TACKLING THE GROWING DIABETES BURDEN IN SUB-SAHARAN AFRICA: A FRAMEWORK FOR ENHANCING OUTCOMES IN STROKE PATIENTS

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Abstract

According to the World Health Organization (WHO), more than 80% of worldwide diabetes (DM)-related deaths presently occur in low- and middle- income countries (LMIC), and left unchecked these DM-related deaths will likely double over the next 20 years. Cardiovascular disease (CVD) is the most prevalent and detrimental complication of DM: doubling the risk of CVD events (including stroke) and accounting for up to 80% of DM-related deaths. Given the aforementioned, interventions targeted at reducing CVD risk among people with DM are integral to limiting DM-related morbidity and mortality in LMIC, a majority of which are located in Sub-Saharan Africa (SSA). However, SSA is contextually unique: socioeconomic obstacles, cultural barriers, under-diagnosis, uncoordinated care, and shortage of physicians currently limit the capacity of SSA countries to implement CVD prevention among people with DM in a timely and sustainable manner. This article proposes a theory-based framework for conceptualizing integrated protocol-driven risk factor patient self-management interventions that could be adopted or adapted in future studies among hospitalized stroke patients with DM encountered in SSA. These interventions include systematic health education at hospital discharge, use of post-discharge trained community lay navigators, implementation of nurse-led group clinics and administration of health technology (personalized phone text messaging and home tele-monitoring), all aimed at increasing patient self-efficacy and intrinsic motivation for sustained adherence to therapies proven to reduce CVD event risk.

Keywords

Stroke; Diabetes; mobile health; navigators; Africa; global health

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Disclosures: None

BURDEN OF DIABETES AND STROKE IN SUB_SAHARAN AFRICA (SSA)

As of 2012, roughly 14 million Africans (4.8%) had Diabetes (DM), and approximately 81% were undiagnosed (vs. 50% worldwide), making Africa the continent with the highest proportion of people with undiagnosed DM. [1] Projections for Sub-Saharan Africa (SSA) indicate the number of diabetics will rise by 71% to 23.9 million by 2030 (predicted global increase is 37%).[1] Pre-DM in SSA is expected to rise by 75.8%, from 26.9 million in 2010 to 47.3 million in 2030. [1] DM accounts for 6.1% of deaths from all causes in SSA with absolute and relative mortality rates highest in 20 to 39 year olds, i.e., the most economically productive range of population.[2]

Major CVD events (including stroke) cause about 80% of the total mortality in people with DM.[3] World Health Organization (WHO) estimates indicate stroke deaths in LMIC account for 85.5% of stroke deaths worldwide. [4] The disability-adjusted life years lost in these countries was almost seven times those lost in high-income countries (HIC). [4] Beyond the personal toll, costs (e.g. direct expenditures and lost productivity) related to stroke are prohibitive.[5] Data from SSA suggest an annual stroke incidence rate up to 316 per 100,000, a prevalence rate up to 315 per 100,000 and 3-year fatality rate up to 84%.[6] Stroke is the leading cause of adult medical admissions and comas.[7,8] Among survivors, a major source of subsequent mortality and functional decline is recurrent stroke and myocardial infarction (MI). [9–13]

Of note, stroke risk is substantially higher in people with DM.[14] Optimal management of DM is likely an important recurrent CVD prevention activity. [15–17] Moreover, while people with a known date of pre-DM onset progress to DM in <3 years,[16] pre-DM is itself independently linked with CVD events. [15–17] A meta-analysis of prospective cohort studies suggested that pre-DM is independently associated with stroke events.[17] Also analysis of nationally representative US data showed that 3.7% stroke survivors had undiagnosed DM, 32.3% had undiagnosed pre-DM, and prevalence of undiagnosed DM and pre-DM were highest in racial-ethnic minorities.[18] Similar data are not available for stroke survivors in SSA, but it's likely that under-diagnosis in SSA is much worse than the US.

