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Potential Telemedicine Applications to Assist Developing Countries in Primary and Secondary Care

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Preface

This report seeks to address new potential avenues for humanitarian telemedicine (HTM), a rapidly evolving field where the space community has a critical role to play. HTM utilizes the tools of telemedicine to provide medical services to individuals in remote, underserved and underprivileged areas. For the purpose of this report, telemedicine is understood as the delivery of health care services, where distance is an obstacle, by health care professionals using information and communication technologies for the exchange of information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, all in the interests of advancing the health of individuals and their communities.

The report first reviews the literature on telemedicine, which has developed tremendously in recent years. It then reviews a set of key case studies, taking place in a range of geographical areas, that have helped push telemedicine forward. It highlights ways in which telemedicine can act as a tool to link the medical communities of different countries and continents. Finally, it discusses various prototypes that could be used to test and measure the appropriateness of such projects, focusing on the potential of HTM for assisting the delivery of primary care in developing countries.

The report follows a conference organized by ESPI that took place in Vienna in 2012. As a follow-up to the publication of this report, a conference on HTM will be organized by ESPI. The conference will serve as an opportunity to discuss the content of this report, the future of HTM in general, and a potential way forward for prototyping the provision of primary care HTM.

Executive Summary

Overview

The use of technology has benefited the medical world tremendously. Through new tools, new software, and new equipment, medical opportunities have been enhanced by technology. This is most evident in the delivery of remote medical care, referred to as telemedicine. Telemedicine, which has grown to include applications such as telecare, telesurgery, and teleradiology, is intrinsically linked to technology and, in particular, the advancement of communication technologies. The advent of satellite-enabled capabilities (telecommunication, global positioning and earth observation satellites), the Internet, and terrestrial networks, is enabling a broader healthcare reach through telemedicine. It has become a sought out method of administrating medical care both in industrialised and developing countries. In the latter case, it has the potential to improve healthcare for all, especially in regions where doctors are often scarce and where assistance from afar is the only realistic care possibility.

The discipline of telemedicine has evolved to such a point that certain countries are now integrating it into their national health policies and practices. Not only is the number of programs carried out by national institutions growing, but the topic now also occupies a central place in international discussions and debates. The World Health Organization, the United Nations, the European Union, the North Atlantic Treaty Organization, and a range of other regional institutions, such as the South Asian Association for Regional Cooperation, are all increasingly involved in telehealth and telemedicine projects, initiatives, and policymaking.

While telemedicine is widely used in industrialised states, there is a great interest in its potential uses for developing countries, particularly in the field of humanitarian aid. Humanitarian telemedicine (HTM), which refers to *the provision of telemedicine (primary and/or secondary) to developing countries in times of immediate and/or permanent medical need with the aim of improving personal health,* has emerged as a fully-fledged discipline. It not only enables a broader reach for medical activities, but also better access to care for patients. Such humanitarian support can be delivered from industrialised and/or developing countries and it can provide primary and/or secondary care to countries in permanent need of medical aid or in immediate situations of crisis. The majority of HTM projects deal with the delivery of secondary care as well as the teletraining of health professionals. Additionally, it has been used extensively in disaster relief situations. Successful projects have seen aid delivered by industrialised and developing countries alike.

In industrialised countries, hospitals, national agencies, non-governmental organisations, and the military have all been involved in HTM. Many telemedicine initiatives and projects have emerged in the past 15 years, making medical care easier to provide at a distance. Recent technological developments have further contributed to the advancement of telemedicine. As some of the breakthroughs in telemedicine have benefited from the use of space-based facilities, the space community is keen to develop projects on this particular topic, including on HTM. Thus, the United Nations Office for Outer Space Affairs, the European Space Agency, as well as national space agencies such as CNES, DLR, NASA, and ROSCOSMOS, have all been involved in projects relating to telemedicine.

However, HTM is also provided by developing countries themselves, and none has been more active in that field than India. Both its national space agency, ISRO, and the Apollo Hospitals network have helped develop telemedicine for domestic use. Not only has the network linked main hospitals to their rural counterparts, but it has also developed mobile solutions to reach a greater number of patients. Moreover, India has been actively enabling and developing the use of HTM in both South East Asia and Africa.

Telemedicine has come to be regarded as an effective way of not only delivering care, but of doing so to underserved regions. HTM improves access to healthcare as well as the very quality of that care. It increases the medical knowledge of doctors (on both ends of the teleconsultation) and benefits future generations through improved health. Most importantly, *it saves lives*. However, for telemedicine to reach its full potential, great focus must be placed on medical aspects, and on the needs at the ground level. Telemedi-

cine may rely extensively on technology, but medical treatment should be the focus of any HTM project. In addition, all projects should undergo strict ex ante analysis (political, economic, legal, cultural, and structural,) in order to mitigate their risk levels, as high dropout rates often follow the pilot stage, and sustainability issues can arise in the medium to long term.

The need for primary care projects is vital. Not only is there a void in this area of telemedicine, but there is a strong need for the improvement of primary care in many parts of the developing world. The unequal distribution of health care workers between low-income and high-income countries, as well as the constant demand for primary health care in developing countries, constitutes a strong case for primary care HTM projects. Therefore, with the greater supply of medical professionals in industrialised states and the benefits that increased primary care could bring to developing countries, there is an opportunity to pick this low-hanging fruit and increase international medical cooperation. Moreover, the widespread availability of technological tools, through the increased usage of mobile phones, and the increasing number of Internet users, further enable the use of HTM. Above all, HTM can be a very effective tool even with modest equipment.

However, the use of primary care HTM, especially between industrialised and developing countries in permanent situations of need, has been discussed very little in the literature on telemedicine. A potential way forward in developing primary care projects is to test their viability in a context of permanent medical need. To this end, this report proposes three pilot project formats that could be used to test the features of primary care HTM: (1) a mobile unit, (2) a fixed remote unit, and (3) a unit alongside local healthcare facilities. As part of such pilot projects, issues such as culture, infrastructure, doctor-patient relationship, and sustainability must all be addressed. This report engages in a comparative analysis of all three models. The level of technology they require, their sustainability, along with the different assessment opportunities that they present, are addressed.

The aim of the report is to provide an overview of telemedicine and a more in-depth analysis of HTM, while analysing successful existing projects and considering the issues that can arise when developing and sustaining such projects, particularly in primary care. Ultimately, this report is designed to address HTM as a field to be more broadly acknowledged. It also aims to pave the way for further discussions on the development of a pilot project in the field of primary care HTM. Additionally, as part of a larger activity, ESPI will organize an event where HTM and these three types of pilot projects will be explored; following which, one is expected to be launched.

Recommendations

From the analysis provided in this report, lessons can be extracted and formulated for the purpose of HTM. Considering that telemedicine is a field ripe for development, that it has proven successful in developing countries, and that there is a vacuum with regards to primary care, it is recommended that:

1. *Primary care HTM should be further explored.*

   The field of HTM has mostly flourished with regards to secondary care. Primary care, which is of critical importance for patients in the rural areas of developing countries, has not witnessed the same level of innovative HTM. Therefore, testing the potential of such projects is a timely opportunity. Controlled evaluations are a particularly pertinent way of testing this.

2. *HTM, fostered by technological advances, should continue to be utilised to improve health care for those most in need.*

   With the field of information and telecommunication technology developing at great speed, and the populations of many developing countries experiencing poor health outcomes, there is much potential for using ICT and space-based infrastructure for solving pressing health problems in the developing world. In a number of cases, such as those enabled by VSAT in India, telemedicine initiatives whereby doctors based in urban centres administer medical care to patients in rural areas have worked very effectively.

3. *As humanitarian projects based on partnerships with local actors are generally more successful and sustainable, HTM projects should follow this lead.*

   While involving local populations and authorities in project delivery and empowering them in that process can be costly due to cultural and language barriers, projects that do so have a higher likelihood of succeeding in the long term.

4. *A number of important cultural considerations, from host and donor populations, should be accounted for.*

   A number of issues can arise in development projects due to socio-cultural differences, and this is no different when these

are health-based. Cultural considerations with regard to medical care differ markedly between industrialised and developing countries. These must be accounted for as part of projects administering health services.

5. *In order to make such projects successful, the medical needs of end users must be prioritised.*

   While, as mentioned in (4), cultural issues arise in the field of medicine, the medical needs of end-users must be prioritised. If this is not the case, they may forego the available care, which represents a failure for the endeavour.

6. *Every low-hanging fruit should be considered.*

   Many successful HTM projects use existing or basic technologies to enable the telemedicine link between parties. This should be sought after primarily before developing and importing expensive and hard-to-manage systems and technologies.

7. *To test the validity of primary care HTM, pilot projects need to be developed.*

   The report highlights the potential of primary care HTM projects to be successful. However, this cannot be demonstrated without concretely testing them with the use of a prototype. Carrying out a pilot project would effectively test the potential of such projects to succeed on a larger scale.

8. *Evaluation is critical for the success of such projects.*

   While carrying out a pilot project may validate primary care HTM projects in certain settings, accurately measuring its success will indicate whether such a project should be scaled up and/or replicated across other settings, and whether it is a sound investment in the field of development. More generally, there is a need for increased feedback in HTM.

1. Introduction

As McLaren and Ball (1995) wrote in their article for the British Medical Journal: "Research is needed on how existing technology can be integrated into health care delivery systems in a way that improves the effectiveness and efficiency of those systems".[1] They also stated: "any new communication tool should be rigorously tested against existing technologies such as the telephone".

1.1 Technological Prowess

Notwithstanding the importance of the telephone, other technological instruments are proving to be equally or more cost effective than that ubiquitous tool. With their growing availability, mobile phones, computers and tablets are capable of connecting to the Internet and of supporting its applications. Through their applications (or apps), these electronic devices hold almost limitless possibilities with regards to telemedicine. On the Internet, one may consult extensive medical libraries, access simulated surgeries, learn about medical procedures step by step, access information on drugs databases, listen to dedicated medical radios, and get the detailed procedures of various treatments. There are also applications being developed where, with a combined use of a mobile phone's camera and the Internet, the extent of the danger presented by a potential melanoma can be assessed.[2] The range of knowledge and capabilities to be transmitted via the Internet to a phone, computer or tablet has barely scratched the surface of the future possibilities presented by these technologies. The use of real bonfires, to communicate the existence of a contagious disease in a town was at the origin of all this, hard as this may be to remember, at a time of rapid development in the field of information-systems.

Thus, telemedicine, understood as the delivery of medical care at a distance, is not a by-product of the Internet, or of any new technology for that matter. It has been used throughout history and has grown as much as the very technology it has used (telegraphy, telephone, radio, television and Internet). Although every technological stride has improved the remote care that could be given, technology is not the primary reason for the development of telemedicine; it is merely the tool that has enabled it to prosper. Technological advancement has enabled the continuous fulfilment of medical needs and made it possible to overcome many obstacles to medical care, such as distance and effective transfer of knowledge.

The current technological revolution is changing our approach to medicine and, more than ever, enabling broader healthcare reach through telemedicine. With this in mind, telemedicine has become a well-researched method of administrating medical care both in developing and industrialised countries. Telemedicine can truly help achieve improved healthcare for all, and particularly for developing countries, where doctors are too often scarce.

1.2 Telemedicine's Contribution to Society

In 2000, the Member States of the United Nations adopted a resolution aimed at eradicating extreme poverty and improving the "health and welfare of the world's poorest people within 15 years".[3] From this resolution, eight goals were formulated which are now widely known as the Millennium Development Goals (MDGs). Health is paramount to these goals. Indeed, six out of eight involve health issues. Although telemedicine is not explicitly mentioned in the MDGs, a "disappointing" fact for some, the potential of telemedicine can no longer be ignored, as it can certainly be used to help achieve the MDGs.[4] For example, existing telemedicine projects deal with secondary care for children in Africa, as well as pregnant women in South

[1] McLaren, Paul and Ball, C. J., "Telemedicine: Lessons Remain Unheeded", British Medical Journal, Vol. 310, No. 6991 (May 27th 1995): 1390-1391

[2] "Top 20 Free iPhone Medical Apps For Health Care Professionals." 14 December 2010. Web. 30 July 2013 <http://www.imedicalapps.com/2010/12/bes-free-iphone-medical-apps-doctors-health-care-professionals/>

[3] "MDG Health and the Millennium Development Goals." World Health Organization. 2005. 30 July 2013 <http://www.who.int/hdp/publications/mdg_en.pdf>

[4] Merrell, Ronald C., "Medical Diplomacy", Telemedicine and e-Health, Vol.16, No.6, (July/August 2010): 645-646

America, helping to achieve MDG Goals 4 “Reducing child mortality” and 5 “Improving maternal health”.

Many telemedicine initiatives and projects have emerged in the past 13 years, providing medical care more easily and effectively at a distance. As mentioned above, recent technological developments have contributed to the advancements of telemedicine. In regions lacking adequate infrastructure, none has done so more than space technology and its applications. Communication satellites are an important facilitator of humanitarian telemedicine (HTM). With the satellite network’s constant availability, along with its independence from ground environmental conditions, it is a tool that has become indispensable to humanitarian aid. Although the technology involved in satellite networks, reception, and transmission of data is of interest from the point of view of the technologist, in this report space is studied solely as a tool that renders telemedicine possible in specific contexts. Thus, space is analysed in terms of the impact it can have on telemedicine, and therefore on global access to health.

