 7-item modified Morisky Medication Adherence Scale was used to assess medication adherence among the participants. The modified Morisky scale provides a score from range 0-7 with higher scores indicative of higher adherence to medication.

Qualitative Methods

Through the qualitative portion of our study, we sought to specifically explore barriers, facilitators and recommended mHealth intervention strategies to control HTN in poststroke survivors in Kumasi, Ghana using FGs and KIIs. The following research questions were addressed: (1) What are the individual, interpersonal, health system and community barriers and facilitators for HTN control and use of mHealth tools (with documented efficacy in high-income countries) among Ghanaian stroke patients? (2) What are the recommended intervening strategies to develop a successful intervention and research study within the Ghanaian health system and community?

Stroke survivors with HTN, their caregivers and community-based spiritual or faith leaders were recruited using a purposive sampling design.[40] Faith and spiritual leaders were included to understand their perspectives on stroke, medication adherence, beliefs and on mobile health as a potential platform for increased care management, given the extent of complementary or alternative treatment modalities utilized within this geographic region.[41] A total of 28 individuals participated in the 4 FG sessions, 3 were comprised of stroke survivors with HTN and their caregivers, and 1 with community and faith-based leaders. In addition to the priority objectives listed above, FGs were used to explore potential patient specific barriers and facilitators of medication adherence, BP self-monitoring and achieving HTN control at the individual, interpersonal and community levels of the SEM,[33]

receptiveity toward a nurse-led model. A FG guide was developed to ensure a systematic and consistent approach in obtaining information from each FG to identify: (1) beliefs about HTN and stroke risk factor control, (2) existing self-management strategies and experiences, (3) expectations and preferences, (4) knowledge and (5) impressions of nurse navigators and remote monitoring or mHealth technology.

KIIs with healthcare providers and hospital administrators (n = 10) were conducted using semistructured qualitative inquiry. Through the KIIs, we sought to explore and understand their perspectives on hyptertension management among stroke survivors and elicit their opinions on the feasibility and practicabilty of mHealth as a potential approach to address HTN among this population, and perceptions on the possibility of task-shifting through a nurse-led model. Participants represented 5 KNUST hospital departments (neurology, social work, pharmacy, nursing administration and information technology). A semistructured interview guide was used to guide discussion in the following areas: (1) current approaches to HTN treatment and stroke risk factor control, (2) perceived gaps in care, (3) cultural competence or communication, (4) knowledge of treatment guidelines, (5) impressions of in-hospital health education, involvement of nurse navigators and mHealth home BP monitoring.

A separate semistructured interview guide was designed for hospital administrators covering these topics: (1) information technology systems support or assessment of accessibility or adequacy of administrative databases and systems for use in intervention and (2) impressions of home BP monitoring and the concept of nurse navigators for chronic disease and symptom management.

FGs and KIIs were transcribed verbatim with strikeouts of any identifiers that might breach subject confidentiality. Transcriptions of audiorecordings were translated to English for interviews conducted with non-English speaking study participants.

Data Analysis

As is standard within a concurrent triangulation design, quantitative and qualitative data were collected and analyzed simultaneously and then compared or contrasted.[36] Basic descriptive statistics of the survey data, including means, standard deviations and frequencies for variables were conducted using SPSS 19.0 (IBM Statistical Package for the Social Sciences). Transcripts of the audiorecordings and field notes from the KIIs and FGs were used for the qualitative data analysis. The investigative team reviewed transcriptions with recordings to check for accuracy and authenticity and imported into NVivo 11.0 (QSR International, Pty, Doncaster, Victoria, Australia) for data analysis using a directed content analysis approach.[42]

Transcripts were coded using the SEM and a priori categories consistent with the research aims. An experienced qualitative researcher conducted line-by-line analysis of raw text. American and Ghanaian collaborators validated 10% of the coding to establish inter-rater reliability and increase trustworthiness, a measure of credibility and rigor in qualitative methodology. Disagreements of attribute codes were resolved through discussion to achieve

consensus. A thematic codebook was specified for content differences in FGs and interviews.[43]

Results

Demographic and Clinical Characteristics of Stroke Survivors (Survey Participants)

Of the 200 stroke survivors who participated in the quantitative portion, 52.5% were males and the median (IQR) age was 62 (52-72) years. Seventy-three percent were employed and 65% were married. Stroke survivors had experienced the initial stroke for a median of 2 years, and had the following co-morbidities: HTN (93%), diabetes mellitus (42.5%) and dyslipidemia (31%) as shown in Table 1. Of the hypertensive stroke survivors, 60% were not on target with BP control.