AMELIORATING THE BURDEN OF DIABETES AND STROKE IN SSA

Fortunately, effective interventions exist to prevent progression of pre-DM to DM. Consensus guidelines recommend that persons with pre-DM be informed of their increased risk, counseled about effective strategies to lower risks, have CVD risk factors treated, and be regularly monitored for DM.[19] Prevention of future CVD events is critical to reducing the morbidity/mortality of patients with stroke, since the risk is highest within 3 months of the index stroke.[20,21] Longitudinal studies in HIC have identified modifiable risk factors including hypertension, DM, and dyslipidemia, [22] which if controlled, could substantially lessen CVD burden. Yet, use of evidence-based therapies for CVD prevention among stroke patients receiving conventional care in LMIC is extremely low.[23] Scaling up interventions to prevent primary and secondary CVD in LMIC could meet a global goal of reducing chronic disease death rates by an additional 2% per year, with only a moderate rise in health expenditure.[24] However, Africans in general, do not use health services unless they are very

sick or there is a specific need,[25] and even in times of infirmity, self-medication and use of traditional medicine are usually the first line of action. [26] A study at the University College Hospital Ibadan, Nigeria, found that glycemic control was achieved in only one third of encountered DM patients, due to poor adherence with prescribed drug regimen, and practice of self-management.[27]

Beyond barriers to optimal DM control at the patient level, in SSA countries, systems-level barriers seem to have an even more adverse impact on health care in general, particularly among those with chronic diseases. [28,29] Inadequate workforces are perhaps the most serious challenges. Poor working conditions and low salaries have triggered a wave of migration of health professionals from SSA to western countries.[30,31] Successful and sustainable strategies for incrementally overcoming impediments to mitigating the burgeoning DM-related CVD epidemic in SSA will need to include: 1) an initial focus on high-risk individuals motivated to improve their health and likely to command the attention of policy-makers,[24] 2) multidisciplinary care coordination initiatives with clinical decision support for management of CVD via easy-to-follow algorithms that can be incorporated into existing hospital-based systems, [32] 3) evidence-based interventions tailored for cultural relevance, 4) task shifting of select chronic care management duties from physicians to nurses and other health providers, [33] 5) involvement of lay community navigators to facilitate patient access to medical and social resources, [34–36] 6) use of novel patient-accessible tools that are relatively inexpensive,[37] 7) a multi-level approach that includes individual- and system-level components. [38–41]

GUIDING THEORETICAL FRAMEWORKS TO IMPROVE OUTCOMES IN SSA

Given the myriad of barriers to management of DM and stroke at various levels in SSA, and evidence from HIC that chronic care interventions are most successful when they simultaneously target several levels in a multidimensional manner,[38–41] it is anticipated that an effective intervention to improve CVD outcomes among DM patients in SSA will require a multimodal intervention based in solid theoretical constructs tailored to the unique health care situation. Furthermore, for any innovation to be implemented successfully, it is necessary to identify potential interacting determining factors derived from different theories that need to be tested for their combined influence on change.[42] Indeed, a lack of theoretical development has been proposed as a major contributor to failure of complex interventions in preventive care after stroke to demonstrate efficacy.[43] Table 1 depicts key theoretical frameworks that underlie possibly successful intervention(s) to enhance outcomes for hospitalized stroke patients with diabetes or pre-diabetes in SSA.

POTENTIAL INTERVENTION STRATEGIES TO IMPROVE OUTCOMES IN SSA

A review of evidence regarding effectiveness of patient, provider, and health system interventions to improve DM care among socially disadvantaged populations revealed that intervention features with consistently positive effects included cultural tailoring, community educators or lay people leading the intervention, one-on-one interventions with individualized assessment and reassessment, incorporating treatment algorithms, focusing

on behavior-related tasks, providing feedback, and high-intensity interventions (>10 contact times) delivered over a long duration (>or=6 months). [44] Table 2 provides a detailed breakdown of various promising strategies based on a literature review and the justification for their consideration. While any of these interventions could individually be tested in a clinical trial, multi-level strategies that include individual- and system- level components, have been consistently been shown to have better efficacy than individual interventions. [38–41] Table 3 proposes four study interventions that may individually enhance outcomes among stroke patients with or at risk of diabetes in Sub-Saharan Africa (SSA). However, with evidence that multi-level strategies may work best, [38–41] Figure 1 depicts the flow within a bundled multimodal approach for reducing CVD risk among hospitalized stroke patients in SSA with DM or Pre-DM that incorporates all the proposed individual interventions mentioned in Table 3.

Prior to conducting any study the components of the intervention(s) will need to be refined in iterative fashion using mixed methods research. Objectives that should serve as a boundary for such pre-trial investigation are: a) To explore help-seeking attitudes and beliefs among stroke patients with pre-DM/DM and their understanding about symptoms and risks; b) To integrate suggestions for enhancing and implementing the intervention; c) To examine patients and caregivers knowledge about clinical trial research design and purpose and how this may affect a subject's decision to enroll in a study. Also after completion of the clinical trial, an examination of utilization/cost of the intervention(s) for the healthcare system will be useful to convince policy makers that the intervention(s) is economically worthwhile. Moreover, to ensure scalability and sustainability of a potentially successful intervention the early and continued involvement of local government agencies, private sectors, non-government organizations, academic institutions and communities will be imperative.

