Redesigning Community-Based Hearing Healthcare: Implementation of mHealth & Tele-audiology Technology in Africa

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INTRODUCTION

Continental surveys conducted by ENT specialists based in Africa during 2009 and 2015 have confirmed that access to ENT, audiology or speech therapy services is either non-existent or severely lacking in the majority of African countries (Fagan & Jacobs, 2009; Malwafu, Ensink, Kuper & Fagan, 2015). In 2009 it was estimated that Africa has a shortfall of at least 20 000 audiologists. Task-shifting of some ENT and audiology services to primary- and middle-level health workers is required. There are currently no official global standards for establishing locally relevant strategies to combat ear and hearing disorders in poor resource settings (Mulwafu, Thindwa, Prescott & Elliot, 2017). Furthermore, there is no system in place to control what methods are implemented by individuals and organisations who set up humanitarian hearing healthcare projects in Africa.

Audiologists who are faced with the sheer scale of hearing loss and the stark reality of working in low resource regions of Africa are looking towards the solutions proposed by the developers of cutting edge mobile health (mHealth) and tele-audiology technology. As mobile phone penetration escalates in Africa & internet connectivity improves, mobile hearing healthcare services have the ability to evolve from high cost, maintenance-intensive physical vehicular mobile clinics to new remote models which can benefit from lower costs, increased scale & further reach. The disruptive technology that is making this possible includes mHealth screening applications (which can be conducted by non-audiologists), remote diagnostic audiology assessments, remote hearing aid fittings (with real ear measurements), as well as remote training/staff supervision (using eLearning) & project monitoring.

The potential impact of mHealth for hearing screening, especially to provide access for underserved populations using decentralised community-based models, is clear (Swanepoel, 2017). However, the screening component is only the first step and should start the pathway of care through to diagnostic and intervention services. With this in mind, HearInAfrica has embarked on a number of pioneering projects to explore the possibilities available to audiologists who wish to set up and manage comprehensive community-based hearing healthcare projects across a variety of contexts in Africa.
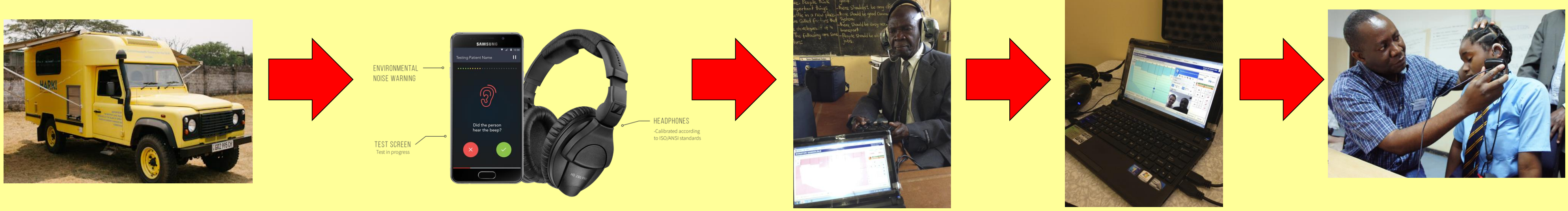
## ZAMBIA: SOUND SEEKERS TELE-AUDIOLOGY PROJECT, NDOLA CENTRAL HOSPITAL (2014 – 2016)

AIM: To introduce a tele-audiology program in Ndola for patients with hearing loss to access improved audiology services and for audiology staff to access improved supervision & distance learning from qualified audiologists in Zambia, South Africa and beyond.

STAFF: 2 qualified audiologists (based in Cape Town, South Africa and Lusaka, Zambia), 2 ENT nurses & 2 ENT clinical officers (based in Ndola, Zambia). Non-audiologists trained by Sound Seekers audiologists in basic audiometry, impression taking, earmould manufacturing and facilitation of tele-audiology clinic.

HARDWARE, SOFTWARE & CONNECTIVITY: 3G mobile data, TeamViewer, Skype, Whatsapp, eMoyo KUDUWave audiometer (developed by eMoyo in South Africa), portable webcam, NOAH, NOAH Link, GN Resound Aurical.

