Addressing post-stroke care in rural areas with Peru as a Case Study. Placing emphasis on evidence-based pragmatism

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Abbreviations

LMIC: Low and Middle income countries

SMS: Short messaging services

Abstract

Stroke is a major cause of death and disability, with most of its burden now affecting low- and middle-income countries (LMIC). People in rural areas of LMIC who have a stroke receive very little acute stroke care and local healthcare workers and family caregivers in these regions lack the necessary knowledge to assist them. Intriguingly, a recent rapid growth in cell-phone use and digital technology in rural areas has not yet been appropriately exploited for health care training and delivery purposes. What should be done in rural areas, at the community setting-level, where access to healthcare is limited remains a challenge. We review the evidence on improving post-stroke outcomes including lowering the risks of functional disability, stroke recurrence, and mortality, and propose some approaches, to target post-stroke care and rehabilitation, noting key challenges in designing suitable interventions and emphasizing the advantages mHealth and communication technologies can offer. In the article, we present the prevailing stroke care situation and technological opportunities in rural Peru as a case study. As such, by addressing major limitations in rural healthcare systems, we investigate the potential of task-shifting complemented with technology to utilize and strengthen both community-based informal caregivers and community healthcare workers.

Keywords: *Stroke, Task-shifting, mHealth, Implementation Science*

1 Introduction

Stroke affects 62 million people worldwide, 87% of whom live in low-and middle-income countries (LMIC),¹⁻³ imposing major societal and economic burdens.⁴ Each year in the US, about 800,000 people experience a stroke and 220,000 die from it.⁵ Consequently, 24% of survivors are discharged to inpatient rehabilitation facilities.⁶ Stroke costs the US \$34 billion annually, including health care services, medications, and lost productivity.⁵ In Canada, 62,000 people experience a stroke each year and 6,500 stroke survivors access in-patient stroke rehabilitation and stay a median of 30 days.⁷ In contrast, for many LMIC, especially in rural settings, access to appropriate stroke care and rehabilitation are substandard. In LMIC, stroke fatality ranges between 18-35%.^{8,9} For instance, a sub-analysis of the INTERSTROKE study,¹⁰ showed that Peruvian participants with a first-ever stroke had a 21% mortality and a 20% re-stroke rate at one year, and less than 20% of stroke survivors completed a rehabilitation program.^{11,12}

Burden of Stroke and Need for Optimal Post-Stroke Care

Stroke is a leading cause of disability and death, including LMIC countries like Peru.¹²⁻¹⁴ However, while stroke mortality rates have recently decreased due to improved medical treatments, the number of individuals living with the residual effects of stroke is rising.¹⁵ Indeed, currently over 75% of patients survive a first stroke, and among these individuals, 25% are left with a minor disability and 40% experience moderate-to-severe disabilities.¹⁶ Beyond the lingering physical, psychological and social effects of an index stroke, up to 25% of stroke survivors experience recurrent strokes,¹⁷ and the morbidity and mortality after a recurrent stroke is more devastating than that of a primary stroke, with a near doubling of the 30-day fatality rate after a first recurrent stroke compared to a first-ever stroke.¹⁸ As well, in family-oriented societies where significant health expenditure is out-of-pocket, stroke dramatically changes the life not only of the stroke survivors but also of their family caregivers. In addition, for a large number of stroke patients living in rural areas, the care they receive is inadequate and far below evidence-based standards.¹⁹

In Latin America, stroke is the fourth leading cause of years of life lost, and in Peru it ranks fifth:²⁰ there is no national stroke program and only three hospitals have stroke units and thrombolytic therapy.²¹ Stroke is listed as a leading cause of disease burden for national priority setting purposes.²² The consequences of stroke disproportionately affect rural populations where there is a severe shortage of neurologists and rehabilitation specialists, and where those

few who receive rehabilitation are at risk of complications that need specialized care.^{23,24} People living in rural areas are at a great disadvantage compared to urban areas: for example, the urban-rural income ratio is 2.4 in Peru (urban US\$ 362, rural \$150).^{25,26}

Limitations of rural healthcare in developing countries

Most healthcare systems are acute-care oriented, specialist-centered, urban-located, and fragmented, and are thus ill prepared to deal with chronic conditions, especially in LMICs.^{27,28} For the vulnerable population of stroke patients in poorly resourced rural areas, secondary prevention and rehabilitation are largely unavailable and, where present, are far below evidence-based standards.²⁹ To rely on specialists to provide such services is not only unrealistic but also unsustainable, particularly in settings where health systems' are fragmented and heavily focused on providing care for acute and infectious diseases rather than chronic conditions.³⁰ Yet healthcare workers and family caregivers, who live in the same communities as the patients, lack the necessary knowledge, training, and tools to provide at least a basic but appropriate level of care.