1.3 Telemedicine and Humanitarian Telemedicine

With the different initiatives surrounding telemedicine, it is imperative to consider not only the achievements that have been accomplished, but also what remains to be done in this field. Many telemedicine projects exist, and a number of them are being successfully executed. However, whether or not all avenues of this field have been explored must be considered. Have all the low-hanging fruit been picked? Can the assistance industrialised countries are providing to the developing world in terms of telemedicine be optimised?

The aim of this report is to provide an overview of telemedicine and a more in-depth analysis of HTM, while also analysing the questions that arise when developing and sustaining such projects, in particular in primary care. Ultimately, this report is designed to address HTM as a method to be acknowledged, and pave the way for further discussions on the setting up of a prototype in that field in primary care. Due to the capacity of HTM to impact outreach in medical care, it is important to identify the issues to address in order to provide effective assistance.

The first chapter will deal with the concepts, definitions and current use of telemedicine and introduce HTM in developing and industrialised countries. The report will then be divided in two sections.

The first section will provide a more in-depth view of successful projects in HTM. It will first look at the use of HTM in different situations, both in scenarios of humanitarian crisis and in permanent situations of hardship. An overview of different civilian and military projects will be given in both primary and secondary care. It will then lay out the potential these projects have for cooperation and development. Both the medical aid provided from industrialised (national and international initiatives) and developing countries (the Indian experience at home and abroad) will be studied.

The second section will be centred on primary care in HTM and the possible way forward in this area. First, the lessons learned from past HTM projects will be examined. The lessons learned, the analysis of what works for developing countries, and the challenges that may occur will be studied. Second, a closer look will be given to opportunities and challenges that may arise when developing and implementing HTM primary care projects. Despite the numerous projects that can be found in secondary care, there still remains a gap in the remote delivery of primary care. It will then lay out the initial steps in establishing a prototype to test the theoretical framework of primary care HTM.

2. From Telemedicine to Humanitarian Telemedicine

As presented in the introduction, the technology behind the advances in remote medical care, although of great value, is only as important as the possibilities it generates for the continued advancement of telemedicine. As Coiera (1995) stated: "Any attempt to use information technology will fail dramatically when the motivation is the application of technology for its own sake rather than the solution of clinical problems".[5]

There is, however, a need to acknowledge technological developments, as without them, we would still refer to remote medical care as just that. Telemedicine, in the last decades, has become much more than the creation of a bonfire to ward off people, it thrives on newly developed technologies. The potential types of transmission presented by new technologies and their applications need to be laid out to fully understand the reach that telemedicine has come to have. The involvement of the international community and regional institutions in telemedicine, as well as the specific national applications of telemedicine, are important inasmuch as they help set the basis for HTM.

2.1 What Is Telemedicine?

2.1.1 Defining Telemedicine

Although telemedicine etymologically translates to medicine at a distance, many definitions of the term can be found ranging from the broad to the specific. One of the broadest definitions of telemedicine comes from Wootton, who defines telemedicine as "an umbrella term that encompasses any medical activity involving an element of distance".[6] Craig and Patterson elaborate on this definition of telemedicine: "the delivery of health care and the exchange of health-care information across distances [...], it encompasses the whole range of medical activities including diagnosis, treatment and prevention of disease, continuing education of health-care providers and consumers, and research and evaluation".[7] Furthering the idea of inclusion in the definition, the United Nations (UN) has defined telemedicine as:

> "the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities".[8]

Whereas these definitions are very inclusive in their interpretation of telemedicine, other authors, such as Wyatt and Liu, have specified telemedicine to be: "the use of any electronic medium to mediate or augment clinical consultations. *Telemedicine* can be simultaneous (for example, telephone, videoconference) or store and forward (for example, an email with an attached image)".[9] In the latter definition, the types of information technology are included. Indeed, unlike the first set of definitions, which lists the *current* applications that can be found in telemedicine, the definition proposed by Wyatt and Liu considers the structural aspect of telemedicine. Telemedicine implies distance, and the information transmitted over that distance can either be synchronous or asynchronous.

When trying to define a concept such as telemedicine, a wide range of definitions is thus available. Far from wanting to burden the already extensive list of definitions, for the purpose of this report *telemedicine will be defined as the delivery at a distance of primary and/or secondary care between a medical professional and a patient or between two or more medical professionals by way of synchronous or asynchronous transmission and communication.* Therefore, medical teleeducation does not fall under this definition.

[5] Coiera, Enrico "Medical informatics." British Medical Journal, Vol. 310, No. 6991 (May 27, 1995): 1381-1387.
[6] Wootton, Richard "Telemedicine." British Medical Journal, Vol. 323, Clinical Review (September 8, 2001): 557-560
[7] Craig, John and Patterson, Victor, "Introduction to the practice of telemedicine", Introduction to Telemedicine, Eds. Richard Wootton, John Craig and Victor Patterson, The Royal Society of Medicine Press Limited (2011): 3-4
[8] "Telemedicine Opportunities and Developments in Member States 2010". Global Observatory for eHealth series. Vol. 2. World Health Organization, 30 July 2013
[9] Wyatt, J.C. and Liu, J. T. L. "Basic Concepts in Medical Informatics." Journal of Epidemiology and Community Health, Vol. 56, No. 11 (November 2002): 808-812

2.1.2 Terms and Terminology

In order to understand telemedicine beyond its definition and within its wider context, a few terms need to be addressed. Indeed, not only has telemedicine come to the forefront of health agendas around the world, it has been increasingly categorised, and a number of terms have been used to define it. For example, telehealth and telemedicine are often not properly distinguished. Figure 1 provides an overview of the most commonly used terms and concepts with regards to both categories of health-related activities.

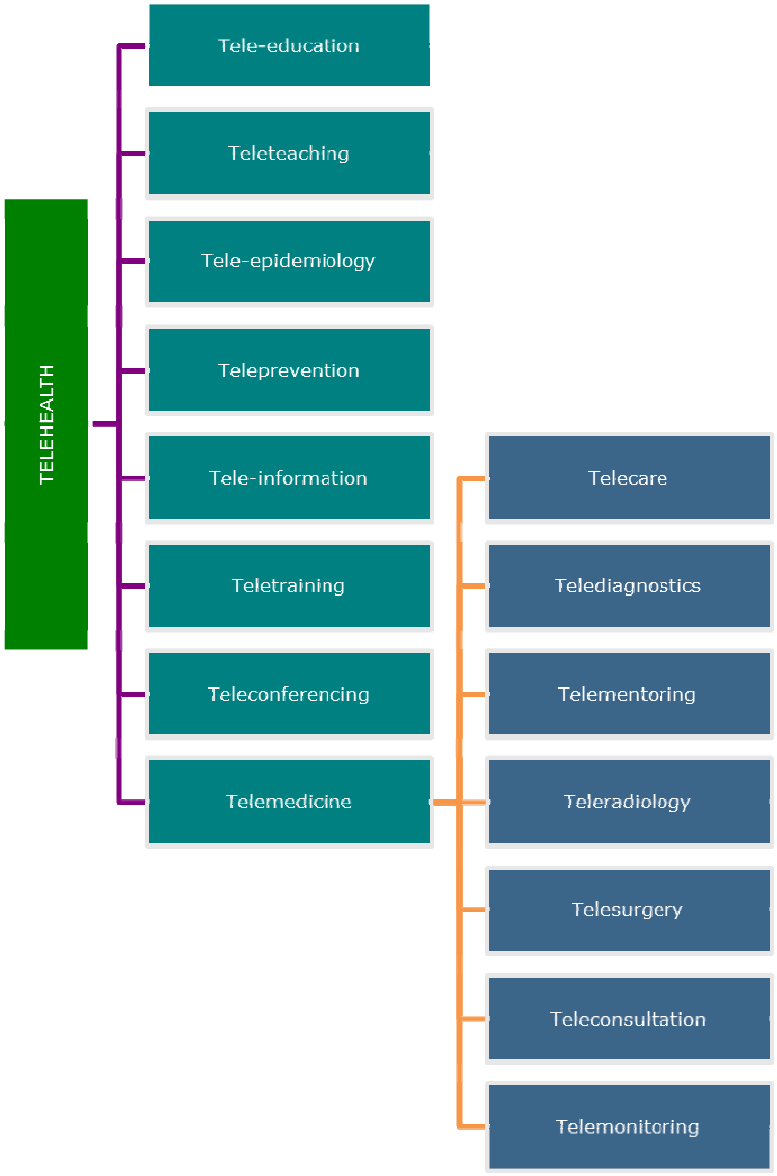

Figure 1: Telehealth and telemedicine applications

Telemedicine is part of a wider concept referred to as telehealth, which encompasses all health related teleservices.[10] On a national level it may also refer to "public health services delivered at a distance, to people who are not necessarily unwell, but who wish to remain well and independent".[11] Telehealth is therefore an overarching term and telemedicine falls under its umbrella.[12]

Telehealth is, however, not to be confused with e-health. E-health refers explicitly to the

[10] Cluzel, Jean, Alajouanine, Guislaine and Grebot, Elisabeth, Groupe d'études de l'Académie des sciences morales et politiques, "Les nouvelles technologies de l'information et de la communication au service de la santé en Afrique", Presses Universitaires de France (2003): p.14

[11] Craig, John and Patterson, Victor, "Introduction to the practice of telemedicine", Introduction to Telemedicine, Eds. Richard Wootton, John Craig and Victor Patterson, The Royal Society of Medicine Press Limited (2011):3-4

[12] "What is telemedicine." *ICUcare LLC.* Web. 30 July 2013. <http://www.icucare.com/PageFiles/Telemedicine.pdf>

use of the Internet as part of the medical exercise. It includes all the concepts that fall under telehealth, but is exclusive, as it only considers the Internet as a medium. Although e-health might be considered as more relevant in today's world, due to the ubiquitousness of the Internet, other types of telecare are also essential, due to the variety of communication channels available in different settings.[13,14]

2.1.3 Applications of Telemedicine

Telemedicine encompasses a number of applications. Figure 1 represents the most common ones, which include tele- care, diagnostics, mentoring, radiology, surgery, consultation, and monitoring.

Teleradiology or tele-imagery is "the electronic transmission of [ultrasounds or] radiological images, such as x-rays, CTs, and MRIs, for the purposes of interpretation and/or consultation. Digital images are transmitted over a distance using standard telephone lines, satellite connections, or local area networks (LANs)".[15] The digitalisation of images, which are made available directly to the doctor, has important advantages. Indeed, there are increased interactions between doctors and patients who are in remote locations. Additionally, there is no greater risk of imagery misinterpretation.[16]

Telediagnostics, like all other applications, can be either synchronous or asynchronous. It can also be done between a medical professional and a patient or between two or more medical professionals. Telediagnostics has proven to be a time efficient and invaluable tool for telehealth. For example, when a hospital possesses radiological equipment but not medical specialists, rather than systematically sending high-risk patients to a nearby hospital, an image can be taken and sent to a specialist, who then deliberates on the need to move the patient or not.[17] This is closely linked to the concept of *teleconsultation,* since it is a clinical consultation between a patient and a medical professional, or two medical professionals.[18] However, in the case of teleconsultation, one is mainly asking for a second opinion or advice. Within the relationships that may be established between two medical professionals, *Telementoring* is yet another application of telemedicine. Telementoring uses "audio, video and other telecommunications and electronic information processing technologies to provide individual guidance or direction".[19] Unlike teleconsultation, telementoring implies a longer relationship between the two medical professionals and a notion of teaching and educating, rather than the offering of a medical opinion on a single case.

Telesurgery is an application of telemedicine that may seem far-fetched even though doctors have been using robotic technologies inside their operating rooms for decades. They are now also capable of performing cross-continental surgeries. A recent breakthrough in telesurgery featured a doctor in the United States (US) performing surgery on a patient in France, by "remotely operating a surgical robot arm".[20] The success of the operation proved that telesurgery has great potential.

The last two applications are, in turn, oriented towards patient care and monitoring. Whereas *telemonitoring* focuses on monitoring the health status of a patient following a specific event, *telecare* is a more rounded provision of medical attention to a patient.[21,22] An example of telemonitoring occurs when medical professionals remotely follow individuals with diabetes who need to take their medicine. On the other hand, an example of telecare is when an elderly person in a home receives general care at a distance.