SUCCESSFUL CLINICAL OUTCOMES:
- ✓ Remote diagnostic assessments
- ✓ Remote hearing aid programming (Phonak Baseo BTEs & custom earmoulds)
- ✓ Remote real ear measurements
- ✓ Remote staff training, supervision and continued professional development
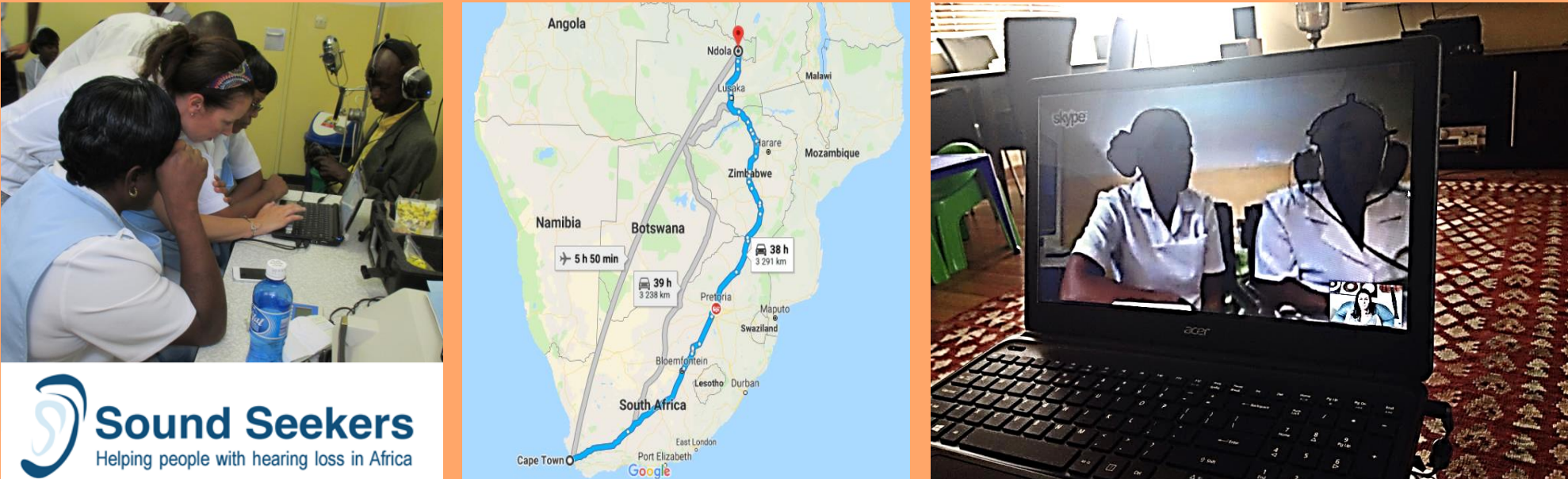
CHALLENGES: Inconsistency of internet connectivity; cost and control of data; staff changes & sick leave; inability to source audiology equipment & consumables locally (i.e. downtime when waiting for customs clearance and delivery of basic consumables [such as impression material & hearing aid tubing] from other countries); distance and cost of travelling to site when tele-audiology service was down; lack of local IT and telecommunication experts to assist with connectivity; implementation of accurate record keeping and administration of patient/clinic logistics.

LESSONS LEARNED: Work with telecommunications specialists & local network providers to confirm feasibility. Establish good & consistent connectivity before anything else. Ensure that suppliers of relevant audiology equipment & hearing aids are made aware of the project & are able to assist with on-site/remote installations, calibrations, software updates & training. Evaluate computer skills of staff before selecting tele-audiology facilitators at local site. Establish clear & enforceable rules/regulations with staff re. use of internet data. Consult with other NGOs to reduce overlap & improve collaborative efforts in order to reduce patient confusion & maintain good relations with local officials. Ensure that staff training includes improvement of computer skills where necessary. Ensure that the administrative requirements of project are clearly understood & implemented (e.g. clinical data collection, accurate stock records of batteries/hearing aids/consumables, time sheets, waiting lists, work done outside of tele-audiology clinics, etc).

SOUTH AFRICA: IMPLEMENTATION OF HEARSCREEN FOR SCHOOLS & HOME-BASED PROJECTS (2015 – 2018)

HearScreen and hearScope, both developed by the hearX Group in South Africa, are mHealth applications that can be used at scale to screen for ear and hearing disorders. HearScreen has specific applications to school-based programs and has been shown to cut traditional screening costs by 50–70%. This equipment has been implemented by HearInAfrica since 2015 to conduct a variety of community-based hearing projects. A variety of clinical protocols have been tested to allow for the development of a service delivery model which could be used in a range of contexts across Africa and other low-resourced areas.

