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Implementation of a Telemedicine Network in Angola: Challenges and Opportunities

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Abstract
Background: The Angolan Ministry of Health is prioritizing the strengthening of the national health system at the district level. To attain this objective, the Angolan Ministry of Health decided to develop a national telemedicine network in partnership with the Geneva University Hospitals (HUG) and the Portuguese Institute of Hygiene and Tropical Medicine (IHMT).
Methods: Telemedicine units were created in strategic locations to enable distance education and tele-expertise activities, using software developed by HUG adapted to local conditions. Selected participants in each site were trained with regards to the use of the tools. A survey using questionnaires distributed to all participants was conducted to evaluate user satisfaction and the impact of the tools. Data were analysed using a descriptive statistical model. Additionally, two working groups were held to discuss difficulties and find appropriate solutions.
Results: Seven telemedicine units were established, and 107 health professionals were trained. Regarding distance education activities, over 70 courses were designed and webcast, and 95.6% of participants answered our survey showing a high level of overall satisfaction. Uptake of tele-expertise activities was poor. Only 3 cases were discussed, and 4.7% of participants answered the survey. This was explained by low levels of computer literacy and motivation among the participants. The lack of a legislative framework and internet access in some places also played a role. Financial constraints halted the process of extension of the network to additional sites.
Conclusion: More research is needed to assess the impact of the network, to understand how to scale-up to other sites, and to conduct a cost-benefit analysis to justify the pursuit of the investments.

Key words: Telemedicine, eHealth, low- and middle-income countries, Africa, telemedicine network

1. INTRODUCTION

During the 27-year long armed conflict in Angola (from 1975 to 2002), most essential services such as health care suffered a near collapse, in most part due to the lack of resources caused by the financial burdens of the war effort, and many doctors fleeing the country, among other constraints [1, 2]. Angola is a large country, spread over 1 246 700 km², thus requiring the proper development of healthcare services to address the needs of a mostly poor population. Even now, 15 years since the end of the civil war, limited healthcare coverage and insufficient human resources continue to be the major challenges that the Angolan

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healthcare system has to face [1,3–6]. As such, in its rebuilding and restructuring effort, the government has placed a great deal of importance on strengthening the health sector by committing a significant part of the national budget towards rebuilding health services and finding staff for medical centres and hospitals, e.g., establishing new medical schools [3,7]

In this context, in 2006, the Angolan Ministry of Health (MoH) started a new project entitled "Municipal Health Service Strengthening Project (MHSS)"[8]. Since then, the project has been conducted in collaboration with UNICEF, WHO, UNFPA and the USAID and is supported by the World Bank and Total E&P Angola. It was designed as an intervention to support the decentralization of care from the provincial to the municipal (i.e., district) level and to shift more resources to the primary health care system, with a focus on obstetrical emergencies and neonatal care.

To help attain this objective, the MoH was convinced of the potential of telemedicine, in other words, the delivery of health care services using information and communication technologies [9]. Indeed, telemedicine is increasingly used to improve quality and access to healthcare in Low and Middle Income Countries (LMICs) with good results [10–14]. Therefore, it was decided to implement a pilot project of a national telemedicine network in Angola. The objective of our study is to demonstrate the technical and organizational feasibility of deploying distance education and tele-expertise (e.g., second opinions) tools in selected hospitals in Angola.

2. METHODS

2.1 Partnership development

One of the strategic lines of The National Health Policy consists of strengthening partnerships to provide better health care [3]. Recognizing the importance of forging these strategic partnerships to facilitate the process of implementation of the telemedicine network in Angola, the MoH adopted a partnership with the Geneva University Hospitals (HUG). For over a decade, the HUG accumulated significant experience and knowledge in the field through the development of the RAFT telemedicine network, currently deployed in 18 African countries and connecting hundreds of health professionals [12,13]. The HUG is recognized as a collaborating centre for eHealth and telemedicine by the World Health Organization and aims to "de-isolate" health professionals working in remote areas by providing the following:

- access to distance continuing medical education,

- the possibility to seek the opinion of experts in complex clinical case management,
- the use of specialized diagnostic tools (e.g., ultrasound and ECG) with remote supervision of experts.

Another strategic partnership was developed with the Institute of Hygiene and Tropical Medicine (IHMT) of the Lisbon New University in Portugal, a WHO Collaborating Center for Health Workforce Policy and Planning, with a strong expertise in healthcare services implementation and the commitment to develop health systems in Portuguese-speaking countries. The aim of this partnership was to overcome any linguistic barriers and contribute to strengthening the network with specialists who can provide distance training and clinical assistance (Figure 1).