As previously noted, telemedicine is only possible when the appropriate technology is available. All of these telemedicine applications have been made possible at one time or another by space-based capabilities. The progress that has been achieved in the re-

[13] Wyatt, J. C. and Liu, J.T.L, "Concepts in Medical Informatics*". Journal of Epidemiology and Community Health.* Vol. 56, No. 11 (November 2002): 808-812
[14] Cluzel, Jean, Alajouanine, Guislaine and Grebot, Elisabeth, Groupe d'études de l'Académie des sciences morales et politiques, "Les nouvelles technologies de l'information et de la communication au service de la santé en Afrique", Presses Universitaires de France (2003): p.14
[15] "What is telemedicine." *ICUcare LLC.* Web. 30 July 2013. <http://www.icucare.com/PageFiles/Telemedicine.pdf>
[16] Cluzel, Jean, Alajouanine, Guislaine and Grebot, Elisabeth, Groupe d'études de l'Académie des sciences morales et politiques, "Les nouvelles technologies de l'information et de la communication au service de la santé en Afrique", Presses Universitaires de France (2003): p.17
[17] Ibid. p. 18
[18] Coiera, Enrico "Medical informatics." British Medical Journal, Vol. 310, No. 6991 (May 27, 1995): 1381-1387.
[19] "What is telemedicine." *ICUcare LLC.* Web. 30 July 2013. <http://www.icucare.com/PageFiles/Telemedicine.pdf>
[20] „Doctors claim world first in telesurgery". *BBC News*. Wednesday, 19 September 2001. Web. 30 July 2013 <http://news.bbc.co.uk/2/hi/science/nature/1552211.stm>
[21] "What is telemedicine." *ICUcare LLC.* Web. 30 July 2013. <http://www.icucare.com/PageFiles/Telemedicine.pdf>
[22] Craig, John and Patterson, Victor, "Introduction to the practice of telemedicine", Introduction to Telemedicine, Eds. Richard Wootton, John Craig and Victor Patterson, The Royal Society of Medicine Press Limited (2011):3-4

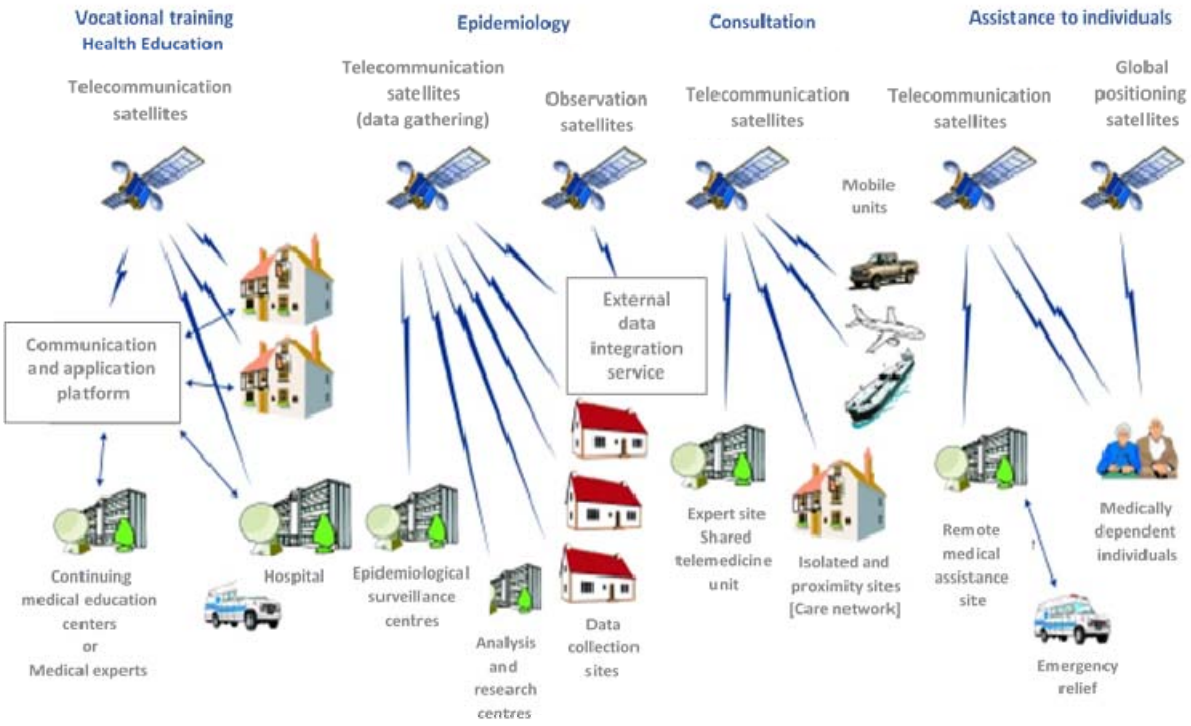

Figure 2: The role of space in telemedicine and telehealth (English translation from CNES.fr 2008)

mote delivery of medical care can be traced back to telecommunication, Earth observation and global positioning satellites (see figure 2).[23]

Telecommunication satellites can enable the connection between remote mobile units, isolated proximity sites, and expert sites. In other cases, such as telemonitoring or telecare, satellite connectivity not only allows for the remote monitoring of patients, but also for their positioning. Therefore, if a patient located in a remote area is in need of immediate assistance, an emergency relief unit can be dispatched to their location. These are but a few examples of the opportunities created by space-based infrastructure.

2.2 Widespread Use of Telemedicine in Industrialised Countries

With the explosion of telemedicine and its applications has come an increase in its implementation within industrialised countries and the international community. Beyond the immediate benefits of telemedicine for delivering healthcare, it has now not only become a tool for diplomacy and development but has also gained momentum in political agendas around the globe.[24] International organisations such as the World Health Organization (WHO) and the UN have taken a keen interest in the matter. Other regional actors have also taken an interest in this domain. For example, the European Union (EU) has included the topic in its strategy for EU growth, represented by its Europe 2020 strategy. Telemedicine is an integral part of national health care policies and has in recent years grown and benefitted greatly from experience.

2.2.1 International Community

International Organisations

Since 2005, telemedicine has been a subject of growing interest for the international community and its health agenda. Following its Global eHealth Survey, the WHO, the primary international organisation on matters of health, affirmed the need to include eHealth in its strategy and urged others to do the same. Indeed, in its Ninth plenary meeting, on 25 May 2005, the WHO noted "the potential impact that advances in information and communication technologies could have on health-care delivery, public health, research

[23] Figure 2 source: "The first operational networks monitoring re-emergent diseases". CNES. Web. 16 January 2014 < http://www.cnes.fr/web/CNES-en/5078-the-first-operational-networks-monitoring-re-emergent-diseases.php>

[24] Merrell, Ronald C., "Medical Diplomacy", Telemedicine and e-Health, Vol.16, No.6, (July/August 2010): 645-646

and health-related activities for the benefit of both low- and high-income countries".[25] It also urged Member States to "consider drawing up a long-term strategic plan for developing and implementing eHealth services in the various areas of the health sector, including health administration, which would include an appropriate legal framework and infrastructure and encourage public and private partnerships". Additionally, it requested its Director-General "to promote international, multisectoral collaboration with a view to improving compatibility of administrative and technical solutions and ethical guidelines in the area of eHealth".[26] With this renewed political will, the year 2005 represented a milestone in the promotion of telemedicine and eHealth, not only for the WHO but also for many other organisations such as the UN and the EU.

The UN has long promoted the practical use of space, which includes telemedicine. During the 2005 General Assembly, the Fourth Committee (focused on special political questions and decolonisation) dedicated its session to the potential contribution of space technologies to the MDGs.[27] The idea that technology can provide assistance in the achievement of the MDGs was reiterated in the 2011 Report of the Reflection Group on the delays that had occurred in their realisation. The importance of Information and Communication Technologies (ICTs) was highlighted, and among the many positive applications that could be utilised were eHealth and telemedicine.

Thus, the WHO and the UN have expressed a need for eHealth, both as a general direction to be undertaken by other organisations and states, and for the achievement of the MDGs.They are also both partners of the International Society for Telemedicine and eHealth (ISfTeH), whose mission is to "facilitate the international dissemination of knowledge and experience in Telemedicine and eHealth and to provide access to recognised experts in the field worldwide".[28] The international community has rallied together on the issue of eHealth and telemedicine and this has also impacted regional strategies, namely the EU's Europe 2020 strategy for growth.

European Union

In 2004 the European Commission (EC), with the aim of developing ICTs in the Health sector, adopted an action plan that resulted in increased national eHealth strategies.[29] It was not until 2008, however, that the EC renewed its firm intent to include eHealth in its policy and strategy. In 2008, eHealth became a part of the Lead Market initiative for innovation, which was followed up by the launch of a survey on eHealth. In April 2008, the EC published the results of the "Benchmarking ICT use among General Practitioners in Europe" survey, which concluded that European doctors were widely practising eHealth. Following these results, the EC sent a communication to the other EU institutions promoting the development of eHealth.[30]

In 2010, the EC proposed a new political strategy to achieve growth that is smart, sustainable and inclusive. In order to achieve this, it presented five targets to be achieved by 2020, hence "Europe 2020".[31] Following the setting of these targets, a programme composed of seven flagship initiatives was set up. The first of these was the Digital Agenda for Europe, which aimed "to help Europe's citizens and businesses to get the most out of digital technologies".[32] Within this Digital Agenda for Europe, seven actions have been taken, one of which is to use "Information and Communication Technologies - enabled benefits for EU society". Four main

[25] The World Bank divides state economies according to Gross National Income per capita. The economies are then classified into income groups, where: low income, $1 035 or less; lower middle income, $1 036 - $4 085; upper middle income, $4 086 - $12 615; and high income, $12 616 or more. Source "Country Classification." *Worldbank.* Web.30 July 2013 <http://data.worldbank.org/about/country-classifications>

[26] World Health Organization. Resolutions and Decisions on its Fifty-Eighth World Health Assembly, Held in Geneva from 16 to 25 May 2005. WHO Doc. WHA58/2005/REC/1

[27] "Quatrième Commission: Les Technologies Spatiales Peuvent Contribuer Aux Objectifs Du Millénaire Pour Le Développement." *United Nations General* Assembly. 17 October 2005. CPSD/321. Web. 30 July 2013 <http://www.un.org/News/fr-press/docs/2005/CPSD321.doc.htm>

[28] "Mission Statement IsfTeH." *ISfTeH*. Web. 30 July 2013 <http://www.isfteh.org/about/about_the_isfteh>

[29] "Survey takes pulse of eHealth in Europe and prescribes wider ICT use among doctors." *European Commission.* IP/08/641 Web. 25 April 2008 <www.europa.eu/rapid/press-release_IP-08-641_en.htm?locale=en>

[30] "Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on telemedicine for the benefit of patients, healthcare systems and society. *European Commission*. COM(2008)689 final 4 November 2008.

[31] Commission of the European Communities. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, on telemedicine for the benefit of patients, healthcare systems and society. COM (2008)689 final of 4 November 2008. Brussels: European Union.

[32] European Commission. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, a Digital Agenda for Europe. COM (2010) 245 final/2 of 26 August 2010. Brussels: European Union.

areas were identified to benefit from ICT, including healthcare.[33]

With regard to space and health more specifically, although the EU has included European citizens in its space strategy, it has not addressed the topic of health for developing countries. Neither the European Space Policy "green and white paper series" (2003), nor the 2011 EC communication "Towards a space strategy for the EU that benefits its citizens" mentions the topic. Although the 2011 communication expresses the need for Earth observation data for "transport safety, cartography, the management of water and rivers, food resources and raw materials, biodiversity, soil use, deforestation and combating desertification", it does not reference how space technology can be relevant in a health context outside the EU.[34]

The importance that the EU has decided to give to eHealth is representative of the global interest in the topic and the need to deal with this issue. Not only are international and regional organisations recognizing the need to include eHealth and telemedicine in their health agendas and strategies, they are also, through international associations and targeted promotion activities, actively promoting it worldwide.

2.2.2 National Initiatives

With the growing international concern for the inclusion of eHealth and telemedicine in policies and practices, it is important to analyse some direct results of telemedicine applications in industrialised countries.

Successes of Telemedicine

Many projects featuring eHealth and telemedicine applications have been implemented in recent years. As early as 1997, the Veterans Health Administration (VHA), "America's largest integrated health care system with over 1,700 sites of care, serving 8.3 million Veterans each year", was "systematically delivering clinical services via telemedicine".[35,36] The VHA is now running a range of telemedicine services, including the tele-anticoagulation program, tele-women's health, tele-palliative care, and the tele-amputee clinic, which provides assistance for veterans who have had limbs amputated.[37] Although many early breakthroughs in the field of telemedicine were accomplished in the military, nowadays, many programmes also flourish in the civilian sector.