METHOD: HearInAfrica collaborated with various NGOs, schools and private organisations to conduct a number of screening projects. Protocols were adapted to the needs and ages of the groups, but typically involved bilateral ear examinations (by an audiologist or nurse), followed by a hearScreen test (by a non-audiologist). Patients who failed the hearScreen test have been managed by HearInAfrica and various other professionals. Follow-up of all cases is being conducted by HearInAfrica.

RESULTS: Please refer to Table 1 below.

MALAWI: SOUND SEEKERS FEASIBILITY STUDY OF THE USE OF HEARSCREEN FOR SCHOOL SCREENING (2017)

Hearing loss is the most common type (23%) of disability in children under 18 years of age in Malawi. Sound Seekers recruited HearInAfrica to conduct a feasibility study of the use of hearScreen and hearScope for the purposes of a primary school hearing healthcare program.

METHOD: 2 audiology clinical officers performed bilateral ear examinations and hearScreen tests on 122 Grade 1 children at a primary school in Blantyre over a 2 day period. All testing was supervised by 2 audiologists. A same-day test-treat-retest protocol was tested. This involved the provision of immediate on-site primary ear treatments & a repeat hearScreen test thereafter. A beta version of hearScope was tested for pre- & post-treatment ear examinations as well as staff training on wax removals.

RESULTS: 13% failed the ear examination and were treated on site. 8% failed the hearScreen test – 40% of these cases had their hearing losses reversed on site. The remaining 60% were referred to the centralised audiology clinic in Blantyre for further investigation.

CONCLUSION: The use of hearScreen for primary school screening in Malawi is feasible. The test-treat-retest protocol is recommended. The use of hearScope is potentially feasible, particulary for training staff on effective ear wax removals, but this equipment was still in its development phase & later models need to be tested before implementation is considered.

CONCLUSIONS & SOLUTIONS: THE BUTTERFLY EFFECT

The need for improved and creative hearing healthcare services across Africa has reached a critical point. The findings, observations & experiences that have emerged from the projects discussed herein indicate that despite a variety of challenges, the implementation of mHealth and tele-audiology applications in Africa is feasible & effective. HearInAfrica has developed a unique model of comprehensive community service delivery termed **The HearInAfrica Model of Hearing Transformation'** which makes use of a combination of conventional, mHealth & tele-audiology methods.

The details of the screening phase of this model are now complete. Once screening is complete and results have been analysed, managers/teachers/ parents are provided with feedback using a simple ABC method: A = ALL OK (the [black] "ants"), B = BEWARE (the [yellow] "bees"), C = CARE REQUIRED (the "caterpillars", of which there are two types: red and orange). All further project management (including primary ear care, diagnostic audiology, specialist ENT care and fitting of hearing aids) is then planned and executed according to this model.

In response to the WHO's call for action, HearInAfrica is committed to the implementation of comprehensive, high quality, effective and sustainable community-based hearing healthcare programs. These will be accompanied by relevant & impactful community awareness & social media campaigns regarding healthy ear care & the signs of hearing loss.

SCREENING RESULTS	TOTAL TESTED (1 023)	FAILURE RATE	
		EAR EXAM (205)	HEAR SCREEN (129)
CAPE TOWN FOSTER HOMES	92 (but only 79 had hearScreen)	32 (35%)	17 (22%)
CAPE TOWN PRIMARY SCHOOLS (GRADES R – 5)	614	143 (23%)	68 (11%)
CAPE TOWN PRE-SCHOOLS (GRADE R)	90	DNE	8 (7%)
ROTARY & AMAZING GRACE PROJECT (GRADES 1 – 3)	49	14 (29%)	7 (14%)
SOUND SEEKERS FEASIBILITY STUDY MALAWI (GRADE 1)	122	16 (13%)	10 (8%)
CORPORATE WELLNESS DAY (ADULTS)	29	DNE	2 (7%)
RETIREMENT VILLAGE (ADULTS OVER 60)	27	DNE	17 (63%)

Table 1: Clinical data from community-based screening projects conducted by HearInAfrica between 2015 and 2018

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