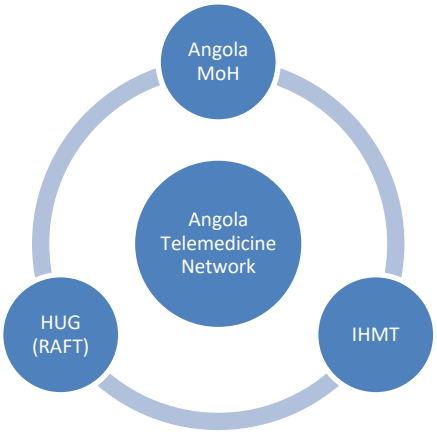

Figure 1: Partnerships for the implementation of the Angolan Telemedicine Network

2.2 Implementation strategy

The implementation of the telemedicine network began in 2014 and was carried out in 6 steps (Figure 2):

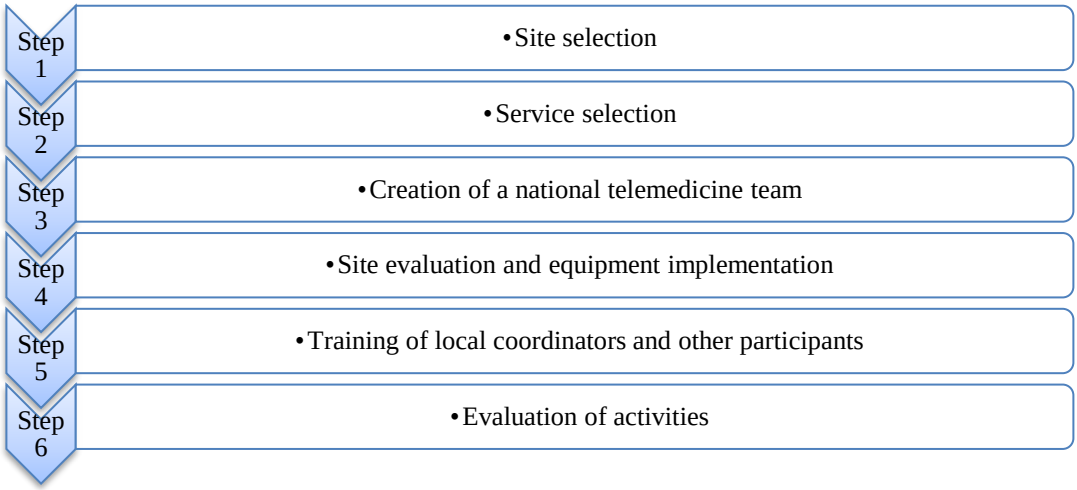

Figure 2: Pilot project design

The first step was the proper selection of sites. To identify the most suitable hospitals for the project, analyses and discussions were conducted by members of the MHSS project and several provincial directors of health. These considered several key aspects of the health facilities such as the level of remoteness or isolation, the capacity for the integration of communication technologies in the management of patients, the capacity to connect to the Internet and whether there was a sufficient amount of activity for potential efficiency gains in terms of organization of care.

The second step was to decide the typology of services to be deployed at these sites. In alignment with the objectives of the MHSS project, it was decided to focus on both distance education and tele-expertise using software created by HUG [12]:

- Dudal: distance education software created for the RAFT network, specifically developed and tuned to function over low-bandwidth connections.
- Bogou: tele-expertise software that enables experts to collaborate remotely to solve patient-specific problems (diagnostic support, second medical opinions, deciding and planning the medical evacuation of a patient) in an asynchronous or store-and-forward mode, which involves the exchange of pre-recorded data between the users at different times.

The third step was the establishment of a national telemedicine team to ensure optimal coordination across the different selected sites. The team is composed of the following members:

- *A national focal* point whose mission is to supervise the national coordination team and to connect the HUG and IHMT with governmental authorities to ensure adequate institutional anchoring.
- *A national medical coordinator* whose mission is to provide day-to-day coordination of the project and link with healthcare facilities and healthcare professionals at the local level.
- *A national technical coordinator* whose mission is to provide technical support for the project.
- *Local site coordinators* whose missions are to serve as the operational contact points for activities in each given healthcare facility.

The fourth step was the proper evaluation of each site regarding the technical requirements. A field trip to each site was carried out by the national telemedicine team to collect the data and meet with the hospital direction and staff to determine the technical and

organizational needs at each site. Each site was then equipped accordingly with the necessary material.