Medication Adherence

Totally, 177 participants (88.5%) reporting taking their medications everyday of the previous week and 179 (89.5%) reported taking their medications the day before, 50 participants (25%) reported forgetting to take their BP medications “sometimes” whereas 87 reported forgetting to take their medications when traveling. Only 41 (20.5%) reported taking their medication because they were going to see their doctor and 10% stopped taking prescribed medicines when “everything was fine.” Only 43 (21.5%) reported having difficulties remembering to take all their medications, whereas 159 (79.5%) took their medicines within 30 minutes if they forgot to take their pills at the exact time.

Mobile Phone and Disease Monitoring Device Use

Three-quarters (76%) of participants had access to a mobile phone, with nearly a quarter reporting access to a smart phone (22.5%) and Internet (24.5%) as well.

Totally, 127 (63.5%), 34 (17%), 31 (15.5%) and 27 participants (13.5%) could send or receive text messages, use the Internet, send or receive e-mails and download ringtones or apps respectively. However, 97%, 92% and 60.5% of participants reported having someone in their household with a working cellular phone, someone who could help them use their cellular phone and someone with a smart phone in their household, respectively. In all, 30% had a home BP or blood sugar monitoring device while only 2.5% reported having a pill dispensing device at home.

Attitudes and Perceptions Toward mHealth

Study participants generally had positive attitudes of perceived benefits of mHealth as shown in Table 2, although only 2% had previously heard about mHealth or telehealth. A total of 99.5% of participants expressed a willingness to participate in a research study involving mHealth and the majority (96.5%) thought it would be worthwhile to conduct studies on how mobile phone or computers could help with control of BP in the community. Almost 98% believed controlling BP could prevent a stroke.

Demographic and Characteristics of FG Participants

The mean age of those who participated in the FG sessions was 55.3 years, and included stroke survivors ($n = 13$), caregivers ($n = 9$) and faith-based community leaders ($n = 6$). Seven stroke survivors participated in both the quantitative and qualitative portions of this research. Overall, most FG participants were females ($n = 18$), married ($n = 18$) and of the stroke survivors, 8 experienced the index stroke o1 year from date of data collection and the remainder were over 1 year ($n = 5$). Twenty two participants (78.6%) reported access to mobile phones, which is consistent with the findings from the survey.

FG and KII Results—Barriers were identified at each level of the SEM and exemplary quotes are noted in Table 3. Facilitators, while not explicitly stated during the FGs, fell generally within the domains of willingness and receptivity toward adopting alternative approaches and learning new skills. Access to mobile phones was consistent with prior reports within SSA of approximately 73%.[27,28] Consistent with concurrent triangulation design, we compared data from qualitative and quantitative approaches. Among our population, 76% of survey participants had access to mobile phones, which was confirmed during the FGs as most ($n = 17$) respondents either had 1 themselves or had regular access to 1 in their household and 180 individuals surveyed (90%) expressed comfort (agree or strongly agree) with their ability to use a mobile phone.

Support for a nurse-led navigational model was consistent among FG and KII. Stroke survivors and their caregivers expressed that having a nurse available to guide them through the management of their care poststroke, including management of their BP would be helpful. This was supported through discussion with mHealth, as well. One participant stated

> she (nurse) would be able to explain how to use it and guide us on BP control and tell us some things on diet and other things related to the illness.

Administrative and physician support also confirmed this through statements such as

> I think that in the community it would be highly accepted for the reasons I mentioned, like reducing the burden and giving individualized care and that is why a nurse-led navigation would really help, as I have realized that nurses are good at advising patients… .

Reducing clinical burden and addressing transportation and financial challenges inherent within the current model of care delivery were reasons identified in favor of both mHealth and a nurse-led navigational model.

Potential challenges to be considered before implementation of such programs include educational needs (patient, family and nursing), technological limitations (connectivity) and cost (mobile phones, equipment and data). Stroke survivors and their caregivers shared concerns over current comfort level with technology and the need for training but strongly conveyed a willingness to adopt this type of ongoing follow-up for care management with adequate training and support. Hospital administration, including information technology specialists and clinicians echoed a willingness to adopt these approaches.