The essence of telemedicine is to provide care at a distance and therefore reach those living in secluded areas.[38] Telemedicine has the potential to improve and save lives in areas that would otherwise be unserviced. Among the many published studies on the subject, the nationwide British Whole System Demonstrator Project is the "largest randomized trial of telehealth in the world".[39] The trial centred around two groups of patients, those who received telehealth and those who received usual care. It was shown that there were fewer deaths in the group that received telehealth. Another study conducted in the US focused on improving diabetes self-care with a Personal Digital Assistant (PDA). It showed that the patients that kept their PDA at all times and completed the programme improved their diabetic situation.[40]

In addition to reducing health inequalities and improving access to medical care, telemedicine improves efficiency and, in some cases, reduces costs. For example, unnecessary journeys to the hospital as well as between hospitals can be drastically reduced with the effective use of telemedicine.[41] The British Whole Demonstrator Systems Project found that there were 20 percent fewer emergency hospital admissions among patients receiving telehealth.[42] Electronic referrals to specialists and hospitals have also been found to be cheaper for both patients and doctors. The costs for a patient to drive to a medical specialist, or for a doctor to visit a home, can

[33] Ibid.
[34] Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions towards a space strategy for the European Union that benefits its citizens. *European Commission.* COM (2011) 152 Final of 4 March 2011.
[35] "Veteran Health Administration." *US Department of Veterans Affairs*. Web. 27 March 2013 <http://www.va.gov/health/default.asp>
[36] Crigger, Bette-Jane. "e-Medicine: Policy to Shape the Future of Health Care." *The Hasting Center Report*. Vol. 36. No.1 (January-February 2006): 12-13
[37] "Telehealth: Care and Convenience for Veterans." *US Department of Veterans* Affairs. Web. 27 March 2013 <http://www.va.gov/health/NewsFeatures/2013/March/Telehealth-Care-and-Convenience-for-Veterans.asp>
[38] Wootton, Richard. "Telemedicine" (2001)
[39] "The Impact of Telehealth and Telecare: the Whole System Demonstrator Project" n*uffieldtrust*. Web. 30 July 2013 < http://www.nuffieldtrust.org.uk/our-work/projects/impact-telehealth-and-telecare-evaluation-whole-system-demonstrator-project>
[40] Forjuoh, Samuel N. et al. "Improving Diabtes Self-Care with a PDA in Ambulatory Care." *Telemedicine and e-Health.* Vol. 14. No. 3 (April 2008): 273-280
[41] Wootton, Richard "Telemedicine." British Medical Journal, Vol. 323, Clinical Review (September 8, 2001): 557-560
[42] "The Impact of Telehealth and Telecare: the Whole System Demonstrator Project" n*uffieldtrust*. Web. 30 July 2013 < http://www.nuffieldtrust.org.uk/our-work/projects/impact-telehealth-and-telecare-evaluation-whole-system-demonstrator-project>

often be eliminated using teleconsultations.[43] Although many initiatives exist, too few countries are equipped with these capabilities and the will to fully incorporate telemedicine into their national health systems.

Implementation Considerations

As Bashshur and Armstrong posited, as early as 1976, telemedicine features include "a heavy reliance on telecommunication technology", "the development of organizational forms uniquely suitable for the remote delivery of medical services", and "an expanded clinical role for the medical provider without an M.D. degree".[44] Only a few countries are capable of strongly engaging in it. For example, within Europe, Denmark, the Netherlands and Norway boast the highest levels of telemedicine (use of email, e-prescriptions, telemonitoring, etc.).[45,46] The reason for telemedicine's rather modest practical uptake is that other factors must be considered in addition to the "e-readiness" that states must possess in order to engage in telemedicine. Telemedicine may indeed not be applicable in all medical cases, and resistance to it can arise from both patients and doctors. There is much to be said about the cultural difficulties involved in establishing a relationship between a doctor and a remote patient. Indeed, in some studies, medical professionals have been found to be resistant to the idea of having reduced face time with their patients. They believe that telemedicine "depersonalizes the relationship and sabotages the trust" that doctors have with their patients.[47,48] Still, telemedicine presents numerous advantages for both healthcare providers and beneficiaries. States and institutions must, however, acknowledge the difficulties that come with this new mode of health care administration. Not only should the changing relationship between the parties be acknowledged and addressed, but so must the patient needs with regards to their conditions, the changing health infrastructure and the interactions between these factors. The aforementioned issues are even more relevant when considering HTM, where patients are often less familiar with advanced medical technologies, and where local conditions are less conducive to medical care.

2.3 Defining Humanitarian Telemedicine

The Oxford dictionary defines the adjective "humanitarian" as a "concern or desire to promote human welfare".[49] The term HTM, however, has a more specific meaning: it is understood as *the provision of telemedicine (primary and/or secondary) to developing countries in times of immediate and/or permanent medical need with the aim of improving personal health.*

The medical aid in question may be provided by medical entities from either industrialised and developing countries or a combination of both. Furthermore, in this definition, an entity refers to either a governmental or non-governmental national or international organisation, or a private sector firm. It should be noted that the medical aid may be provided to, and from, more than one entity at a time; it may arise from a partnership between private and non-governmental organisations (NGOs), or between hospitals and/or local NGOs. Figure 3 depicts the relationship between the actors involved.

As highlighted earlier in this section, telemedicine includes a wide range of medical initiatives taking place at a distance. The same can be said of HTM. Both in cases of humanitarian crises and in cases of enduring hardship, HTM can play a crucial role in increasing access to medical services. HTM's role is to deliver primary or secondary care to those who are in need and who are located in underserved regions. It constitutes an integral part of the effort to help improve worldwide access to health care.

Just as surgery and orthopaedics are standalone areas of medicine, so is HTM, even if it encompasses a variety of medical disciplines. With so many regions in the world in a dire need of medical care, HTM has brought forth the possibility not only to overcome distances

[43] Wootton, Richard "Telemedicine." British Medical Journal, Vol. 323, Clinical Review (September 8, 2001): 557-560

[44] Bashshur, Rashid A., and Patricia A, Armstrong. "Telemedicine: A New Mode for the Delivery of Health Care." *Inquiry.* Vol.13. No.3 (September 1976): 233-244

[45] European Commission. Press Release. "Survey takes pulse of e-Health in Europe and Prescribes Wider ICT Use among Doctors." IP/08/641 on 25 April 2008. Brussels: European Union.

[46] "Services" *NST Norwegian Centre for Integrated Care and Telemedicine.* Web. 25 September 2013 < http://www.telemed.no/services.5108575-258951.html>

[47] Brindle, David. "Telehealth 'not Effective' for People with Long-Term Conditions, Study Finds" The Guardian 27 February 2013. Web. 30 July 2013.

[48] Chen, Pauline W. "Are Doctors Ready for Virtual Visits?" *The New York Times* 7 January 2010. Web. 30 July 2013.

[49] "Humanitarian." Oxford Dictionaries. 27 March 2013. <http://oxforddictionaries.com/definition/english/humanitarian?q=humanitarian>

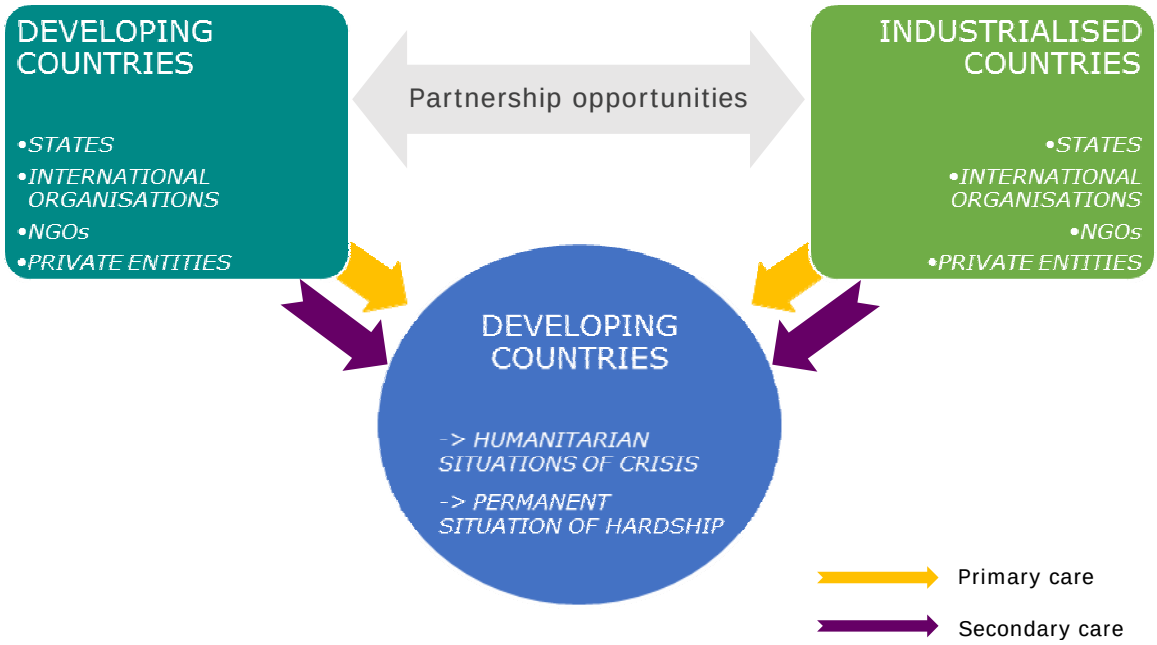

Figure 3: HTM representation

and provide medical care to the most remote regions of the world, but also to improve health care in general. A lack of access to medical professionals constitutes a challenge for patients, and medical institutions themselves. HTM possesses its own limitations, structural needs and characteristics, which need to be identified and analysed by those wishing to develop and implement HTM projects.

Part 1. Successful Humanitarian Telemedicine Projects

3. Popular Uses of Humanitarian Telemedicine

As shown in the first section, HTM concerns itself with the delivery of healthcare in countries that are in a permanent situation of hardship or in humanitarian crises. These two types of situations require distinct HTM measures. Whereas countries facing humanitarian crises require urgent, immediate help, those facing more systemic hardship, although equally in need of immediate action, are also in need of long-term assistance. The following section distinguishes between the two types of situations.

3.1 Permanent Situation of Hardship

Many countries are in a dire situation when it comes to health and their population's access to it. There are severe health care distribution inequalities, not only between industrialised and developing countries, but also within developing countries. Whereas cities generally hold the few available health professionals and access facilities, rural areas face severe shortages.[50]

In HTM, as elsewhere, healthcare can be either primary or secondary in nature. Whereas primary care consists of medical treatment provided by medical generalists directly to patients, secondary care refers to a treatment dispensed by specialised doctors.[51] In terms of telemedicine, both primary and secondary in nature, the most commonly used applications are telediagnostics and teleconsultations.

Teleconsultation aims to "move expertise, not people".[52] While there is a shortage of doctors in certain developing countries, medical specialists represent an even rarer "commodity". It is therefore crucial to connect them with each other and with primary care medical specialists. The Medical Missions for Children (MMC) and the *Réseau en Afrique Francophone pour la Télémedicine* (RAFT) projects are examples of the many projects enabling this connection. The RAFT project offers remote assistance with diagnostics, provides second medical opinions, and assists with the evaluation, decision, and planning of medical evacuations and transfer of patients. Through asynchronous communication, medical professionals are able to reach each other and ask for medical opinions in specialised areas such as radiology, dermatology, surgical follow-ups, and infectious diseases.[53] In addition to enabling the connection between doctors or specialists who need assistance on a difficult case, the benefits that arise with a more permanent connection are not to be dismissed. Thus, MMC's Telemedicine Outreach Program provides mentoring in addition to specialist medical paediatric advice. The same is true for RAFT. Help can now be provided in the monitoring of treatment, the supervision of specialised services, and advances in diagnostic tools. Teleconsultations have proven their benefit, which is highlighted by the number of countries that participate in such projects, 108 in the case of MMC, and in the number of requests for teleexpertise that are made, 800 per year in the case of RAFT.[54]

[50] "Squeezing out the Doctor". *The Economist* 2 June 2012: 25-27. Print.
[51] "Primary Care. *Cambridge Dictionary.* Web. 16 April 2013 <http://dictionary.cambridge.org/dictionary/british/primary-care?q=primary+care> and "secondary care." *Cambridge Dictionary*. Web. 16 April 2013.<http://medical-dictionary.thefreedictionary.com/secondary+care>

[52] Geissbuhler, Antoine. "Telemedicine for Development and Humanitarian Purposes." European Space Policy Institute, HTM. 14 June 2012 in Vienna
[53] Ibid. and "The RAFT network A Telemedicine Network in Africa to Support Healthcare Professionals where they are Most Needed" *RAFT* Web. 30 July 2013 <http://raft.hcuge.ch/10-04-14%20RAFT%20detailed%20description.pdf>
[54] Geissbuhler, Antoine. "Telemedicine for Development and Humanitarian Purposes." European Space Policy Institute, HTM. 14 June 2012 in Vienna and Riehl, John.

Whereas teleconsultations are increasing, another application of telemedicine has shown to be successful: telediagnostics. It truly epitomises the idea of "moving expertise, not people". While teleconsultations and telementoring mostly occur between two medical professionals, telediagnostics generally involve a direct link, through video for example, between a medical professional and a patient, in which the medical professional could be located on another continent. There is often, however, a nurse or another medical professional present with the patient, who helps transmit, translate, and/or apply the decisions made by the off-site medical professional. In existing projects developed in the area of telediagnostics, the local point of contact can either be fixed or mobile. Therefore, in order to truly move expertise in the area of diagnostics, a project can have a mobile point of contact, such as the telemedicine "suitcase" developed by the French Space Agency CNES in French Guyana.[55] The aim of this initiative is to offer a primary diagnostic to identify whether it is necessary to transfer a patient. With a computer, a satellite phone, a microscope, an electrocardiogram, and a digital camera, the information is gathered in the field and sent (via satellite connection), to the hospital in Cayenne. The decision to transfer the patient is then taken directly by a medical professional located at the hospital.[56] Using technology originally developed for the primary care of astronauts, CNES has broadened the reach of primary care services to some of the most secluded areas of French Guyana.