The fifth step was the training of the local coordinators in the use of the different tools, who would then train and provide support to other selected members in their respective sites (cf. 2.3 Population and sample size). These training sessions were organized at each site by the technical coordinator at a subsequent site visit for two days.

The sixth and final step was the evaluation of activities carried out during the project (cf. 2.4 Data collection and analysis).

2.3 Population

The selection of participants to be trained in the use of the telemedicine tools was decided jointly between the national coordination team and the local coordinators considering criteria such as expertise, proficiency in informatics and motivation to participate. A total of 107 participants received the training. Details regarding the number and characteristics of participants in each site are described in Table 1.

Hospital	**Number of participants**	**Participant characteristics**
Amercio Boavida Hospital	13	General Director of the hospital, Clinical Director, Head of Dermatology and 6 dermatologists, Head of the Intensive Care Unit, Head of Surgery, 2 Nurses.
David Bernardino Pediatric hospital	3	Clinical director, Head of Cardiology, Head of Surgery
Provincial hospital of Bengo	7	General director of the hospital, Clinical Director, Head of Internal Medicine, 3 General Physicians, 1 Nurse
Provincial hospital of Malanje	26	Clinical director, Head of Internal Medicine, 8 General physicians, 3 Gynaecologists, 5 Dermatologists, 2 General surgeons, 6 Nurses
Lunda-Sul Provincial Hospital	12	Clinical director, 9 General physicians, 2 Nurses
Bié Provincial Hospital	34	Clinical director, Head of Internal Medicine, 12 General physicians, 5 Gynaecologists, 4 General surgeons, 11 Nurses
Cabinda Provincial Hospital	12	General Director, Clinical director, 6 General Physicians, 1 Ophthalmologist, 3 Nurses

Table 1: Number of participants and characteristics according to each site

The courses webcast on the network were designed for all healthcare staff working in the selected hospitals. The course content was purposefully varied in nature to target different audiences such as nurses, undergraduate students and post-graduate physicians. To stimulate attendance by a maximum number of participants, great efforts were made to publicize the dates and times of the courses using flyers, group emails and reminders during staff meetings. Public viewing sessions were organized for those who were not trained in the use of the education platform Dudal.

2.4 Data collection and analysis

Structured journals of activities (logbooks) and questionnaires were developed to record and analyse activity carried out during the project. They were developed and validated by the national coordination team, then distributed to the local coordinators who were instructed on their proper use. The following questionnaires were developed:

- Questionnaires to assess the usability of each software (distance education and tele-expertise). These were completed once by all participants after the first use of the programmes.
- Questionnaire to evaluate the degree of subjective utility and satisfaction of the educational sessions. This was completed by users after each viewing of an educational session.
- Questionnaire to measure the clinical impact of the tele-expertise platform. This was completed by the author of the case discussed after its resolution.

The rating scale used in the questionnaires was designed as a four-point Likert scale (to avoid a neutral response option and force a specific response) with the following response options: strongly agree, partially agree, partially disagree, and strongly disagree.
Each user of the network received the appropriate questionnaire and instructions from the local coordinator. Data were analysed using a descriptive statistical model.

3. RESULTS

3.1 Sites

A total of 7 sites were selected: 2 reference hospitals in the capital (tertiary-level hospitals responsible for providing clinical assistance and distance education), the Americo Boavida Hospital (ABH) and the Pediatric Hospital David Bernardino, and 5 peripheral hospitals, the provincial hospitals of Cabinda, Bengo, Malanje, Lunda-Sul and Bié (Figure 3).