> It would be good if the device uses both chargers and a battery for the power cuts that happen here.
>
> Although they will accept it, they wouldn't have wireless services.
>
> I think this requires education to some extent and after that people can use it well.
>
> Many people just carry phones but hardly know much about using it for other purposes aside from receiving or making calls. They would be very interested if they can get some help for using this technology.
>
> It seems like it will be of great benefit to the patients, especially those who have to travel from far places to come to the hospital. Having this would reduce the number of patients coming for the BP checks and also would save them some money on transport.

Following both separate quantitative and qualitative data analysis, data from each were compared and contrasted for convergence and divergence according to the SEM. Although stroke survivor clinical measures obviously were individually focused, responses from both sets of data, quantitative and qualitative represented consistent support when considered within the SEM framework. Examples include factors contributing to medication adherence (individual, interpersonal and policy level factors) and access to technology converged between data sets and within the model. Participants who completed surveys as well as those who were enrolled in the FG sessions identified high levels of individual or interpersonal access to mobile devices, which was supportive of future interventional efforts but identified community-level and policy (governmental) related concerns with inconsistent connectivity access. Using a mixed methodological approach increases confirmability of data, thus better informing future work in this area.

Discussion

The results of this study support the need for innovative approaches to address HTN management among stroke survivors in Ghana. Interventions, especially those implemented in LMICs, need to be culturally relevant, cost-effective and built upon existing infrastructure for expediency, as the burden of hypertention among stroke survivors in SSA, including within Ghana, is burgeoning. Proximity to care, financial limitations, high patient to physician ratios and cultural and spiritual beliefs influence access to care, care management and medication adherence among this underserved population. Moreover, limited healthcare personnel, inadequacy of healthcare systems and a paucity of treatment options, compound this issue, thus necessitating a call for action.

Our study explored the barriers, facilitators and potential use of mHealth as a strategy to control HTN among poststroke survivors, including the perceptions, beliefs and willingness of patients and their caregivers to use mHealth for follow-up stroke and HTN care management. Both qualitative and quantitative data overwhelmingly supported the use of mHealth to manage poststroke care and medication management, including through a nurse-led navigational model. Our concurrent triangulational design study assessed findings at all levels of the SEM and yielded confirmatory results between survey, FG and KIIs data.

Ghanian hospital administrators, information technology personnel and clinicians also support both the use of mHealth and a nurse-led navigational model for enhanced care delivery among the population of interest. Moreover, the SEM explored through qualitative inquiry is a useful approach to best understand the multifactorial, multisystem needs of stroke survivors and their caregivers in real world settings.

Although consistent support for these approaches was evident, concerns over cost, training and continuity of connectivity were expressed by participants. These challenges would need to be further explored and addressed before any large scale programmatic implementation. Given that prior stroke is the greatest predictor of future stroke, that HTN is one of the most modifiable risk factors for stroke and that the prevalence of HTN, especially in rural areas of SSA, is estimated around 70%,[8] there is a pressing need for interventions to address this clinically significant health priority. MHealth may be a viable, low-cost, innovative approach to reducing the burden of HTN among stroke survivors in SSA. We have since completing the present study, commissioned an on-going pilot, feasibility randomized controlled trial in Ghana to test whether an mHealth technology-enabled, nurse-led, multilevel integrated approach is effective in improving BP control among stroke patients within 1 month of symptom onset compared with standard of care. Included in our current feasibility trial is an expanded evaluation of infrastructural support, connectivity assessments and costs of implementing an mHealth intervention among stroke patients.[44] A feasible and preliminarily effective intervention would lead to a larger more definitive efficacy or effectiveness randomized controlled trial powered to look at clinical events, with the potential to reduce stroke-related morbidity and mortality in LMICs.

Acknowledgments

The authors would like to acknowledge the following individuals for their support and efforts with data collection: Isaac Nkrumah, Nathaniel Mensah and Samuel Badu.

Source of funding: This study was supported by the Medical University of South Carolina's Center for Global Health (CGH).