CONCLUSIONS

Very few countries in SSA can afford to broadly screen and treat the various complications of DM in a general population.[45] A focused incremental approach built upon existing infrastructure with proof-of-concept among high risk persons may first be needed. [28] While there have been a few modestly successful strategies to improve care for DM patients in SSA, these have generally focused on uni-modal interventions aimed at primary care populations, evaluating effects on care processes, patient satisfaction, or glycemic control. Patients hospitalized with a recent stroke who have DM or Pre-DM represent a high risk population that could be targeted for theory-driven, evidence-based intervention(s) to lower major DM-related CVD complications. By starting during the inpatient encounter and extending well into the post-discharge/community period, the bundled multi-level intervention proposed in this article (figure 1) uniquely traverses the stroke care continuum and explores various care transition issues in SSA that could be vitally important for reducing recurrent vascular events.

A clinically-effective bundled strategy, if scaled up, could have the potential to reduce DM-related CVD morbidity, mortality in SSA and might be applicable to CVD risk reduction for pre-DM and DM patients with other major CVD entities like coronary artery disease, congestive heart failure and chronic kidney disease. It would facilitate the routine screening

for pre-DM and DM when these patients are hospitalized, an issue of major significance given the level of under-diagnosis of both these conditions in SSA, and the opportunity to prevent progression of pre-DM to DM in high CVD risk patients. A cost-effective multimodal intervention could be highly appealing to policy makers in this under-resourced region, and would be impetus for broader implementation. [46] In fact, the proposed task-shifting strategy, which uses nurses to deliver CVD risk reduction, could potentially mitigate the critical shortage of healthcare workers in the region, and leveraging the high (and rising) mobile phone penetration in the region could ameliorate mHealth logistics challenges, integrate care systems, and improve patient access.

Acknowledgments

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Highlights

- Article proposes a theory-based framework for stroke and diabetes management

- Discussion centers on scalable strategies for patients in Sub-Saharan Africa

- Proposed interventions include health education and mobile health technology

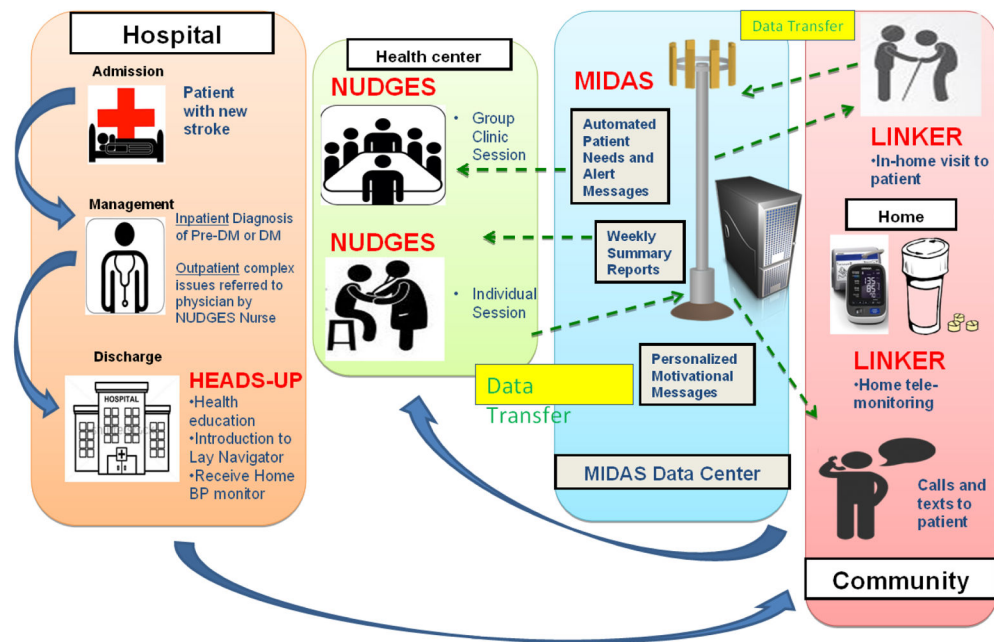- Proposed personnel include trained community lay navigators and nurse practitioners