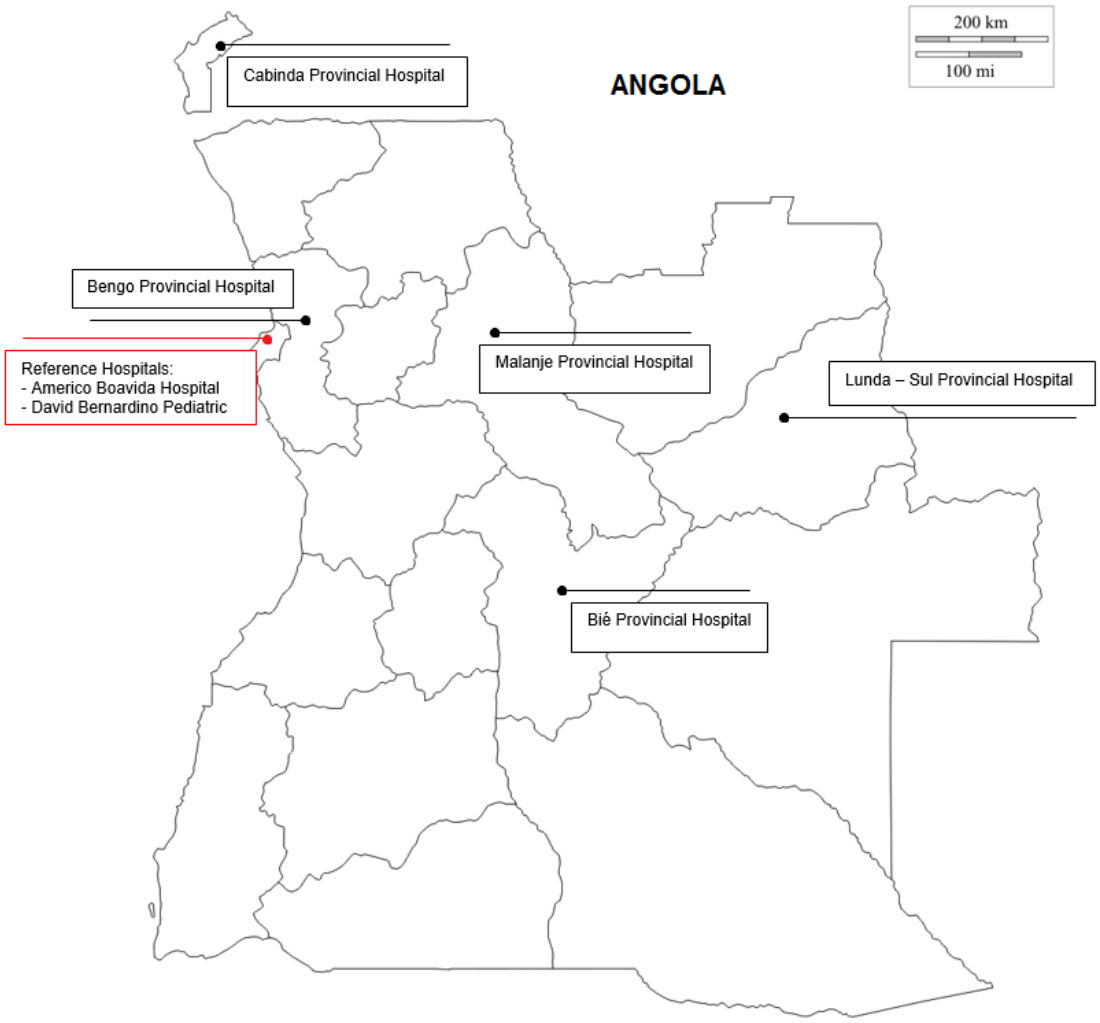

Figure 3: Selected Hospitals for the pilot project

3.2 Overall activity

To date, over 70 courses have been successfully webcast, covering a variety of different subjects (e.g., internal medicine, paediatrics, neurology, infectious diseases, patient safety), designated not only for doctors but also for nurses and health technicians. Most courses were webcast in Angola by the ABH, but seven courses have been webcast from Portugal and viewed by the Angolan partners. These courses were often launched on Wednesdays in order to create a routine. All courses are still available on the RAFT website (http://raft.g2hp.net/). However, a lack of utilization of the tele-expertise platform was identified, with only 3 clinical cases discussed.

With the aim of promoting the partnership and enlarging the telemedicine network to other health professionals, a set of seminars for the broader presentation of the Telemedicine project was held in Portugal (Lisbon, Coimbra and Porto). The different seminars had the

presence and contribution of a panel of professionals and experts in health care in Portugal and allowed the establishment of good contacts with family doctors, nurses and tropical medicine physicians working in Portugal who had expressed their will to join the network to create courses and give their clinical expertise.

3.3 Evaluation of activities

3.3.1 Distance education activities

From the 91 participants who viewed a presentation, all received a questionnaire, and 87 (95.6%) answered it. The results show that users considered the content of the webcast courses to be directly applicable (93.1%) and that this will positively impact the quality of their work (94.3%). The presentations were interactive, with a majority (85%) of users able to obtain answers to their questions. Users expressed a high level of motivation to attend the sessions (89.6%), and they expressed their intent to attend another presentation (95.4%). Overall satisfaction was very high (93.1%). The detailed results are included in Figure 4.