References

1. Feigin VL, Forouzanfar MH, Krishnamurthi R, et al. Global and regional burden of stroke during 1990-2010: findings from the Global Burden of Disease Study 2010. Lancet. 2014; 383(9913):245–54. [PubMed: 24449944]
2. Feigin VL, Krishnamurthi RV, Parmar P, et al. Update on the global burden of ischemic and hemorrhagic stroke in 1990-2013: the GBD 2013 study. Neuroepidemiology. 2015; 45(3):161–76. [PubMed: 26505981]
3. Owolabi MO, Karolo-Anthony S, Akinyemi R, et al. The burden of stroke in Africa: a glance at the present and a glimpse info the future. Cardiovasc J Afr. 2015; 26(2 suppl 1):S27–38. http://dx.doi.org/10.1161/CIR.0000000000000350. [PubMed: 25962945]
4. Go AS, Mozaffarian D, Roger VL, et al. Heart disease and stroke statistics-2014 update: a report from the American Heart Association. Circulation. 2014; 129(3):e28–292. [PubMed: 24352519]
5. Lewington S, Clarke R, Qizilbash N, et al. Prospective studies collaboration: age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. Lancet. 2002; 360(9349):1093. http://dx.doi.org/10.1016/S0140-6736(02)11911-8.

6. Biffi A, Anderson CD, Battey TW, et al. Association between blood pressure and risk of recurrent intracerebral hemorrhage. J Am Med Assoc. 2015; 319(9):904–12.
7. BeLue R, Okoror TA, Iwelunmor J, et al. An overview of cardiovascular risk factor burden in Sub-Saharan African countries: a soci-cultural perspective. Global Health. 2009; 5:10. [PubMed: 19772644]
8. Nulu S, Aronow WS, Frishman WH. Hypertension in Sub-Saharan Africa: contextual view of patterns of disease, best management, and systems issues. Cardiol Rev. 2016; 24(1):30–40. [PubMed: 26284525]
9. Feigin VL. Stroke epidemiology in the developing work. Lancet. 2005; 365:2160–1. [PubMed: 15978910]
10. Lemogoum D, Degaute JP, Bovet P. Stroke prevention, treatment, and rehabilitation in Sub-Saharan Africa. Am J Prev Med. 2005; 29:95–101. [PubMed: 16389133]
11. Oke DA, Bandele EO. Misconceptions of hypertension. J Natl Med Assoc. 2004; 96:1221–4. [PubMed: 15481752]
12. Owolabi MO. Taming the burgeoning stroke epidemic in Africa: stroke quadrangle to the rescue. West Indian Med J. 2011; 60:412–21. [PubMed: 22097671]
13. Dusing R. Overcoming barriers to effective blood pressure control in patients with hypertension. Curr Med Res Opin. 2006; 22:1545–53. [PubMed: 16870079]
14. Borzecki AM, Oliveria SA, Berlowitz DR. Barriers to hypertension control. Am Heart J. 2005; 149:785–94. [PubMed: 15894958]
15. Okonofua EC, Simpson KN, Jesri A, et al. Therapeutic inertia is an impediment to achieving the Healthy People 2010 blood pressure control goals. Hypertension. 2006; 47:345–51. [PubMed: 16432045]
16. Andrade SE, Gurwitz JH, Field TS, et al. Hypertension management: the care gap between clinical guidelines and clinical practice. Am J Manag Care. 2004; 110:481–6.
17. Glynn LG, Murphy AW, Smith SM, et al. Self-monitoring and other non-pharmalogical interventions to improve the management of hypertension in primary care: a systematic review. Br J Gen Pract. 2010; 60:e476–88. [PubMed: 21144192]
18. Glynn LG, Murphy AW, Smith SM, et al. Interventions used to improve control of blood pressure in patients with hypertension. Cochrane Data-base Syst Rev. 2010; 19:CD005182.
19. Cappiccio FP, Kerry SM, Forbes L, et al. Blood pressure control by home monitoring: meta-analysis of randomised trials. Br Med J. 2004; 329:145. [PubMed: 15194600]
20. Agarwal R, Bills JE, Hecht TJ, et al. Role of home blood pressure monitoring in overcoming therapeutic inertia and improving hypertension control: a systematic review and meta-analysis. Hypertension. 2011; 57:29–38. [PubMed: 21115879]
21. Furie KL, Kasner SE, Adams RJ, et al. Guidelines for the prevention of stroke in patients with stroke or transient ischemic attack: a guideline for healthcare professionals from the american heart association/american stroke association. J Cereb Circ. 2011; 42:227–76.
22. Hardie K, Hankey GJ, Jamrozik K, et al. Ten-year risk of first recurrent stroke and disability after first-ever stroke in the Perth Community Stroke Study. Stroke. 2004; 35:731–5. [PubMed: 14764929]
23. Moroney JT, Bagiella E, Paik MC, et al. Risk factors for early recurrence after ischemic stroke: the role of stroke syndrome and subtype. Stroke. 1998; 29:2118–24. [PubMed: 9756592]
24. van de Vijver S, Oti S, Addo J, et al. Review of community-based interventions for prevention of CVD in low- and middle-income countries. Ethn Health. 2012; 17:651–76. [PubMed: 23297746]
25. Gurman TA, Rubin SE, Roess AA. Effectiveness of mHealth behavior change communication interventions in developing countries: a systematic review of the literature. J Health Commun. 2012; 17:82–104.
26. Kallander K, Tibenderana JK, Akpogheneta OJ, et al. Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low- and middle-income countries: a review. J Med Internet Res. 2013; 15:e17. [PubMed: 23353680]
27. Okoro EO, Sholagberu HO, Kolo PM. Mobile phone ownership among Nigerians with diabetes. Afr Health Sci. 2010; 10:183–6. [PubMed: 21326973]