Healthcare systems in resource-poor settings are plagued with many barriers to prevention and control of chronic conditions including fragmentation of care, over reliance on healthcare facilities, over burden of specialists in tertiary care, among others. The World Health Organization identifies six main building blocks of healthcare systems: service delivery, information and evidence, medical products and technology, health workforce, health financing, and leadership and governance.³¹

The chronic care model provides a systematic framework with six key elements—community, health system, self-management support, delivery system design, decision support, and clinical information systems—that are critical to effective management of chronic diseases.³² Addressing all six key elements is broadly relevant to most chronic conditions, where fatal and non-fatal outcomes bring a major share of global disability and burden.³³ Focusing on post-stroke care in rural settings highlights multiple challenges given it's role as a major cause of mortality, morbidity, disability, productivity loss, and poverty in LMICs, and because it's a condition encompassing multiple dimensions of health care, each with specific risk factors, associated health conditions, consequences, at various health services and community levels of the healthcare system.

The opportunity of technology and mHealth

Rapid growth in cell-phone use, Internet connectivity, and digital health technology in low-resource countries and regions³⁴ present new opportunities for improvements in healthcare delivery and population-based outcomes,³⁵ including the engagement of frontline healthcare workers and community actors in mHealth-oriented activities.³⁵⁻³⁷ A systematic review aimed to describe approaches to improve mental health in rural areas found that the majority of interventions took advantage of technology in many ways such as telemedicine and videoconferencing in order to help professionals to provide care in remote areas.³⁷

Cell phone usage has also been rising dramatically and reached high levels in many LMIC. Only in the last ten years, cell phone subscriptions (per 100 people) have increased from 20 to 110 in Peru and nearly to 180 in African Countries.³⁸ By 2013, almost 80% of Peruvian households had at least one family member with access to a cell-phone. Interestingly, the largest increase in the 2012-2013 in mobile phone ownership was observed in rural areas.³⁹ Usually the cost of sending short messaging services (SMS) is only charged to those who send it. In terms of planning interventions using such platforms, the evidence suggests that more than 95% of those with a cell phone can receive an SMS and more than 90% know how to read it,⁴⁰ so people generally do not need training. Elderly patients report the daily use of cellphones for calls,⁴¹ and this was noted despite the fact that most participants stated having never used a computer (78%), e-mail (84%), or the Internet (84%).⁴¹ Yet, the majority of this group (70%) had at some time forgotten to take their medicine, 73% would like to be reminded to take their medication, and importantly 68% had a family member who could help them with access to information and communication technologies, signaling opportunities to work with caregivers or family contacts.⁴¹

Interventions using mHealth components, especially those oriented to primary prevention or those addressing behavior change, are complex interventions by nature,⁴²⁻⁴⁴ requiring working together with technology and engineering teams to develop mHealth platforms, as well as health communicators to develop appropriate and culturally-sensitive messages.⁴⁵ A recently published randomized controlled trial to prevent the progression from prehypertension to hypertension was designed to test an mHealth approach, a tailored telephone contact followed by SMS, oriented to modify health behaviors, including weight reduction, and conducted in three Latin American countries. This study was a primordial prevention study where enrolled subjects from poor urban communities had normal levels of blood pressure. The results showed significant dose-

response effects in weight reduction, up to 4.8 kg/m² among those who received 75% or more of the intervention, thereby signaling challenges in the uptake of complex interventions.⁴⁰

In a similar vein, SMS provide both opportunities based on simplicity, reach and costs, yet from a health communications point of view, they also raise the need for context-specific and culturally-acceptable SMS to be tailored to an individual's risk profile and behavioral stages of change. For some, SMS should provide only one concept, use simple and direct language, and be understandable to lay people,⁴⁵ something easier to be said than done.