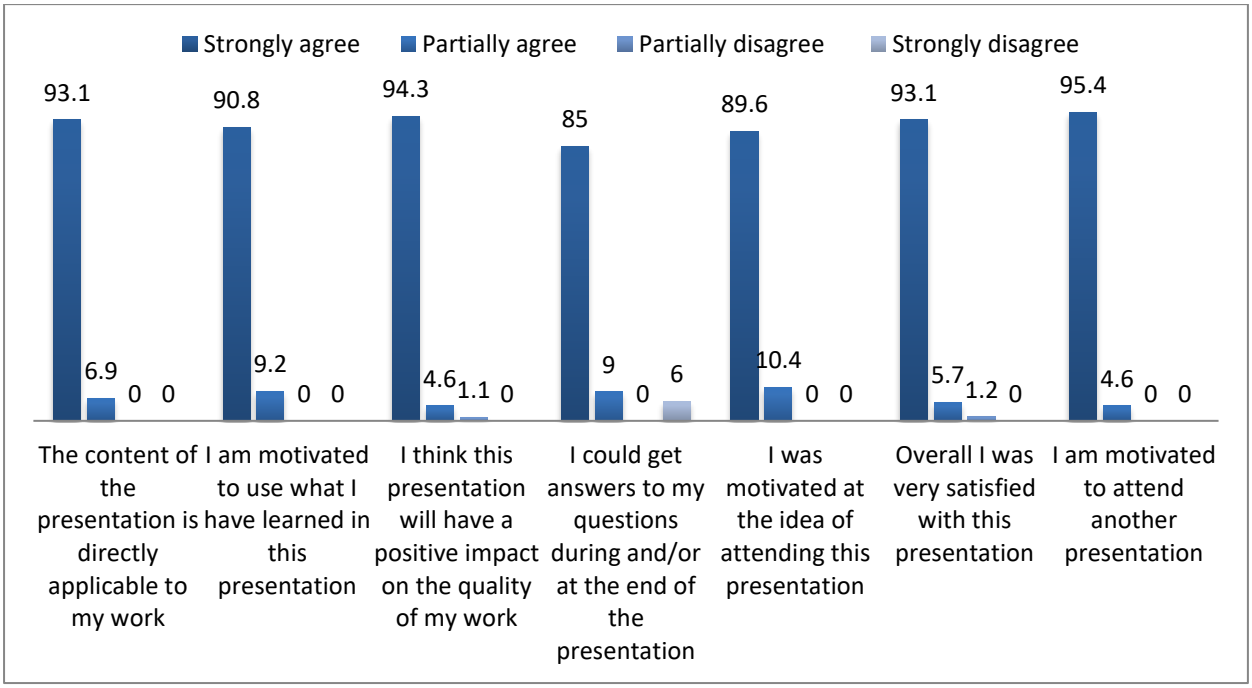

Figure 4: Evaluation of distance education activities

3.3.2 Tele-expertise

Of the 107 participants trained, only 5 (4,7%) users answered the questionnaire that was distributed to them. The low participation rate was explained by a lack of utilization of the tele-expertise platform. Among the responders, all estimated that the software was easy to use and could be quickly mastered. A majority (80%) felt that this could be done without the help of a technician. A minority (20%) felt unconfident while using the software. The overall level

of satisfaction was very high, and users expressed their desire to use the software frequently. The detailed results are included in Figure 5:

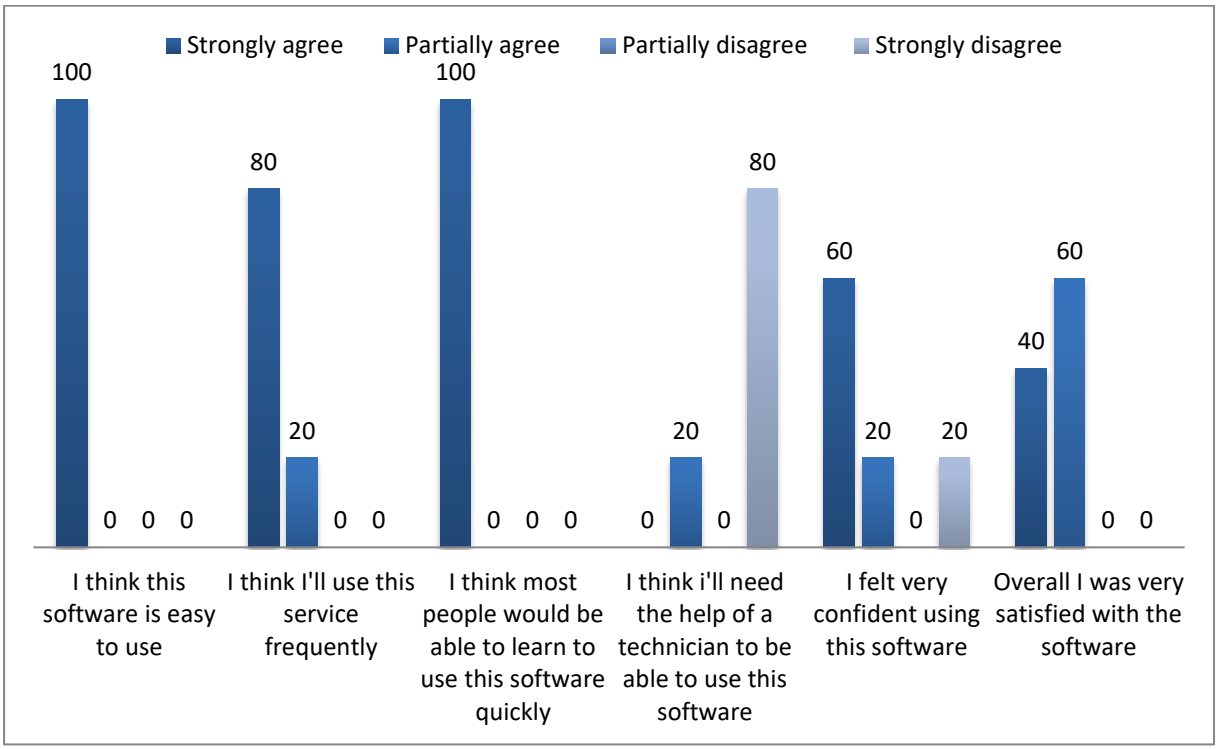

Figure 5: Evaluation of tele-expertise activities

We sought to also evaluate the clinical impact of the discussion of cases on the network. We distributed the questionnaire to the three participants who discussed a case on the platform. However, we were unable to obtain any answer.

3.4 Scale-up of activities

With the pilot project running, considering that activity was building up, especially the distance education activities, we estimated that conditions were met to consider further deployment at a larger scale, in particular because government support and buy-in of care professionals was strong. Subsequently, the scale-up of activities was decided, with 20 additional sites selected to join the network, 6 tertiary-level hospitals and 14 primary hospitals, 6 months after the project started.

The evaluation of the sites was carried out and local coordinators identified. Unfortunately, the decline in international crude oil prices since 2014 has had a substantial impact on budget balances for the government [15]. As a result, the project was confronted

with a lack of funds to guarantee Internet connectivity in the new sites as well as funds for training and equipment deployment. To rationalize the available funds, a priority for consolidation of the network in the pilot sites was prioritized.

4. DISCUSSION

Distance education activity is building up favourably with high levels of user satisfaction. However, that is not the case for the tele-expertise activities that have not reached a routine level that enables the proper evaluation of their impact. Working groups with the local coordinators and voluntary participants were held to understand the poor uptake of the tele-expertise activities. The main reasons encountered were low levels of computer literacy among the participants, at the peripheral sites. Indeed, insufficient computing skills and lack of technology readiness were identified in the literature as major factors associated with the failure of e-Health projects [16–18]. Thus, efforts are being made by the telemedicine team to organize regular meetings to develop familiarity with the telemedicine tools (access, simulations and demonstrations). A possible solution that was suggested was to introduce telemedicine training as part of medical student education and nurse training, with students exposed to its routine use which would facilitate the appropriation of the technology into daily activity. This strategy has also been acknowledged by the American Medical Association (AMA), who enacted a new policy in 2016 encouraging the inclusion of telemedicine training into undergraduate and graduate medical programmes [19]. In South Africa, since 1998, the University of KwaZulu-Natal has developed medical informatics graduate programmes that aim to develop medical informatics capacity in sub Saharan Africa and are being shared with other Universities in Uganda, Mozambique and Zimbabwe [20]. A partnership with such institutions could be an interesting solution.