Teleconsultations are among the most popular telemedicine applications used for HTM. Due to the ease with which they are established, their presence can be easily observed in the vast majority of the projects where they are used. For example, in Operation Village Heath (OVH), over 800 patients have received care. The operation was originally set up by Harvard-affiliated physicians to support Cambodian health workers. With a fixed point-of-care, clinical data such as medical histories, physical exams, and lab and digital images are transmitted to Boston, and diagnoses are then sent back to Phnom Penh via email within hours.[57] The main objective of the OVH programme is diagnosis of patients at a distance. These projects have not only saved lives but have also improved medical awareness among local populations, and helped de-isolate medical professionals.[58] In the Cambodian village where OVH operates, the waiting time to receive medical attention has been decreased from three years to six months. Additionally, in areas where transport constitutes a financial burden, the efficiency of such systems enables substantial savings from cases where patients do not require to be transported but might have otherwise.

3.2 Situations of Humanitarian Crisis

When developing countries are struck by a disaster, they witness a great need for medical aid, as their medical structures can often find their situation unmanageable. Therefore, many HTM projects can be found in such situations. Indeed, a majority of the aid distributed via telemedicine is intended to remedy situations of crisis.

The UN has defined disaster as a "serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of the affected people to cope using its own resources", or in the case of developing countries, *further* exceed their ability to cope.[59] Disasters may be natural or man-made. On the one hand, natural disasters are characterised as being unintentional and are categorised by the Centre for Research on the Epidemiology of Disasters (CRED) into six categories: "geophysical [e.g.: earthquakes or volcanoes], meteorological [e.g.: hurricanes, cyclones and tornadoes], hydrological [e.g.: floods], climatological [e.g.: extreme temperatures, droughts or wildfires], biological [epidemic or infestations], and extra-terrestrial [e.g.: meteorites]".[60] On the other hand, man-made disasters may be unintentional (e.g.: chemical and radiation release, structure collapses, or sinking boats…) or intentional (e.g.: a result of terrorism or

"Telemedicine in Action: the Example of Medical Missions for Children." European Space Policy Institute, HTM. 14 June 2012 in Vienna.

[55] "Téléconsultation, un service d'urgence dans une valise." *CNES*. Web. 30 July 2013. <http://www.cnes.fr/web/CNES-fr/6352-teleconsultation-un-service-durgence-dans-une-valise.php>

[56] Ibid.

[57] "Operation Village Health" *Centre for Connected Health* Web. 30 July 2013 < http://www.connected-health.org/programs/remote-consults--virtual-visits/center-for-connected-health-initiatives/operation-village-health.aspx>

[58] Ibid.

[59] World Health Organization. "Coping with Emergencies: WHO Strategies and Approaches to Humanitarian Action." Geneva. 1995.

[60] Judkins, Daniel G, Rifat Latifi, and George J Hadeed,. "Trauma and Disasters as a Worlwide Problem: An Overview." *Telemedicine for Trauma Emergencies and Disaster Management.* Ed. Rifat Latifi. Norwood: ARTECH HOUSE, 2011. 23-35. Print.

war).[61,62] Whether natural or man-made, disasters all have two medical phases. The first phase is called acute or subacute, and it generally lasts between several hours and a week. It is characterised by patients having acute trauma and needing lifesaving treatment. The second is called the recovery phase. It starts immediately after the end of the acute phase and may last up to several months, or years. It is usually characterised by chronically ill patients in need of primary or specialty care.[63] As part of the HTM that is provided to developing countries in times of crises or disasters, examples of both primary and secondary care can be found. This subsection therefore focuses on these two types of care provision.

3.2.1 Primary Care

Natural Disasters

According to the CRED, 332 natural disasters occurred in 2011, which "caused the death of more than 30,770 people, made 244.7 million victims and caused a record amount of USD 366.1 billion of damages".[64] Natural disasters not only cause the death of countless people, they also damage infrastructure, services, resources, and social structures, thus creating more victims beyond the first wave of mortality following the disaster. Injuries resulting from infrastructure debris, fires or explosions, illnesses resulting from contaminated air and water, and other threats such as rape, increase the number of victims affected indirectly by a natural disaster. With injuries multiplying after the first hit of a natural disaster, the need for medical availability is more urgently felt, especially in primary care. Indeed, in order to appropriately identify injuries and possible diseases to be treated by specialists, a triage of the wounded and sick must take place.

To satisfy medical needs in times of natural disasters, access to telecommunication infrastructure must be ensured, since only this tool makes the delivery of telemedicine possible. Often, only space-based telecommunication will be possible, as terrestrial networks are frequently destroyed. However, getting priority access to bandwidth can be challenging.[65] This can be due, in part, to competing, well-funded news media operating on the ground. Additionally, satellite-based communication services are difficult to trigger spontaneously and rapidly, and they can be a heavy financial burden.[66]

Despite these challenges, several organisations have developed equipment that utilises communication satellites for crisis HTM. For example, les Casques Rouges has created a tool for managing humanitarian crises called Emergesat, in collaboration with CNES and Thales Alenia.[67] Emergesat is a humanitarian container that can be deployed to a disaster zone within 48 hours and that sets up a communications network. Along with the communications infrastructure, numerous software items are available, including some for epidemiology (through cartography), and more importantly, for victim management.[68] As previously mentioned, there is a need for triage in such situations, and victim management software allows for the identification of victims. It can even identify the severity of patients' wounds, and their position on a map. In addition to the software and infrastructure that the container provides, it is also medically equipped (electrocardiogram, microscope for analysis, ultrasound, a mini medical laboratory…).[69] Emergesat was successfully deployed in Haiti in 2010 and, in addition to establishing a communication network, it helped coordinate the international humanitarian effort in the country.

Other projects have been successfully set up to monitor patients in cases of natural disasters. During the 2008 Wenchuan earthquake, the Chinese Rescue Terminal, which enables

[61] Ibid.
[62] War-related disasters, otherwise known by the United Nations as a complex emergency, consists of "a humanitarian crisis in a country, region or society where there is total or considerable breakdown of authority resulting from internal or external conflict and which requires an international response that goes beyond the mandate or capacity of any single agency and/or the ongoing United Nations country program". Ibid: p 29.
[63] Lam, David M. "Telemedicine in Disaster Management – The Military Viewpoint." 3rd Intensive Balkans Telemedicine and Ehealth Seminar on February 2009 in Skopje. Web. 30 July 2013 <http://www.youtube.com/watch?v=dg0sqyerF0U> and Turnock, Matthew. "Pre-hospital Application of Telemedicine in Acute-Onset Disaster Situations". UN SPIDER. 9 December 2008. Web. 30 July 2013 <http://www.un-spider.org/sites/default/files/Prehospital%20telemedicine%20in%20disasters.pdf>
[64] Guha-Sapir, Debby, et al. "Annual Disaster Statistical Review 2011 The Numbers and Trends" *Project Disaster*. Web. 30 July 2013. <http://projectdisaster.com/media/DisasterReview-2011-WHO.pdf>
[65] Klock, Erich, and Mildred, Trögeler. "Space Applications for Civil Protection". ESPI. Report 37. (September 2011): 5
66 Ibid. 29
67 "Emergesat, Un Outil De Gestion Des Crises Humanitaires." *Emergesat*. Web. 30 July 2013 <http://www.emergesat.org/>
[68] Epelboin, Fabrice. "Les Casques Rouges Installent Emergesat en Haiti." *Readwriteweb France* 15 January 2010.
[69] "Deux conteneurs Emergesat en Haïti" *Thales.* Web. 30 July 2013 <http://www.thales-avionics.eu/News_and_Events/Markets/Space/Deux_conteneurs_Emergesat_en_Ha%C3%AFti/>

the telemonitoring of vital signs, also enabled not only the monitoring of the rescue crews, but also the localisation of the wounded.[70] A more recent example is that of the 2011 Japanese tsunami. With the loss of infrastructure and the unavailability of medical professionals, Dr. Kario established the Disaster Cardiovascular Prevention Network (D-CAP). The network not only put doctors in contact with the relevant authorities, but also monitored patients at a distance. The blood pressure of the evacuated could even be monitored remotely. This enabled doctors to detect conditions early on, and to diagnose them more accurately, thus avoiding unnecessary doctor visits and hospitalisations.[71] It should be noted that these projects, centred on the primary care to be given during a natural disaster, have proven successful in cases of desperate need. When infrastructure and resources are scarce in times of natural disasters, telemedicine has helped increase both the quantity and quality of medical aid provided.

Man-Made Disasters

Estimates of yearly deaths related to armed conflicts vary between 20,000 and 50,000 per year.[72,73] Just as natural disasters cause many more victims than the number of direct deaths, so do man-made disasters. Indirect victims of conflicts can see their health affected by "the displacement of populations, the breakdown of health and social services, and the heightened risk of disease transmission", or can die from "a variety of specific causes [...] from easily preventable diseases such as dysentery or measles, or from hunger or malnutrition".[74,75] The number of indirect victims of man-made disasters is difficult to quantify accurately. However, according to the Global Burden of Armed Violence 2008 report published by the Geneva Declaration, "a reasonable average estimate would be a ratio of four indirect deaths to one direct death in contemporary conflict, which would represent *at least 200,000* indirect conflict deaths per year".[76] Therefore, much like natural disasters, man-made disasters generate much medical need due to their high number of casualties.

The use of telemedicine for primary care in man-made disasters is less developed than for natural disasters. The instability, the violence, and the significant threat level to personnel add to the already desperate need for medical aid. There are, however, successful examples to be found in such settings. *Médecins Sans Frontières* (MSF) successfully set up a HTM system in Somalia in 2010. With the country increasingly hostile to international staff, the organisation, with the help of audio–visual communications, managed to provide 222 remote consultations, even after having withdrawn international staff from the country.[77] MSF estimates that "105 of these 222 patients would likely have died" if it had not been for their telemedicine consultations.[78] Even though some projects have been developed to assist humanitarian organisations with the delivery of their aid in war-affected territories[79], examples of primary care telemedicine in such situations are scarcer than for any other disaster situation.

3.2.2 Secondary Care

Since the 1985 Mexico City earthquake, secondary care has made tremendous strides in disaster situations. Many projects have been developed, and have been successful in remotely delivering secondary care to patients during these situations of crisis. Additionally, military experiences in this field have helped further develop the care that can be provided at a distance.

[70] Zhao, Junping, et al. "The Design and Implementation of a Rescue Terminal with Vital Signs Telemonitoring Based on Beidou 1 Navigation Satellite System." *Telemedicine and e-Health*. Vol.17. Issue 2 (2011):76-79. Print.
[71] Eto, Masatake. "Telemedicine as a Tool in Japan Disaster Relief, Disaster Cardiovascular Prevention Network." Continua Summer Summit, Washington D.C. 27 July 2011. Web. 30 July 2013 <http://www.youtube.com/watch?v=oHbq4Nx1mgI>
[72] "Battle-related Deaths." *World Bank.* Web. 30 July 2013 <http://data.worldbank.org/indicator/VC.BTL.DETH?order=wbapi_data_value_2011+wbapi_data_value+wbapi_data_value-last&sort=asc>
[73] Global Burden of Armed Violence 2008. "Chapter 1. Direct Conflict Death" *Geneva Declaration* Web. 30 July 2013 <http://www.genevadeclaration.org/fileadmin/docs/GBAV/GBAV08-CH1.pdf>
[74] Murray. C.J.L., et al. "Armed Conflict as a Public Health Problem." *British Medical Journal.* Vol.324 (2002): 346-349. Print.
[75] Global Burden of Armed Violence 2008. "Chapter 2. The Many Victims of War: Indirect Conflict Deaths" *Geneva Declaration* Web. 30 July 2013 <http://www.genevadeclaration.org/fileadmin/docs/GBAV/GBAV08-CH2.pdf>
[76] Global Burden of Armed Violence 2008. "Chapter 2…" *Geneva Declaration* Web. 30 July 2013…
[77] Papp, Andreas. "MSF & Telemedicine the Somalia Experience." European Space Policy Institute, HTM. 14 June 2012 in Vienna.
[78] "20 June 2012. HTM at ESPI". *ESPI.* Web. 30 July 2013 <http://www.espi.or.at/news-archive/816-humanitarian-telemedicine-at-espi>
[79] Humanav, developed by CNES, equips humanitarian vehicles with space technologies (GPS, telecommunications, cartography…) in order to guaranty their safety. "Humanav: Une Offre De Service Innovante Aux Agences Humanitaires." CNES. Web. 30 July 2013. <http://www.cnes.fr/web/CNES-fr/9532-gp-humanav-une-offre-de-service-innovante-aux-agences-humanitaires.php>