28. Jidenma, N. [Accessed February 8, 2014] The real mobile revolution: Africa's smartphone future. CNN Marketplace Africa. http://www.cnn.com/2013/11/07/opinion/real-mobile-revolution-africa-smartphone/
29. Powell, AC. [Accessed February 9, 2014] Gallup/BBG Survey: Massive increase in mobile phone, Internet use in Nigeria. http://uscpublicdiplomacy.org/index.php/newswire/cpdblog_detail/gallup_bbg_survey_massive_increase_in_mobile_phone_internet_use_in_nigeria/
30. Lester RT, Ritvo P, Mills EJ, et al. Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): a randomised trial. Lancet. 2010; 376:1838–45. [PubMed: 21071074]
31. Mukund Bahadur KC, Murray PJ. Cell phone short messaging service (SMS) for HIV/AIDS in South Africa: a literature review. Stud Health Technol Inform. 2010; 160:530–4. [PubMed: 20841743]
32. Trickett EJ, Beehler S, Ceutsch C, et al. Advancing the science of community-level interventions. Am J Public Health. 2011; 101(8):1410–9. [PubMed: 21680923]
33. Bronfenbrenner, U. International Encyclopedia of Education. Oxford, England: Elsevier Sciences; 1994. Ecological models of human development; p. 3
34. City Population. Republic of Ghana. 2017. Accessed at: https://www.citypopulation.de/Ghana-Cities.html
35. Sarfo FS, Akassi J, Badu E, et al. Profile of neurological disorders in an adult neurology clinic in Kumasi, Ghana. eNeurologicalSci. 2016; 3:69–74. [PubMed: 27110596]
36. Creswell, JW., Plano Clark, VL. Designing and Conducting Mixed Methods Research. 2nd. Washington, DC: Sage; 2011.
37. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults-The evidence report. National Institutes of Health. Obes Res. 1998; 6(suppl 2):51S–209S. [PubMed: 9813653]
38. World Health Organization. Screening for type 2 daibetes report of a WHO and International Federation meeting. Geneva: 2003.
39. Strategies for the prevention of coronary heart disease: a policy statement of the European Atherosclerosis Society. Eur Heart J. 1987; 8:77–88.
40. Patton, MQ. Qualitative Research and Evaluation Methods. 3rd. Thousand Oaks, CA: Sage; 2002.
41. Sarfo FS, Nichols M, Qanungo S, et al. Stroke related stigma West Africans: patterns and predictors. J Neurol Sci. 2017; 375:270–4. [PubMed: 28320146]
42. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. Qual Health Res. 2005; 15(9):1277–88. [PubMed: 16204405]
43. Lincoln, YS., Guba, EG. Naturalistic Inquiry. Newbury Park, CA: Sage Publications; 1985.
44. Sarfo FS, Treiber F, Jenkins C, et al. Phone-based Intervention under Nurse Guidance after Stroke (PINGS): study protocol for a randomized controlled trial. Trials. 2016; 17(1):436. [PubMed: 27596244]

Table 1

Demographic, vascular risk factor profile and clinical characteristics of stroke survivors involved in the surveys.