Another barrier identified came from a couple of senior physicians and experts who showed a lack of motivation and interest and were afraid that the telemedicine tools implied an additional workload. For the successful adoption of telemedicine by health professionals, Zanaboni et al. identified the advantages for users as the crucial determinant [21]. Health professionals require reaching a higher perception about the potential of these technologies to improve the way they can practice. Therefore, efforts are being made to show these healthcare professionals the benefits of this technology. The researchers also identified advantages in the form of personal incentives. We are studying the option to use telemedicine as part of the evaluation of the performance of health professionals, with a bonus for the most

active participants such as participations in conferences. Additional strategies suggested to increase adherence to the project were to use marketing tools for advertising the project to all the hospital staff.

Furthermore, some experts expressed concerns regarding the lack of legal policies and guidelines concerning the use of telemedicine. What happens if a mistake occurs? Research shows that incorporating telemedicine solutions into national health policy and strategy may be of greater importance in developing countries than in developed countries, where telemedicine initiatives are frequently developed and put in place with policy and legislation on their use introduced retrospectively [9,22]. To answer these concerns, the government is actively working on developing policy and legislation to streamline this process linked to other policies such as Science and Technology, Telecommunications and Education. The aim is to develop a positive policy environment to allow widespread telemedicine development and implementation. The work is being done for the institutionalization of the telemedicine project within the MoH, to ensure its sustainability.

Expansion of the network was halted at the moment due to financial constraints. As already mentioned, the decline in international crude oil prices has had a substantial impact on the allocation of funds to projects such as telemedicine. Internet connectivity, power outages, and other services that are critical for the proper functioning of the project are deeply impacted by this lack of funds. As such, several additional options for seeking funds are being actively explored. It has been claimed that there is no conclusive evidence that telemedicine and telecare interventions are cost-effective compared to conventional health care [23]. A proper cost-benefit analysis in the Angolan context needs to be done to assess the actual benefits of the network and to be able to determine if it is worth pursuing the investment in such a project.

Promisingly, the Community of Portuguese Language Countries (CPLP) Ministries of Health agreed, in October 2017, that telemedicine is a strategic instrument to further contribute to the universal health coverage [24]. This agreement is supposed to relaunch telemedicine and grab new funds to develop new telemedicine services in CPLP. A technical group involving experts from all the CPLP countries was created to address this challenge.

5. CONCLUSION

Our objective of deploying telemedicine tools in reference and peripheral hospitals in Angola was successfully accomplished. Despite the many obstacles encountered, activities are continuing favourably with new courses frequently being transmitted. The network has

the potential to improve the health care system by allowing distance education and capacity-building, particularly in rural areas. An important aspect of this project is that the Angolan Telemedicine strategy is associated with primary care reform aiming at universal health coverage, which correctly emphasizes both organizational and technical issues.There is also a growing number of Portuguese and Angolan experts (while working in Portugal) who want to not only collaborate in the webcasting of educational sessions but also contribute with their clinical expertise. The ongoing efforts carried out for the institutionalization of the project within the MoH and the overall enthusiasm of the participants in the selected hospitals are very favourable elements that create a dynamic that will help consolidate the network and ensure its sustainability.

The network can be better developed when national eHealth policies are introduced, more human resources are trained, regular funding is committed, and long-term plans are made.

6. Conflict of Interest

The project was financially supported by the World Bank.

7. Acknowledgements

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8. REFERENCES

[1] Queza AJ. Sistema de Saúde em Angola: Uma Proposta à luz da reforma do serviço Nacional de Saúde [Masters thesis]; Universidade do Porto. 2011. Available from: https://repositorio-aberto.up.pt/bitstream/10216/50407/2/Sistema%20Nacional%20de%20Sade%20Angolano%20e%20Contributos%20%20Luz%20da%20Reforma%20do%20SNS%20Portugus.pdf

[2] Country Development Cooperation Strategy | Angola | U.S. Agency for International Development [Internet]. [cited 2018 Jan 12]. Available from: https://www.usaid.gov/angola/cdcs

[3] WHO Country Cooperation Strategy 2015-2019: Angola. World Health Organization. WHO Regional Office for Africa. 2016 [Internet]. [cited 2017 Oct 13]. Available from: http://apps.who.int/iris/bitstream/10665/250515/1/ccs_ago_2015_2019_en.pdf

[4] Plano Nacional de desenvolvimento sanitario 2012-2025 volume 1. Ministerio da Saude da Republica de Angola, Agosto 2012. Available from: http://www.minsa.gov.ao/download.aspx?id=1083&tipo=publicacao

[5] Angola bianual health report 2012-2013. WHO [Internet]. [cited 2017 Oct 15]. Available from: http://www.afro.who.int/sites/default/files/2017-06/angola_bianual-health-report-2012-2013.pdf

[6] Macaia D, Lapão LV. The current situation of human resources for health in the province of Cabinda in Angola: is it a limitation to provide universal access to healthcare? *Hum Resour Health*. 2017 Dec 28;15(1):88.