Figure 1.
Flow within a bundled multimodal strategy for reducing cardiovascular risk among hospitalized stroke patients in Sub-Saharan Africa with diabetes or pre-diabetes that incorporates several individual interweaving interventions

Table 1

Guiding theoretical frameworks/models to support strategies to improve outcomes among stroke patients with or at risk of diabetes in Sub-Saharan Africa (SSA)

Model/Theory	Description	Justification
Transtheoretical	• Behavioral interventions are most effective for people at the "determination" or "action" stage.[47,48]	• Pre-DM/DM in context of a recent stroke is likely to be strong motivation for individuals to be ready to change
Health Care Navigator Model	• Goal of navigation is to improve self-management of chronic diseases and to reduce barriers to health care. • Navigators are a subset of community health workers, who provides informal community-based health-related services and establishes links between providers and persons in the community.[49–51] • Navigators are usually lay workers provided training and supervised by health care professionals.	• Effective in increasing compliance in DM and CVD in HIC.[52–55,102,103] • Peer-for-progress model is successfully utilized in SSA demonstration projects including a DM project in Cameroun and a CVD project in Kenya.[34–36] • Patient navigation is a central recommendation of the Institute of Medicine's report on health care disparities.[56]
Chronic Care Model (CCM)	• Identifies the essential elements of a health care system that promote high-quality chronic disease care • Includes delivery system redesign, self-management support, community resources, decision support, clinical information systems, organization of healthcare.	• Majority of interventions based on model improved care processes or outcome measures, and reduce health care costs.[57] • Delivery system redesign (enhanced coordination of care) component of model strongly linked to improvements in health outcomes.[58–61] • Self-management (confidence in one's ability to behave in a way to produce a desirable outcome) support component of model strongly linked to favorable outcomes.[58,62,63]

Table 2

Promising strategies to consider for the improvement of outcomes among stroke patients with or at risk of diabetes in Sub-Saharan Africa (SSA)

Strategy	Rationale
Lay health workers	• Lay health workers shown effective in management of infectious diseases in SSA,[64–70] and could be a viable aspect of interventions aimed at managing DM. • Community-based interventions are high on United Nations Millennium Development Goals' policy agenda,[71]
Task shifting	• Task shifting to "non-physician clinicians" in Cameroon resulted in decrease of fasting plasma glucose by 3.4 mmol/l (p < 0.001) among diabetics.[72] • WHO task shifting program in Nigeria associated with significant reduction of Systolic and diastolic BP.[33] • Task shifting is high on the United Nations Millennium Development Goals' policy agenda.[71] • WHO interested in utilization of scalable task-shifting programs targeted at CVD risk reduction in LMIC.[73]
Nurse-led Risk Reduction	• Nurse-run care systems in SSA based on protocol/education,[32] are feasible with improved glycemic control.[74–76] • Local health system-wide nurse-led program used to follow patients with DM and HTN in South Africa, improved overall early detection and referral of high risk patients. [77]
Group clinics	• Comprise elements of a support group and subspecialty clinic. [78–81] • Associated with improved patient knowledge, [82] increased patient satisfaction, [78,79,83] lower HbA$_{1c}$ levels, [78,82] • Associated with reduction in ED visits, [84] fewer inpatient admissions, [83] reduced utilization, [78] and reduced costs. [83]
Mobile Phone Technology	• Survey conducted in Nigeria showed that two-thirds of DM patients had active mobile phone lines. [37] • DM Patients in an urban, public hospital receiving 2 daily text messages for 6 months showed trends toward improvement in HbA$_{1C}$, quality of life, medication adherence, and decreased ED utilization.[85]. • Phone text message program targeting DM resulted in positive perceptions of the program and positive behavior (diet and physical activity) change.[86] • Multimodal intervention comprising cell phone delivery of lifestyle information, goal setting, health literacy information and navigator coaching had the best results over a 12 month trial, reducing HbA1c by −1.9% vs. −0.7% in the standard care group.[87]
Home tele-monitoring	• Can produce accurate and reliable data, empowers patients, influences their attitudes and behaviors, and potentially improves their medical conditions, [39,88] • Academic partnership in Kenya led to task-shifting strategy plus technology: Android tablet-based electronic Decision Support and Integrated Record-Keeping tool to record patient data and assist with clinical decision-making; approach highly usable.[89]
Multimodal Risk Modification	• Home tele-monitoring more effective when "augmented" with nurse-management.[90] • Targeting multiple CVD risk factors with drugs plus lifestyle counseling may have an additive impact on CVD reduction. [91,92] • Community Outreach and Cardiovascular Health (COACH) Trial in the United States showed that risk factor control implemented by a Nurse and Community Health Worker using drug titration algorithms and tailored behavioral counseling vs. usual care resulted in greater 12-month improvement in control of glycemia, BP and cholesterol.[93]