Whilst technology and mHealth appear as suitable candidates to deploy stroke-related interventions, they require attention in their development. Technical barriers such as Internet connectivity in rural areas are of concern and could be overcome by working with engineering professionals to ensure mHealth tools reach target populations. Besides, assembling and testing the multiple components of a complex intervention for post-stroke care and rehabilitation will require the combination, in many cases, of expertise in behavioral psychology, technology and health communication in addition to clinical medicine and rehabilitation.

Informal caregiving and access to rehabilitation

Taking Peru as a case-study, a nationwide analysis of people living with disabilities showed that 1.6 million Peruvians have a disability, 40% of whom require assistance with daily living activities, and 95% of such assistance is provided by informal caregivers.⁴⁶ An emphasis on the gaps that remain to reach coverage, at least contact coverage, there is a wide disadvantage for rural dwellers in access to rehabilitation services. First, over 95% of people with any disability know about the presence of healthcare and rehabilitation services in urban areas, yet only 43% of them know about the existence of rehabilitation services in rural areas. Second, the utilization of rehabilitation services is low, but even lower among people from rural vs. urban areas, i.e. 10% vs. 28%. Thirdly, and related to the later, 35% of individuals with disabilities in rural settings reported accessibility issues related to transportation, distance to rehabilitation centers and presence of physical barriers in health centers.

Reaching out to stroke survivors and their caregivers, in particular those who do not access healthcare or rehabilitation services is another challenge. A recent study focused on approaching those serving as a caregiver of a stroke survivor, the stroke event occurred at least 6 months prior to the study, had received medical attention for the acute episode within the public health system, and required assistance to perform daily activities as a result of the stroke.

Of the 67 potential caregivers contacted, 23 were eligible, yet only 15 were finally interviewed.⁴⁷ This experience suggests substantial challenges in reaching those stroke survivors and its caregivers who are in most need.

The experiences of informal caregivers of stroke survivors in a context where the health system does not provide them any training, financial support and mental health services indicate major burdens.⁴⁷ Major burdens include emotional distress as a consequence of their relative's disabled condition, the need to see a professional to improve their mental health; and, the need to receive more information about how to take care of someone who suffered a stroke.⁴⁷

Ongoing studies in stroke care in underserved populations

In high income settings, mobile health apps with educational content on stroke symptoms have been utilized to assist the lay public and healthcare providers to identify stroke, prompt emergency responses and promote risk assessment for timely recognition and treatment of stroke thus helping overcome delays in health seeking after stroke which is a prime barrier to optimal management of acute stroke.⁴⁸⁻⁵⁰

In resource-replete and rural settings, telemedicine based interventions, adapted to an mHealth based platform expedited access to safe and efficacious thrombolytic therapy with improved outcomes for ischemic stroke.⁵¹⁻⁵³ The aforementioned data notwithstanding, it should be mentioned that despite the rapid growth of mobile health applications, there are still relatively few culturally-appropriate and sustainable stroke-specific apps⁵⁴ and the overwhelming majority of published studies have focused on the pre-stroke or ultra-early stroke (within hours of onset) periods, not the post-stroke period (days, weeks, months after onset), the latter of which is the much more common presentation scenario in rural settings of LMIC. Enhancing post-stroke outcomes by optimizing secondary preventive care and rehabilitation via culturally-relevant mHealth interventions will likely be the most viable strategy for greatly reducing the burden of stroke in rural areas of LMIC. A recent systematic review and meta-analysis of randomized control clinical trials that evaluated the effect of mHealth on major stroke risk factors found that of 79 studies identified, 13 of them met eligibility criteria (Ovbiagele B, personal communication). Authors concluded that mHealth improved glycemic control and smoking abstinence rates, two factors that may lead to better stroke outcomes, but that there is a need for mHealth to be tested in modifying other premier risk factors for stroke including hypertension (Ovbiagele B, personal communication).