[7] Plano Nacional de desenvolvimento sanitario 2012-2025 volume 2. Ministerio da Saude da Republica de Angola, Agosto 2012. Available from : http://www.nationalplanningcycles.org/sites/default/files/country_docs/Angola/angola_pnds_2012_2025_vol_22.pdf

[8] World Bank. 2009. Angola - Municipal Health Service Strengthening Project. Washington, DC: World Bank. Available at: http://documents.worldbank.org/curated/en/225291468002138325/Angola-Municipal-Health-Service-Strengthening-Project

[9] World Health Organization, editor. Telemedicine: opportunities and developments in member states: report on the second Global survey on eHealth. Geneva, Switzerland: World Health Organization; 2010. 93 p. (Global observatory for eHealth series).

[10] Blaya JA, Fraser HSF, Holt B. E-health technologies show promise in developing countries. *Health Aff Proj Hope.* 2010 Feb;29(2):244–51.

[11] Kim JA. Telehealth in the Developing World. Healthc Inform Res. 2010 Jun;16(2):140–1.

[12] Bediang G, Perrin C, Ruiz de Castañeda R, Kamga Y, Sawadogo A, Bagayoko CO, et al. The RAFT Telemedicine Network: Lessons Learnt and Perspectives from a Decade of Educational and Clinical Services in Low- and Middle-Incomes Countries. *Front Public Health.* 2014;2:180.

[13] Geissbuhler A, Bagayoko CO, Ly O. The RAFT network: 5 years of distance continuing medical education and tele-consultations over the Internet in French-speaking Africa. *Int J Med Inf.* 2007 Jun;76(5–6):351–6.

[14] Sheikh M. Digital Health Information System in Africa's resource poor countries: current challenges and opportunities. J Health Inform Dev Ctries [Internet]. 2014 Jun 5 [cited 2018 Mar 3];8(1). Available from: http://www.jhidc.org/index.php/jhidc/article/view/118

[15] WorldBank. Angola Overview [Internet]. Last updated Dec 22, 2017 [cited 2018 Jan 12]. Available from: http://www.worldbank.org/en/country/angola/overview

[16] Luna D, Almerares A, Mayan JC, González Bernaldo de Quirós F, Otero C. Health Informatics in Developing Countries: Going beyond Pilot Practices to Sustainable Implementations: A Review of the Current Challenges. *Healthc Inform Res*. 2014 Jan;20(1):3–10.

[17] Oak M. A review on barriers to implementing health informatics in developing countries. J Health Inform Dev Ctries [Internet]. 2007 Dec 18 [cited 2018 Mar 3];1(1). Available from: http://www.jhidc.org/index.php/jhidc/article/view/4

[18] Yusif S, Soar J. Preparedness for e-Health in developing countries: the case of Ghana. J Health Inform Dev Ctries [Internet]. 2014 Jul 3 [cited 2018 Mar 3];8(2). Available from: http://www.jhidc.org/index.php/jhidc/article/view/121

[19] AMA Encourages Telemedicine Training for Medical Students, Residents | American Medical Association [Internet]. [cited 2017 Dec 21]. Available from: https://www.ama-assn.org/ama-encourages-telemedicine-training-medical-students-residents

[20] Mars M. Building the capacity to build capacity in e-health in sub-Saharan Africa: the KwaZulu-Natal experience. *Telemed J E-Health Off J Am Telemed Assoc*. 2012 Feb;18(1):32–7.

[21] Zanaboni P, Wootton R. Adoption of telemedicine: from pilot stage to routine delivery. *BMC Med Inform Decis Mak*. 2012 Jan 4;12:1.

[22] Lapao L, Dussault G. The contribution of eHealth and mHealth to improving the performance of the health workforce: a review. *Public Health Panorama* Vol. 3. 2017. 463 p.

[23] Hema Mistry. Systematic review of studies of the cost-effectiveness of telemedicine and telecare. Changes in the economic evidence over twenty years. *J Telemed Telecare.* 2012 Jan 1;18(1):1–6.

[24] Lapão LV, Messina LA, Ungerer R, Campos F. Roteiro estratégico para a telessaúde na CPLP: diagnóstico e prioridades para o desenvolvimento da telessaúde. *An Inst Hig Med Trop*. 2016;15 Supl. 1: S65-73