Characteristic	*N* (%)
Male, *n* (%)	105 (52.5)
Age, median (IQR)	62 (52-72)
Educational status	
None	36 (18.0)
Primary	56 (28.0)
Secondary	77 (38.5)
Tertiary	31 (15.5)
Area of residence	
Rural	7 (3.5)
Semiurban	54 (27.0)
Urban	139 (69.5)
Employment status	
Employed	146 (73.0)
Not employed or retired	54 (27.0)
Marital status	
Currently married	130 (65.0)
Separated, divorced or never married	32 (16.0)
Widow	38 (19.0)
Vascular risk factors	
Hypertension	186 (93.0)
Dyslipidemia	62 (31.0)
Diabetes mellitus	85 (42.5)
Obesity	46 (23.0)
Cigarette smoking	13 (6.5)
Alcohol abuse	48 (24.0)
Stroke types	
Ischemic	140 (70.0)
Hemorrhagic	36 (18.0)
Untyped	24 (12.0)
Duration of stroke in years, median (IQR)	2 (1–4)
NIHSS, mean ± SD	8 (2–12)
Proportion with SBP >140 mmHg	98 (49.0)
Proportion with DBP >90 mmHg	94 (47.0)
Proportion with uncontrolled BP	120 (60.0)

Table 2

Frequency of responses on perceptions and attitudes towards mHealth.

Question	Responses (*n*)				
	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
If someone provided a free mHealth device and a “smart” phone, set it all up and taught me how to use the devices, I would use them as directed.	5	0	1	62	132
If someone were always available to answer my questions about the devices at no cost to me, I would use the devices as directed.	2	0	0	18	180
I feel comfortable with a doctor or a nurse monitoring my health information using mHealth technologies.	2	1	7	50	140
I feel comfortable using a cellular phone	6	6	8	43	137
I believe mobile technology will help remind me to follow my doctor's directions.	4	2	4	61	129
I believe mobile technology will allow my doctor to make changes in my medications more quickly.	3	2	5	52	138
I am confident that my privacy would be protected if my health information was being monitored using mHealth technologies.	2	3	6	50	139
It is important to follow my doctor's directions.	3	1	2	46	148
I feel confident that this technology can effectively communicate with my healthcare providers about my medical conditions.	3	1	4	50	142

Table 3

Exemplary quotes related to barriers at the various levels of the social ecological model (SEM).

SEM level	Barriers
Individual	• Knowledge: For me what I know is that once my BP was 160/90 but I do not have HTN. • You know mobile device is not part of our general day to day activities. Once it is introduced we will know how to go about it. • Nonadherence: …among the men you notice that they stop taking their medications due to the fear of getting sexual dysfunction… • Transportation: Sometimes there is no one to bring me to the hospital. • The hospital was also far from where I lives so coming every month was not easy for me. • Beliefs: I know somebody who was taken to the pastor and he told her that someone has put a spell on her and that is why she had the stroke. • We have this belief that medicinces do not help. • It was God's time to give me such a sickness at that time…that is what I think. • Financial: I will say it is the financial issues. Some of the drugs are costly and it is not easy to buy all of them. • If you are a pensioner…buying the drugs is not easy.
Interpersonal	• Financial: The money is a big problem…I am a man and I need to provide for my family. You know, here in Ghana, the women expect you to look after them; even if you are dying, you still have to look after your women.
Organizational	• Provider limitations: The load of the patient every day to see a doctor. • The doctor patient ratio.
Community	• Religion/beliefs: In our church we believe that we are not supposed to take medicines. • Certain tribes have strong beliefs. • Most Ghanaians are religious people so quite apart from the Orthodox medicines we prescribe for them…they resort to faith-based beliefs. • It is a common belief like some say somebody has caused that to you. Like for my father they said that someone is doing that to him; the pastor also said that to him so we also believed it. • Infrastructure: We have lots of problems with power cuts so that is the challenge. • Access: I think its also accessibility of the herbalists. The herbalist might just be a walking distance away from your home so you take the patient there but the hospital might be far…it is more affordable to go to the herbalist.
Policy	• Clinical guidelines: There are no local guidelines for the management of hypertension in stroke patients so we use the guidelines in America. We do not really know the applicability of these guidelines in our patients.