Strategy	Rationale
	• While obtaining tighter risk factor control at 1 year in COACH resulted in more drug usage and laboratory tests, the mean incremental total cost per patient was only $627.[94] • When compared to the average direct cost of a recurrent stroke of approximately $12,000 in the first year,[95] the intervention in COACH would probably result in a significant cost savings to the healthcare system.

Table 3

Proposed individual study interventions that may enhance outcomes among stroke patients with or at risk of diabetes in Sub-Saharan Africa (SSA)

Intervention	Description
HEADS-UP (Health Educator Advice for Diabetes and Stroke to Upgrade Prognoses)	• Hospital nursing staff will provide patients/caregivers with brief counseling on CVD and glycemic risk factor modification and importance of adherence to the medical regimen on day of hospital discharge using a protocol adapted from published pathways. [96–99] • Patients/caregivers will also receive tailored educational materials on CVD, Pre-DM/DM and a participant handbook.
LINKER (Lay Indigenous Navigator Know-how for Employing Resources)	• Inpatient nurse will introduce the patient during their inpatient stay to a primary lay navigator. • The peers-to-progress navigator model will be used for community navigation. [34–36] • Navigator will provide a series of services to the patient, actively screening for barriers to adherence/access via home visits, communicating through automated SMS text or voice mail messages (based upon patient preference). • Navigator will also provide tailored health education regarding medication adherence, lifestyle modification, and DM/stroke awareness. Techniques used will include motivational interviewing, application of health behavior principles, and practical problem solving. Navigators will interact with primary care doctors/nurse when necessary, and assist patient in obtaining medications.
NUDGES (Nurse Ushered Diabetes Group Encounters after Stroke)	• An initial group clinic session will be 2 weeks post discharge.[100,101] • Group clinics will take place in the outpatient facilities of the participating hospital sites. Six group clinics will be scheduled over the 12 months. • Caregivers who would typically attend a provider visit with the patient will also be invited to the group clinic. Size of each group clinic will be ~10 patients and their caregivers. • After introductions, the NUDGES nurse will lead an interactive seminar. First part will focus on education for treatment of pre-DM and DM, and modifiable CVD risk factors. Patients will then be informed about medication goals, potential adverse effects and how to handle them, as well as practical lifestyle modification strategies. • Second part of the seminar will focus on community resources: stroke and DM support groups, avenues for getting low cost drugs, opportunities to enhance physical activity. Following the interactive educational seminar, there will be a break so patients can mingle with each other, speak one on one to the nurse, etc. There will then be a question and answer session with all participants encouraged to participate since their inquiries will not only benefit themselves but likely the group as a whole. • Following the group clinic, there will be brief one-on-one sessions with the nurses who will review individual home BP readings, medication adherence, side effects, etc. The nurse will follow formal care coordination steps that should be taken if a problem is identified. [73] • Once the patient's CVD risk is determined those at high risk will be referred to the affiliated tertiary hospital for further management. Nurse will initiate the treatment protocol for patients who are at low or medium risk. Importantly, they will enter these points of needed improvement into the main server file. • During subsequent group clinic sessions, there will be a brief review of the educational information from prior sessions, new content provided based on feedback from participants attending prior group clinic sessions, followed by an interactive discussion of participants' efforts, challenges, and successes in implementing medical regimen and lifestyle changes.
MIDAS: (M-health Implementation in Diabetics After Stroke)	• At hospital discharge, patients randomized to IG will receive a home BP monitoring device with tele-monitoring capability and will be instructed and then demonstrate they can follow a 7 minute protocol to take their BP, based upon their designated time window preference (e.g., 6am–8am; for text message/voice mail reminders) in the morning every three days across the 12 months. This protocol had a 90–93% adherence in several other mHealth trials among poor, ethnic minorities.[102,103] • Home BP measurements will be accessed in the memory chip of the devices by patients or caregivers and delivered to providers for review/management during 6 outpatient clinics visits over a period of one year.