An ongoing study looking at the use of mHealth to improve hypertension control after stroke is

the Phone-based Interventions under Nurse Guidance after stroke study (PINGS).^{55,56} PINGS is a pilot randomized controlled trial that seeks to show that a theoretical-model-based, mHealth technology-centered, multi-level integrated approach is effective in improving sustained blood pressure control among 60 recent Ghanaian stroke patients within one month of symptom onset. Blood pressure readings and medication adherence data are sent remotely to nurses by patients who will receive feedback motivational messages delivered by text messages based on levels of blood pressure control and adherence to therapy with targeted interventions coordinated by the nurse under a physician supervision in the intervention arm. A feasible and preliminarily effective PING intervention could lead to a larger more definitive efficacy/effectiveness RCT powered to look at clinical events.^{55,56}

Moving forward: Post-stroke care and rehabilitation in underserved rural areas

Emphasis on pragmatism

Working on post-stroke care and rehabilitation with underserved populations and in rural areas requires addressing currently non-existent but much-needed practical tools and interventions at the community level, including task shifting. A myriad of interventions could be proposed, yet the absorptive capacity of rural areas, in other words the likelihood of implementing them, will be minimal given current shortcomings in various aspects. LMIC cannot afford to replicate the existing infrastructure of health systems in high-income settings, thus providing an opportunity for leapfrogging.³⁰ Any intervention to be developed in post-stroke care should place emphasis on its pragmatism and its emphasis on external validity⁵⁷ by developing and introducing simple and feasible ways to bring evidence-based post-stroke management, including preventive secondary care and rehabilitation, to rural areas traditionally underrepresented in research.

The potential of incorporating a technology-driven tool that facilitates integration across different tiers of healthcare facilities and the community is substantial. As such, the strategy may be exported as a feasible and highly cost-efficient model of healthcare worker and caregiver involvement rehabilitation that minimizes costs and can be provided in community settings, much needed to ensure high-quality care for underserved areas, as well as for other chronic diseases. In so doing, this opens an ideal opportunity to train LMIC-based scientists and international peers on hands-on approaches towards implementation science, with major exposures to this discipline early in their career development.⁵⁸⁻⁶²

Evidence-based stroke rehabilitation

After the occurrence of a stroke, multiple actions are deployed to provide acute care, prevent medical complications, implement rehabilitation, and prevent stroke recurrence.⁶³ Multiple guidelines and reports show a strong body of evidence supporting activities to reduce mortality, to improve functionality, and to prevent recurrence of stroke.^{7,22,63-66} Among literature, stroke rehabilitation is oriented to restoring the functions lost due to stroke—mobility, language, dysphagia, and occupational skills—and is one of the main dimensions of stroke care. Early rehabilitation has proven to be effective at reducing mortality and improving function in daily life activities following an acute stroke.⁶³ Community-based rehabilitation for stroke patients includes efforts to deliver rehabilitation to remote areas, including task-shifting activities, adaptation of tools for rehabilitation, monitoring of stroke evolution, and group activities.⁶³

As important as is stroke rehabilitation, it also represents a big challenge when it comes to its implementation and testing. A major review highlighted that “*stroke rehabilitation presents specific challenges for research and for the application of evidence-based practice [...] interventions tend to be complex and contain several interrelated components [and] treatments might target several different problems from relieving very specific impairments to improving activity and participation. Interventions can occur at different points on a continuum of complexity ranging between highly complex treatments and specific treatments.*”²⁶

Evidence-based home-based stroke rehabilitation

Home-based rehabilitation care is efficacious at preventing deterioration and improving ability to undertake daily life activities,⁶⁷ and rehabilitation at home also accelerates discharge without affecting health outcomes in stroke patients.⁶⁸ A minimum package of evidence-based home-based interventions could be pursued focusing on:

i) *Sub-acute stage of stroke*: After patient discharge, early mobilization provided by physiotherapist or nurses has proved to decrease mortality rates.⁶⁹⁻⁷¹ To date, no consensus about dose of mobilization has been achieved. Whilst the AVERT trial concludes that high doses of very early mobilization, within 24 hrs of stroke onset, could be harmful for stroke patients,⁷² this does not preclude initiating the involvement of caregivers and primary health care workers in learning about the importance and types of mobilization.

ii) *Chronic stage of stroke*: After 3 months of the index stroke, the objective is to recover basic motor functions to increase independence in patients.⁷³ The task-specific approach has a level

A of evidence as it pragmatically combines problem-solving activities with daily life activities and physical exercises, and has proven to be effective in recovery of gait skills and trunk stability,^{74,75} but there is conflicting evidence about the recovery of arm functions.⁷⁶

iii) For both sub-acute and chronic stages, intensive training is recommended to condition disused muscles, foster function recovery and to prevent problems related to immobility such as deterioration, risk of fractures, recurrent stroke, or premature mortality.⁷⁷

A home-based oriented rehabilitation requires not only the involvement of physical therapists or healthcare providers, but also the direct participation of caregivers.