Civilian

In 1988 a major earthquake devastated the Northwest of what was, at the time, the Armenian Soviet Socialist Republic. Under the auspices of the USA and the USSR Joint Working Group on Space Biology and Medicine, the American National Aeronautics and Space Administration (NASA) established a telecommunications bridge between several medical centres in Armenia, elsewhere in the USSR, and in the USA.[80] The Spacebridge to Armenia, as it was called, provided mainly for teleconsultations between medical professionals, and was active for three months. During that time, between 209 and 240 cases were transmitted from Armenia to medical facilities located outside the country. Consultations were provided in various medical disciplines, such as neurology, orthopaedics, psychiatry, infectious diseases, and general surgery. They resulted in 54 patient diagnosis changes (approximately 25 percent) and 47 treatment plan changes.[81] The success of the project was due not only to the effectiveness of the teleconsultations, but also because it proved to be adaptable to other situations. Shortly after the earthquake struck Armenia, there was a large train explosion in Ufa, Soviet Union. With too many casualties to be handled by medical professionals in Ufa alone, images were sent to the Spacebridge in Yerevan for help with the diagnoses.[82] Following the success of the Spacebridge to Armenia, a follow-up project was created in 1993, namely the Spacebridge to Moscow. The project established a two-way live video and audio connection between universities in the USA and a clinical hospital in Moscow. It was activated following an attempted coup in Moscow and resulted in 18 "clinical consultation sessions [involving] internal medicine, disaster and trauma management, surgery, and public health".[83] With radio images being sent from one hospital to another, and the spacebridge being adaptable to both man-made and natural disasters, it was further developed to include technologies such as the World Wide Web and graphic interface. It was later renamed, a third and final time, to Spacebridge to Russia.[84]

NASA, through the establishment and development of telemedicine, has provided the evidence needed to further develop this tool for other disasters. More recently, in the aftermath of the major earthquake that struck Haiti in 2010, many potential uses of telemedicine by civilians were tested successfully. Days after the earthquake struck the island, the University of Miami set up a tent hospital on the ground and established a satellite connection with their colleagues in Florida. Through the satellite connection, the medical staff located in Haiti were able to request medical supplies and to send images of patients needing specialist care. This, in turn, enabled a first series of triage.[85] In that particular crisis, the military also used its infrastructure to help with remote consultations, through its navy hospital.[86]

Military

Due to the nature of military activity, telemedicine is one of the tools that armies use to deliver remote medical care, in particular radiology and specialist diagnostics. Telemedicine has proven to be effective not only for the military, but also in response to disaster situations.[87] The conditions under which soldiers fight and those under which civilians find themselves when a disaster strikes have similarities, which make military telemedicine adaptable to HTM.[88] Just as the time constraint is important in both situations, so is the impossibility of bringing high numbers of specialists to the crisis area. The robustness of military applications, due to the hostile environments in which they generally operate, is equally beneficial to HTM. Additionally, in both cases, when local infrastructure is destroyed, a need arises to set up telecommunication networks.

The military has helped alleviate suffering in civilian disasters since the early 1990s. From natural disasters such as Hurricane Hugo, which hit the Virgin Islands in 1989, to man-made disasters such as the civil war in Somalia in 1992, which resulted in widespread famine and infectious diseases, the military

[80] Doarn, Charles R. "Chapter 2. Evolution of Telemedicine in the Space Program and Earth Applications" *Telemedicine for Trauma Emergencies and Disaster Management.* Ed. Rifat Latifi. Norwood: ARTECH HOUSE, 2011. 9-22. Print.
[81] Garshnek, Victoria, and Frederick M. Burkle, Jr. "Applications of Telemedicine and Telecommunications to Disaster Medicine". *Journal American Medical Informatics Association*. Vol. 6. No. 1(1999):26-37
[82] Ibid.
[83] Ibid.
[84] Doarn, Charles R. "Chapter 2. Evolution of Telemedicine in the Space Program and Earth Applications" *Telemedicine for Trauma Emergencies and Disaster Management.* Ed. Rifat Latifi. Norwood: ARTECH HOUSE, 2011. 9-22. Print.
[85] Louden, Kathleen. "Telemedicine Connects Earthquake-Ravaged Haiti to the World." *Medscape* 18 February 2010. Web. 30 July 2013.
[86] Freudenheim, Milt. "In Haiti, Practicing Medicine from Afar." *The New York Times* 9 February 2010. Web. 30 July 2013.
[87] Merrell, Ronald C. "Historical Notes". Ed. Rifat Latifi (2011)
[88] Rafiq, Azhar and Ronald C. Merrell. "Telemedicine in Extreme Conditions: Disasters, War, and Remote Sites". *Telemedicine for Trauma Emergencies and Disaster Management.* Ed. Rifat Latifi. Norwood: ARTECH HOUSE, 2011. 161-171. Print.

successfully provided secondary care to local populations via telemedicine.[89] The main applications of telemedicine in the US military are teleradiology and teleconsultations. For example, following the major earthquake that struck Pakistan in 2005, there were over one million radio images sent from the disaster zone to a base in Germany.[90] Although the technology has grown from black and white low resolution images to high-resolution digital images, and consultations can now be carried out through real time video transmission rather than voice messages, the core application of medicine in such situations remains the same.[91]

The military has helped improve HTM applications in disaster situations. Among the core issues in that domain that persist today is the need for medical standardisation. The North Atlantic Treaty Organization (NATO) represents military cooperation at its most diverse, as it involves intercontinental cooperation in many fields. When many different armed forces work together, it is essential to create common standards appropriate for all.[92] Civilian organisations share a need for strong coordination and cooperation with their partners. Certain telemedicine applications, in particular in secondary care, have been successful, but would not have been had they not included strong cooperation among all parties involved.

[89] Garshnek, Victoria, and Frederick M. Burkle, Jr. "Applications of Telemedicine and Telecommunications to Disaster Medicine". *Journal of the American Medical Informatics Association*. Vol. 6. No. 1(1999): 28

[90] Lam, David M. "Telemedicine in Disaster Management – The Military Viewpoint." 3rd Intensive Balkans Telemedicine and Ehealth Seminar on February 2009 in Skopje. Web. 30 July 2013 <http://www.youtube.com/watch?v=dg0sqyerF0U>

[91] Ibid.

[92] Lam, David M. "Establishing Clinical Protocols and Standards: The Military Approach" *Telemedicine for Trauma Emergencies and Disaster Management.* Ed. Rifat Latifi. Norwood: ARTECH HOUSE, 2011. 147-159. Print.

4. Telemedicine: A Springboard for Cooperation and Development

Telemedicine is a tool that services the delivery of medical care. It is not an end in itself but rather the medium through which the provision of medical care is made possible. As such, one must look at the users of this tool and the way in which they approach the delivery of medical care through telemedicine. As seen in the previous sections, telemedicine can be delivered by countries that are industrialised or developing to countries that are suffering due to permanent situations of hardship or that have been struck by a natural or man-made disaster. In addition, the aid provided can be delivered by international organisations (governmental or non-governmental), or by national organisations (governmental or educational, and military or civilian).

The numerous actors who could help improve medical care through telemedicine are inevitably and systematically faced with the need to cooperate with other actors, and to take into account the work that they do. The most significant cases for cooperation generally arise as part of medical disaster responses, where resources often come from "[national] governments, [external] countries, humanitarian assistance organisations, medical personnel, [...] and volunteers from external sources".[93] The need for effective cooperation when dealing with the aftermath of a disaster is essential. However, cooperation is not only necessary in disaster situations but also in providing long-term care in countries where there are systemic health lacunae. In order to draw a picture of the aid currently distributed, the next section will first focus on the industrialised/developing country relationship, and then on the aid provided to and from developing countries themselves.

4.1 Industrialised/Developing Country Cooperation

Of the numerous projects that aim to provide medical aid to populations that suffer from medical shortages, most projects come from industrialised countries. Indeed, with many developing countries in dire need of trained medical personnel, and with a high proportion of medical professionals located in industrialised countries, medical aid is often provided by the latter. Among the industrialised countries that provide medical aid through telemedicine, a number of international institutions and national initiatives are used to channel the support delivered.

4.1.1 International Institutions' Initiatives

Space Related Organisations

International institutions working in the space industry have a permanent mandate for dealing with the topic of cooperation. They also have a keen interest in telehealth and telemedicine, as these are highly visible applications of space technology, in particular where satellite connections are relied upon for telecommunications. The two space-related institutions that have developed projects centred on these space applications, and that are the most engaged in promoting these, are the European Space Agency (ESA) and the United Nations Office for Outer Space Affairs (UNOOSA).

In terms of telemedicine projects, ESA has a series of programmes in Advanced Research in Telecommunications Systems (ARTES), in which some projects deal with the use of telemedicine in developing countries. The majority of the projects related to eHealth and telemedicine are in the ARTES 1 element (Preparatory: strategic analysis), ARTES 3-4 (Products: development, qualification and demonstration) and ARTES 20 (Integrated Applications Promotion (IAP): development, implementation and pilot operations). Within the ARTES programmes, there are over ten

[93] Turnock, Matthew. "Pre-hospital Application of Telemedicine in Acute-Onset Disaster Situations". UN SPIDER. 9 December 2008. Web. 30 July 2013 <http://www.unspider.org/sites/default/files/Prehospital%20telemedicine%20in%20disasters.pdf>

projects dealing with eHealth.[94] One of these projects relates to eHealth for sub-Saharan Africa (eHSA). The project has four studies planned, two of which have been executed; one on regulatory frameworks, and one on governance. The goal of this programme is to provide "various types of eHealth [satellite-enabled] services to benefit citizens and health workers".[95] As part of eHSA, and in order to demonstrate the readiness and effectiveness of eHealth solutions, the Satellite African e-Health Validation (SAHEL) was set up.[96] In terms of medical tele-education, ESA has set up a project called Inside 4 Africa that aims to provide a one-step solution for the collection, organisation, delivery, and use of educational contents in that field.[97] Although the ESA ARTES projects relating to eHealth and telemedicine are in different phases, the sheer number of ongoing projects that it maintains demonstrates the attention that ESA is paying to the topic.

UNOOSA has also shown significant interest in eHealth and telemedicine. The Office is heavily invested in space related activities for supporting disaster management – i.e.: the United Nations Platform for Space-based Information for Disaster Management and Emergency Response, UN-SPIDER, established in 2006. In terms of telemedicine, UNOOSA has actively promoted and supported a number of projects. Between 2000 and 2010, it organised and actively participated in over 20 conferences, workshops and expert meetings on such topics.[98] In addition, it supports the South Asian Association for Regional Cooperation in its telemedicine project, which was initiated by the government of India following the 2009 Thimphu declaration.[99,100] The commitments and involvement of UNOOSA in that field have demonstrated its engagement in applying space technologies to health and medicine.

Increasing interest in the utilisation of space technologies for supporting cooperative undertakings in the field of telemedicine has also recently emerged in the two space-related international organisations of the Asia-Pacific region: the Japan-led Asia-Pacific Regional Space Agency Forum (APRSAF) and the China-led Asia-Pacific Space Cooperation Organisation (APSCO). Within the APRSAF framework, the Communications Satellite Application Working Group has identified telemedicine as one of the key areas for developing new satellite applications[101], particularly with regards to the establishment of a comprehensive disaster management support mechanism.[102] Similarly, the Communication Satellite Application Project launched by APSCO in November 2011 encompasses, among its priorities, the development of tele-education and telemedicine applications that will be jointly utilised by APSCO member states.[103]

Other International Institutions

With the establishment of the MDGs in September 2000, the UN has committed to the achievement of eight development-related objectives. As stated in Chapter 1, health is central to the achievement of half of these goals. In 2005, the WHO published a report on eHealth, which stated, in the first paragraph:

> » "The emergence and growth of information and communication technologies, touching many spheres of life, have in the past decade brought opportunity and challenge to all countries. This is reflected in the Millennium Development Goals, especially target 18: 'In cooperation with the private sector, make available the benefits of new technologies, especially information and communications'".[104]

[94] "ESA's Telecommunications and Integrated Applications Directorate" *ESA*. Web. 30 July 2013 <http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=160>

[95] "eHealth for Sub-Saharan Africa (eHSA) – Study on Regulatory Aspects" *ESA*. Web. 30 July 2013 <http://iap.esa.int/projects/health/ehsa> and "eHealth for Sub-Saharan Africa (eHSA) – Governance study" *ESA*. Web. 30 July 2013 <http://iap.esa.int/projects/health/ehsa-governance>

[96] "Satellite-enhanced eHealth for sub-Saharan Africa Programme (eHSA)". *ESA*. 25 September 2012. Web. 30 July 2013<http://iap.esa.int/showcases/third-party-collaboration/ehealth-for-ssa-2>.

[97] "ISIDE 4 Africa" *ESA*. Web. 30 July 2013 <http://iap.esa.int/projects/development/iside4africa> and "ISIDE 4 Africa" *ESA*. Web. 30 July 2013 <http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=29901>

[98] United Nations. "UN/Office for Outer Space Affairs Panel on "Satellite Application to Health"." Medetel from 6 to 8 April 2011 in Luxemburg.

[99] "About SAARC Telemedicine Project." *SAARC*. Web. 30 July 2013. <http://www.saarctf.org/About/SAARCTF.aspx>

[100] The Thimphu declaration signed on July 30th 2009 brings together the SAARC countries in order to "improve access to quality healthcare through telemedicine and Tele-health". SAARC. "Thimphu Declaration on Tele-Health" SAARC meeting from 27 to 30 July 2009 in Bhutan.

[101] "Communication Satellite Applications Working Group". APRSAF. Web. January 15 2014 <http://www.aprsaf.org/working_groups/csa/>

[102] "Sentinel Asia: Disaster Management Support in the Asia-Pacific Region". APRSAF. Web. January 15 2014. <http://www.aprsaf.org/initiatives/sentinel_asia/>

[103] "ACAP". APSCO. Web. January 15 2014 <http://www.apsco.int/program.asp?LinkNameW1=ACAP&LinkCodeN=88>

[104] World Health Organization. "Fifty-Eighth World Health Assembly eHealth Report by the Secretariat". On 7 April 2005. WHO Doc. A58/21. Print.

The same year, during the Fifty-eighth World Health Assembly, the WHO adopted a resolution establishing the eHealth strategy for the organisation. Following that resolution, it established the Global Observatory for eHealth.[105] Its mission is to "improve health by providing Member States with strategic information and guidance on effective practices and standards in eHealth".[106] So far, the Observatory has published six reports, ranging from country profiles to opportunities and challenges of telemedicine and eHealth. The initiatives undertaken by the WHO since 2005 have demonstrated the possibility for telemedicine to be used for the achievement of improved access to healthcare. Moreover, the WHO has been working in close collaboration with other actors in the field of telemedicine in disaster crises (i.e.: during the 2005 Pakistan Earthquake) as well as in supporting telemedicine projects (i.e.: the maternal and new-born health in Mongolia project).[107]

Other international organisations are also taking a keen interest in the topic of eHealth. NATO, for example has shown an interest in telemedicine for civilian matters. It has tried to achieve a consensus on the issue of standardisation among its members, in terms of telemedicine protocols, and has taken important steps towards the further inclusion of telemedicine in its agenda.[108] The NATO-Russia Council's (NRC) Science for Peace and Security Committee is currently working "towards a multinational disaster response network" through a set of dedicated workshops.[109] The capabilities of telemedicine therefore constitute a matter to be considered, not only by governmental organisations, but also by military as well as non-governmental ones.

NGOs are especially involved in broadening the use of telemedicine to improve health care worldwide. Numerous examples show the prominence of NGO initiatives in telemedicine, some of which were mentioned above.

4.1.2 National Initiatives

Telemedicine projects were first used extensively as part of national governmental initiatives. However, state institutions are no longer the sole actors in the field of HTM: academics, doctors and private enterprises also engage in these activities.

In the field of government-led telemedicine projects, space-related institutions prevail. Just as international institutions dealing with space affairs are keen to develop and use space applications for telemedicine projects, so are national agencies. As previously explained, NASA was the first agency to extensively use telemedicine in disaster scenarios. Since the 1980s other national space agencies have followed suit and have established similar projects.

Generally, national space agencies have invested significant time and resources in telemedicine projects for their own specific space purposes. Thus, the German space agency DLR has actively researched telemedicine applications for astronauts [along with the military], as have the American, European, and Russian space agencies, respectively, NASA, ESA and ROSCOSMOS.[110,111] In terms of HTM, both industrialised and developing countries are showing growing interest in the matter. The Indian space agency, ISRO, and the Nigerian space agency, NASRDA, are among the interested parties, albeit mostly for national applications.[112] More recently, other national space agencies have participated in HTM projects, such as the French space agency CNES. Since 1998, CNES has been interested in eHealth and has developed four areas of application: (1) broadening health reach, (2) environment, climate and health, (3) crisis management, and (4) education.[113]

[105] "Directory of eHealth policies" *WHO*. Web. 30 July 2013. <http://www.who.int/goe/en/> and World Health Organization. Resolutions and Decisions on its Fifty-Eighth World Health Assembly, Held in Geneva from 16 to 25 May 2005. WHO Doc. WHA58/2005/REC/1

[106] "Directory of eHealth policies" *WHO*. Web. 30 July 2013. <http://www.who.int/goe/en/>

[107] Lam, David M. "Telemedicine in Disaster Management – The Military Viewpoint." 3rd Intensive Balkans Telemedicine and Ehealth Seminar on February 2009 in Skopje. Web. 30 July 2013 <http://www.youtube.com/watch?v=dg0sqyerF0U> and "Telemedicine Opportunities and Developments in Member States 2010". Global Observatory for eHealth series. Vol. 2. World Health Organization, 30 July 2013

[108] Lam, David M. "Establishing Clinical Protocols and Standards: The Military Approach" *Telemedicine for Trauma Emergencies and Disaster Management.* Ed. Rifat Latifi. Norwood: ARTECH HOUSE, 2011. 147-159. Print.

[109] "NATO-RUSSIA Council Practical Cooperation Fact Sheet." *NATO.int*. 30 July 2013 <http://www.nato.int/nato_static/assets/pdf/pdf_2012_11/20121204_121128-NRC-factsheet.pdf>

[110] Cermack, M. Monitoring and telemedicine support in remote environments and in human space flight" *British Journal of Anaesthesia* Vol. 97. Issue 1(2006): 107–14

[111] "Fact Sheet" *NASA* Web. 30 July 2013. <http://www.nasa.gov/mission_pages/station/research/experiments/562.html#publications>

[112] "PRWeb – Telemedicine in Space" *AMD*. 11 November 2007. Web. 30 July 2013 <http://www.amdtelemedicine.com/media/press-071111.html>

[113] "La Télésanté L'espace au service de la santé." CNES. Web. 30 July 2013 <http://www.cnes.fr/automne_modules_files/standard/public/p6195_2b9d3d73e247c66544547197895c9e0ePlaquette_TELESANTE.pdf>

Many university hospitals have become involved with telemedicine, and more generally, eHealth. One of the most renowned projects in this respect is the RAFT project. The African network for telemedicine was initiated and developed by the Geneva University Hospitals, under Professor Geissbuhler.[114] The project, which focuses on telediagnostics and tele-education, started in Mali and is now present in over 20 countries. The RAFT Network illustrates that doctors themselves are among the initiators of telemedicine projects. The OVH project is another such project. Initiated in 2001, this operation has enabled Harvard-affiliated physicians in the Partners Health Care system, a non-profit organisation, to support Cambodian health workers in the village of Rovieng. In practice, the health workers are able to collect medical information in the village and, when needed, to send that information to hospitals located in Phnom Penh, Cambodia, and in Boston, USA. The medical files are then reviewed, and a diagnosis is provided and sent back within hours to the health workers.[115] While it is not as extensive as the RAFT Network, the project illustrates the importance of good communication channels, on both technological and human levels.

4.2 Cooperation between Developing Countries: The Indian Experience

While medical aid predominantly originates from industrialised countries, there are also initiatives to be found between developing countries. While technology and culture may present lesser barriers to care in such cases[116], other elements must be considered. For instance, the need for coordination and collaboration is the same. India is a predominant actor in providing aid to developing countries and emerging economies; it is involved in numerous projects in Asia and in Africa. This extensive experience with inter-country telemedicine projects stems from vast experience in that domain within its own borders.

4.2.1 Indian Telemedicine Background

India has vast experience in terms of telemedicine application. With 80 percent of the country's medical professionals located in metropolitan areas, where 20 percent of its population resides, the importance of reaching the other 80 percent of its population acted as the early catalyst for the initiation of national telemedicine projects.[117] The Indian centres, in which the extensive community of telemedicine users can be found, are ISRO and the Apollo Hospitals. They cooperated on their first project in 1998, along with the Department of Space and the Government of India. The project was centred around the establishment of a secondary care hospital in the village of Aragonda, 250 miles from Chennai, which was equipped with medical equipment ranging from testing-based equipment to scanners and operating theatres.[118] One year later, these various actors came together to set up a satellite connection for the hospital. Through a Very Small Aperture Terminal (VSAT) supplied by ISRO, teleconsultations were provided from the Apollo Hospital in Chennai. The success story of Aragonda prompted ISRO to establish a second pilot project, the Narayana Hrudayalaya, which successfully provided specialist cardiac care.[119]

ISRO

Following these successes, ISRO established a satellite-based Telemedicine network (through the Indian Satellite System INSAT), which included approximately 400 nodes.[120] Nodes consist of interconnected remote and specialist hospitals, as well as mobile units. In the case of ISRO, in 2010, there were 330 remote/rural hospitals connected to 52 specialty hospitals and 14 mobile units.[121] In addition to remote and specialty hospitals satellite connections, ISRO's telehealth net-

[114] "The RAFT network A Telemedicine Network in Africa to Support Healthcare Professionals where they are Most Needed" *RAFT* Web. 30 July 2013 <http://raft.hcuge.ch/10-04-14%20RAFT%20detailed%20description.pdf>

[115] "Operation Village Health" *Centre for Connected Health* Web. 30 July 2013 < http://www.connected-health.org/programs/remote-consults--virtual-visits/center-for-connected-health-initiatives/operation-village-health.aspx>

[116] Although from a cultural perspective this is not necessarily so. An Indian doctor, operating remotely in Africa, would appear to be almost as culturally displaced as a Swedish one.

[117] Bhaskaranarayana, A., L.S. Satyamurthy, and Murthy L.N. Remilla. "Indian Space Research Organization and Telemedicine in India." *Telemedicine and e-Health.* Vol. 15. Issue 6 (2009):586-591. Print.

[118] Ganapathy, Krishnan, and Ravindra Aditi. "Telemedicine in India: The Apollo Story." *Telemedicine and e-Health.* Vol. 15. Issue 6 (2009): 576-586. Print.

[119] "Telemedicine Healing Touch Through Space." Indian Space Research Organization (ISRO). 30 July 2013 < http://www.isro.org/publications/pdf/Telemedicine.pdf>

[120] Kanta Mishra, Saroj, et al. "Telemedicine in India: Current Scenario and the Future." *Telemedicine and e-Health.* Vol. 15. Issue 6 (2009): 568-576. Print.

[121] Kasturirangan, Krishnaswamy. "The Power of Telemedicine to Bring Medical Care to Underserved Communities." European Space Policy Institute, HTM. 14 June 2012 in Vienna.

work also includes Continuing Medical Education, Mobile Telemedicine, and Disaster Management Support (DMS). The DMS sections of ISRO's telemedicine initiatives enabled the use of existing telemedicine-equipped facilities in the country following the 2004 Asian Tsunami.[122]

The most used mobile units are the Hospital-on-Wheels (HoW) and the tele-ophthalmology units. The HoW was set up as part of the Distance Healthcare Advancement Project (DISHA), which involves ISRO, the Apollo Hospitals, Philips Medical Systems and the DHAN foundation.[123] The well-equipped air-conditioned van enables direct teleconsultations between a specialist located in a distant hospital and the doctors and paramedical staff present in the van.

DISHA has proven very successful by providing medical consultations to 4,000 patients during its pilot phase, which lasted 18 months.[124] The project is currently in its post-pilot phase and its goal for technology use is to "virtually connect health providers and patients instead of a traditional doctor visit".[125] Additionally, the tele-ophthalmology specialty boasts the most mobile units and provides a service for "early diagnosis and treatment of ophthalmic disease under the National Blindness Control Program".

ISRO has established a range of services, which they provide through their satellite connectivity, and in particular through VSATs. In 2009, over 400,000 teleconsultations were provided through ISRO's Telemedicine Network.[126]

Apollo Hospitals

The Apollo group was founded by Dr. Reddy in 1983 and is now Asia's largest healthcare provider. In 1999, the group founded the Apollo Telemedicine Networking Foundation (ATNF), a not-for-profit organisation. The ATNF is the "oldest and largest multi-specialty telemedicine network in South Asia" and "specializes in giving remote consultation and second opinion to both patients and doctors".[127] The ATNF received high appreciation for its activities from former US President Clinton in 2000,[128] as well as from Access Health International, a US not-for-profit organisation working in emerging economies.[129]

ATNF enables the remote examination, investigation, monitoring, and treatment of patients located at a distance from doctors. In order to appropriately connect centres, the Foundation uses Broadband Internet as well as Integrated Services Digital Network (ISDN) lines and VSATs.[130] In over 13 years, the Foundation has conducted over 75,000 consultations through 115 centres, of which 80 percent have been teleconsultations.[131] ATNF is now developing new ways to bridge the geographical and demographic divide. In order to expand the areas in which doctors may connect to provide teleconsultations, the new concept of "Desktop Telemedicine" has been introduced, where teleconsultations may take place from anywhere in a hospital or even from a doctor's home.[132] In addition, the Foundation has conducted a pilot in mobile-health (m-health), which uses the technology of mobile phones, and where doctors in specialty hospitals are "able [through a 3G connection] to clinically "examine" the patient through a high-quality webcam".[133] Finally, one of its recent developments is the project

[122] "Telemedicine Healing Touch Through Space." Indian Space Research Organization (ISRO). 30 July 2013 <http://www.isro.org/publications/pdf/Telemedicine.pdf>

[123] Kasturirangan, Krishnaswamy. "The Power of Telemedicine to Bring Medical Care to Underserved Communities." European Space Policy Institute, HTM. 14 June 2012 in Vienna.
and Ganapathy, Krishnan, and Ravindra Aditi. "Telemedicine in India: The Apollo Story." *Telemedicine and e-Health.* Vol. 15. Issue 6 (2009): 576-586. Print.