Evidence-based secondary prevention

Acknowledging that not all health services are available in rural settings, a minimum package of evidence-based secondary preventive care interventions is warranted. This shall include the identification of acute symptoms signaling occurrence of stroke or complications, identification and avoidance of risk conditions and actions, use of evidence-based affordable and available medications and fostering adequate social involvement.⁷⁸⁻⁸¹ Systolic blood pressure is the single most important modifiable risk factor for stroke recurrence and is also sensitive to improvement in lifestyle and anti-hypertensive care.⁸² Reduction of high systolic blood pressure is a recommended therapeutic target beyond the acute phase for all stroke survivors to prevent recurrent stroke, regardless of type, timing, or severity of stroke. Expert consensus guidelines recommend that secondary preventive therapies and rehabilitation after stroke should be started soon after onset of symptoms and adhered to persistently to reduce risk of recurrent strokes, as well as facilitate re-integration of stroke survivors back into the society.⁸²

Emphasis on implementation science

Addressing post-stroke care in rural areas will require engagement of policy makers and other stakeholders.⁶⁰ The identification of potential facilitators and barriers not only for developing suitable interventions, but also for is implementation, is also needed.⁸³ Ensuring sufficient expertise within existing research teams in conducting mixed-methods studies and developing complex interventions will be crucial, including familiarity with hybrid effectiveness-implementation designs.⁵⁹ Implementation outcomes such as acceptability, adoption, appropriateness, feasibility, fidelity and costs, as well as sustainability will be important to be defined and captured.^{61,62} It is anticipated that *“hybrid studies require more research expertise and personnel, and larger budgets, than non-hybrid designs.”*⁵⁹ This tradeoff considers

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251 anticipated benefits by testing in real-world situations what works and for whom.^{61,83-85}

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Anticipating challenges in designing future studies

Context matters

Understanding context and needs for the implementation of adequate, sustainable, appropriate, evidence-based responses to stroke care in rural settings matters. Studies of barriers and facilitators using rapid assessment tools to gauge the readiness of existing care systems would be informative. This type of studies could enhance our understanding of provider and user current ongoing practices and views in relation to secondary prevention, adherence to medication, accessibility to rehabilitation services, and views about home-based rehabilitation including the training required. The assessment of current service delivery infrastructures, how they work and what are their most and least appreciated features, from the point of view of patient and caregivers are important. As guidance, among several other tools, the WHO's Six Building Blocks framework⁸⁶ could be used as an analytical framework for its simple and universal approach to health system assessment.⁸⁷ The framework describes each health system through the following components: a) information; b) leadership and governance; c) financing; d) health workforce; e) service delivery; f) medical products, vaccines and technologies. Each of these components includes relevant topics about health system performance.

User-centered designs

The implementation of post-stroke care in rural settings requires a strong evidence-based approach paired with engagement with its end-users. Implementation strategies amenable to the introduction of task shifting and community-oriented components may be needed. In so doing, a user-centered design focusing on the adaptation of materials for training and the development of technology including usability testing are needed.

Co-design workshops organized with PHWs, nurses, caregivers, and patients will help to obtain their input on the design of the various components of a potential intervention. There is a plethora of stroke-related materials to use,^{78-81,88-90} which will need refining, simplification, and integration with ease for its users, potentially patients, caregivers and community healthcare workers. Technology will be key in the creation or adaptation of algorithms that contain both knowledge and decision support, and can be paired with capacities to collect patient data for monitoring and performance evaluation. Usability evaluation techniques and tools, see for example <http://www.usability.gov/>, will also be needed to guarantee end-user's engagement.

Worth mentioning, communities' inherent beliefs about health will have to be identified and understood as they may prevent people to accept different care from what they are accustomed. An ethnographic study conducted in rural Dominican Republic reported that inhabitant's cultural habits and beliefs gave equal significance to both folk and professional care.⁹¹

Targeting incident vs. prevalent stroke cases

In rural areas, investigators should be aware of the tension in addressing incident vs. prevalent stroke cases. The effect of the intervention is likely to be larger among new patients than prevalent cases. The risk of recurrent stroke is highest during the first 90 days after an index stroke and longitudinal studies indicate that approximately 1 out of every 2 recurrences occurring in the first year occurs within the first 90 days.⁹² While focusing on newly onset stroke has the advantage of achieving larger effect sizes from the intervention, from a pragmatic implementation research perspective, it will ignore a much larger number of patients with an existing stroke.

Targeting stroke subtypes

The neurology literature describes differential recoveries according to the type of stroke, being less favorable in hemorrhagic strokes.⁹³⁻⁹⁵ But this dichotomy is also observed in various scenarios within the stroke field —the same differential outcome is observed within ischemic stroke subtypes, e.g. small vessel has better outcome than large vessel or cardioembolic strokes, younger patients have better outcomes than older patients, stroke patients with diabetes have worse outcomes than those without diabetes, etc. In reality, most rural communities do not have access to neurologists to address such detailed triaging and decision-making. Placing an emphasis on pragmatism, and on the provision of simple evidence-based recommendations could guarantee access to some rehabilitation to and post-stroke care to all stroke cases.

When to start? It is never too late

Many barriers exist for the provision of acute stroke care, and more so in rural areas. The AVERT trial showed no marked differences with the introduction of very early mobilization in hospitals,⁷² providing an opportunity to initiate some rehabilitation. Challenges also remain in many high-income settings where many patients do not receive a prescription for a statin or blood-pressure-lowering drug at one-month after the index stroke case⁹⁶⁻⁹⁹ despite their demonstrated benefit.^{96,100} This period has the additional advantage of accommodating to the

new household structures, including the identification of those who will assume on a caregiving role.

Conclusions

As noted, stroke often has an adverse impact on patient dexterity, communication, and cognition which serves as a barrier to ready self-adherence to evidence-based post-stroke secondary preventive care and rehabilitation. This situation is further compounded in LMIC, especially the rural areas of these countries, where local healthcare workers and family caregivers lack the necessary knowledge, training, and tools to provide optimal stroke care to stroke survivors. Fortunately, the rapid growth in cell-phone use, Internet connectivity, and digital health technology in rural areas of LMIC, might be appropriately exploited for health care training and delivery purposes, to improve post-stroke outcomes in these regions. Expert consensus guidelines recommend that secondary preventive therapies and rehabilitation after stroke should be started soon after onset of symptoms and adhered to persistently to reduce risk of recurrent strokes, as well as facilitate re-integration of stroke survivors back into the society.⁸² The achievement of these goals depends on a coordinated and multi-disciplinary team effort involving several health professionals and the stroke patient/caregiver, which might best be coordinated using mHealth approaches and immediate stakeholders like caregivers. Careful patient selection, focused culturally-appropriate mHealth interventions, and accommodation for practicality, targeting key aspects of the post-stroke care continuum, should allow for greater availability and accessibility to, and sustainability of evidence-based stroke care in these highly stroke burdened areas.

Before mHealth interventions can gain widespread integration and sustained application in routine stroke care, some key issues need to be resolved. For example, it is not clear which specific aspects of stroke care that mHealth offer would produce the most profound benefits for patients/caregivers and healthcare providers. Resolving this key question will necessitate the conduct of several studies aimed at assessing targeted components of post-stroke care to derive high-level evidence-based data to inform policy adoption. It is expected that App developers would need to work closely and responsively with stroke patients, healthcare providers, system administrators, public health personnel, and researchers to fine tune interventions to 1) be adaptable in various residential and cultural settings; and 2) be screened by regulatory bodies to prevent unintended occurrences such as incorrect information and medical errors. These approaches would be in accord with expert recommendations on the use

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of mobile devices, social media and crowdsourcing as digital strategies to improve care of
individuals with vascular disease.¹⁰¹

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