[124] Ganapathy, Krishnan, and Ravindra Aditi. "Telemedicine in India: The Apollo Story." *Telemedicine and e-Health.* Vol. 15. Issue 6 (2009): 576-586. Print.
and "Now, tele-hospital goes mobile" Mallady, Shastry V. *The Hindu*. 9 July 2009. Web. 30 July 2013 <http://www.hindu.com/2005/07/09/stories/2005070915730300.htm>

[125] "Distance Healthcare Advancement (DISHA)". Centre for Health Market Innovations. *Web*. 9 October 2013 <http://healthmarketinnovations.org/program/distance-healthcare-advancement-disha>.

[126] "Telemedicine Healing Touch Through Space." Indian Space Research Organization (ISRO). 30 July 2013 < http://www.isro.org/publications/pdf/Telemedicine.pdf>

[127] Bollineni, Raja. "Apollo Telemedicine Networking Foundation (ATNF)" *Access Health International* (2011). Web. 30 July 2013 <http://healthmarketinnovations.org/sites/healthmarketinnovations.org/files/CaseStudy_ATNF.pdf>

[128] "I think it is a wonderful contribution to the healthcare of the people who live in rural villages, and I hope that people all over the world will follow ATNF lead, because if they do, then the benefits of the hi-tech medicine can go to everyone and not just people who live in big cities" Source: "Telemedicine...
Making Geography History" *ATNF*. Web. 30 July 2013 <http://www.telemedicineindia.com/Brochures/ATNF%20New%20brochure.pdf>

[129] "Our vision is that all people, no matter where they live, have a right to access high-quality, affordable healthcare" *Access Health International*. Web. 30 July 2013. <http://www.accessh.org/whoweare.aspx#.Ua79EUD-GY8>

[130] Ganapathy, Krishnan, and Ravindra Aditi. "Telemedicine in India: The Apollo Story." *Telemedicine and e-Health.* Vol. 15. Issue 6 (2009): 576-586. Print.

[131] Challapalli, Sravanthi. "Doctors is in… tele-con." *Hindu Business Online* 31 January 2013. Web. 30 July 2013. < http://www.thehindubusinessline.com/features/weekend-life/doctor-is-in-telecon/article4361392.ece>

[132] "Telemedicine India". Website. Web, 30 June 2013. <http://www.telemedicineindia.com>

[133] Ibid.

"Telemedicine 2.0", which aims to provide telehealth services on phones and tablets, and to integrate them with "hospital systems, electronic medical records of hospitals and mobile personal health records".[134]

In addition to bridging the diagnostic gap in the country, ATNF is improving healthcare services in telecare and telenursing. A pilot study, enabling constant and close monitoring of patients through a Multi-parameter Digital Acquisition Unit (MDAU), has been set up. The MDAU allows for the collection, recording, transmission, and storing of information about patients (i.e.: blood pressure, heart and respiratory sounds, and temperature).[135] The extent of the services provided by ATNF, and their ability and will to align these services with existing technological possibilities, has kept ATNF on the forefront of telemedicine initiatives in Asia. However, despite the Foundation's undisputed success stories, challenges have arisen, especially with regards to national diversity in education and language (six different Indian languages were recorded during teleconsultations).[136]

4.2.2 Indian Inter-Country Telemedicine Initiatives

India and Asia

In terms of inter-country cooperation, India has been very active in medical aid provision.[137] Hosting the biggest telemedicine network in South Asia, India has expanded not only to other Asian countries, but also to the African continent. It has been involved in different telemedicine projects with its regional neighbours, both at the governmental and non-governmental levels.

In 1985, India, along with six other nations, founded the South Asian Association for Regional Cooperation (SAARC). Born through the initiative of Bangladeshi President Rahman in the 1970s, the founding seven countries adopted the Declaration on South Asian Regional Cooperation in 1983, and the Charter establishing SAARC in 1985.[138] The Association is dedicated to "economic, technological, social and cultural development emphasizing on collective self-reliance".[139] In 2007 - the year Afghanistan officially joined SAARC - the Association "noted with appreciation the establishment of a collaborative health care project involving a regional telemedicine-network".[140] This statement followed the conclusion of the preparatory work that was done for the pilot project (initiated by the Government of India), which connected hospitals in SAARC countries with specialty hospitals in India. Following the 2009 workshop on applications of telehealth, the Thimphu Declaration was signed and the project was officially inaugurated and named the SAARC e-Network Telemedicine project.[141] With the opportunity to reduce the shortage of medical professionals and contribute to the MDGs, the SAARC countries have built a Telemedicine network that connects rural areas throughout South Asia to health professionals.[142] Through a satellite, the network currently connects hospitals in Thimphu (Bhutan), Kathmandu (Nepal) and Kabul (Afghanistan), with two specialty hospitals in the north of India; the first in Lucknow and the second in Chandigarh. In total there have been, since 2009, 148 tele-education sessions, 110 Continuing Medical Education sessions, and 15 teleconsultations; which include 19 distinct specialisations, ranging from paediatrics to neurosurgery.[143]

Other successes have also originated in India, again with ATNF playing a central role. Regionally, the Foundation has been involved in the SAARC e-Network Telemedicine project, and it has also managed its own projects. As the biggest Telemedicine network in South Asia, ATNF is a member of several committees, including the Working Group of the South Asian Association of Regional Countries Committee on Telemedicine.[144] The foundation also has ten centres located overseas, in countries such as Iraq, Yemen, and Kazakhstan. Finally, in 2012, it announced the launch of its telemedicine services in Yangon,

[134] Samal, Itishree. "Apollo to Offer Services on Mobiles, Tablets." *Business Standard* 24 September 2012. Web. 30 July 2013. < http://smartinvestor.business-standard.com/market/CResults-134763-CResultsdet-Apollo_to_offer_services_on_mobiles_tablets.htm#.UqyfwRDuY8>

[135] "Telemedicine India". Website. Web, 30 June 2013. <http://www.telemedicineindia.com>

[136] Ibid.

[137] Kasturirangan, Krishnaswamy. "The Power of Telemedicine to Bring Medical Care to Underserved Communities." European Space Policy Institute, HTM. 14 June 2012 in Vienna.

[138] "Charter Day" *SAARC* Web. 30 July 2013. <http://www.saarc-sec.org/Charter-Day/6/>

[139] "About SAARC." *SAARC*. Web. 30 July 2013. <http://www.saarctf.org/About/SAARC.aspx>

[140] South Asian Association for Regional Cooperation "Declaration of the Fourteenth SAARC Summit" from 3 to 4 April 2007 in New Delhi.

[141] Kanta Mishra, Saroj, et al. "Telemedicine in India: Current Scenario and the Future." *Telemedicine and e-Health.* Vol. 15. Issue 6 (2009): 568-576. Print.

[142] "Nepal launches telemedicine service" *The Times of India.* 22 January 2011.

[143] "SAARC Telemedicine Project in India." *SAARC* Web. 30 July 2013 <http://www.saarctf.org/Countries/India.aspx>

[144] Ganapathy, Krishnan, and Ravindra Aditi. "Telemedicine in India: The Apollo Story." *Telemedicine and e-Health.* Vol. 15. Issue 6 (2009): 576-586. Print.

Myanmar.[145] The centres located abroad function under the same concept as the ones within India. The doctors in the foreign hospital, such as KC Healthcare in Yangon, are connected to specialists from the Apollo Hospitals in India for "referrals, consultation, second opinion, reviews, [and] post treatment follow-ups besides facilitating tele-continuing medical education".[146] Furthermore, India has not only taken a keen interest in helping the South Asian subcontinent, but has also extended its reach across the Arabian Sea to Africa.

India and Africa

The ATNF's emerging involvement in Africa is similar to its South Asian operation. In 2012, as a successful self-standing network, the Foundation signed a Memorandum of Understanding (MoU) to set up 25 centres in Africa, bringing its number of centres outside India to over 40.[147] Most of these centres will be set up within the framework of the Pan African e-Network Project. This project has been developed in collaboration with AfroIndian Medical Services and, together, they are building a network of telemedicine services and hospitals.[148]

The Government of India, its Ministry of External Affairs, and its former President, Dr. Kalam, set up the Pan African e-Network in 2007. The project has been allocated a budget of over USD 120 million by the Indian Government. Its first phase, which involved 11 countries, including Burkina Faso, Ghana, and Mauritius, was officially launched in 2009.[149] Through satellite connectivity (VSATs) and a fiberoptic network, the project connects 17 super-specialty hospitals in India to 8 regional specialty hospitals, 45 Learning Centres, 40 Patient-End Hospitals and 37 VVIP Nodes (video conference) in Africa.[150] As mentioned, ATNF was chosen as a partner for its telemedicine expertise.[151] The network allows for tele-education, telemedicine, and conferencing.[152] The focus seems to be on tele-education, with over 1,100 Continuing Medical Education sessions having taken place between Hospitals located in India and in several African countries since 2009.[153]

The activities undertaken by India on its own soil and in Africa demonstrate its will to establish self-standing projects that enable the delivery of medical care to remote locations, regardless of distance. Other projects have had the same intentions, such as the RAFT project. Although it was initiated in an industrialised country, 80 percent of its teleconsultations are now carried out between African countries. This project can be considered a bridge project, as it involves assistance from both industrialised and developing countries. There are other such Bridge projects that have been created in the past, such as the *Force d'Intervention Sanitaire Satellitaire Autoportée* (FISSA), which was developed by CNES, the *Institut de Médecine et de Physiologie Spatiales* (MEDES), the *Association Education Santé* (Created by Madame Wade, wife of a former Senegalese President) and the *Organisation Mondiale des Experts-Conseils-Arbitre* (OMECA), supported by the UN. This particular project, focusing on pregnant women, has facilitated the transmission of ultrasound images between Ninefesha and Dakar, which are separated by over 700 kilometres.[154] Although these projects involve actors from industrialised states, the bulk of the activities take place within developing countries. Such projects have generally generated positive feedback, as they work in an integrated fashion with local institutions and actors.

[145] Bollineni, Raja. "Apollo Telemedicine Networking Foundation (ATNF)" *Access Health International* (2011). Web. 30 July 2013 <http://healthmarketinnovations.org/sites/healthmarketinnovations.org/files/CaseStudy_ATNF.pdf>

[146] Dutta, Vishal. "Apollo Enters Myanmar with Telemedicine Service." *The Economic Times* 12 December 2012. Web. 30 July 2013.

[147] Samal, Itishree. "Apollo to Offer Services on Mobiles, Tablets." *Business Standard* 24 September 2012. Web. 30 July 2013.

[148] Challapalli, Sravanthi. "Doctors is in… tele-con." *Hindu Business Online* 31 January 2013. Web. 30 July 2013.

[149] "Inauguration of Pan-African e-Network Project (Phase 2)" Web. 30 June 2013 <http://www.panafricanenetwork.com/>

[150] "Implementation Status" *Pan African eNetwork Project*. Web. 30 July 2013. <http://www.panafricanenetwork.com/Portal/ProjectDetails.jsp?projectidhide=7&projectnamehide=Implementation%20Status>

[151] Ganapathy, Krishnan, and Ravindra Aditi. "Telemedicine in India: The Apollo Story." *Telemedicine and e-Health.* Vol. 15. Issue 6 (2009): 576-586. Print.

[152] Kanta Mishra, Saroj, et al. "Telemedicine in India: Current Scenario and the Future." *Telemedicine and e-Health.* Vol. 15. Issue 6 (2009): 568-576. Print.

[153] "About the Project" *Pan African e-Network*. Web. 30 July 2013. <http://www.panafricanenetwork.com/Portal/ProjectDetails.jsp?projectidhide=13&projectnamehide=About%20the%20Project>

[154] Cluzel, Jean, Alajouanine, Guislaine and Grebot, Elisabeth, Groupe d'études de l'Académie des sciences morales et politiques, "Les nouvelles technologies de l'information et de la communication au service de la santé en Afrique", Presses Universitaires de France (2003): 113-121, 137

Part 2. The Way Forward for Developing Humanitarian Telemedicine Projects

Telemedicine has come to be considered an effective way of delivering care, especially to underserved regions. There are multiple lessons to be learned by actors who wish to develop and establish new HTM projects from the projects that have been developed in the past. The following section focuses on the practicalities of HTM projects.

5. Lessons Learned

5.1 Positive Impact of Humanitarian Telemedicine

As stated in the Organisation for Economic Co-operation and Development (OECD) Policy Brief of November 2003, "Health is higher in the international agenda than ever before and improving the health of poor people is a central issue in development".[155] Many organisations and projects have been set up for telemedicine activities to improve general health access and delivery to achieve the development goals set up by the UN over 13 years ago. With the MDGs "deadline" approaching, it is important to consider the impact of HTM projects, and whether they are contributing to these goals. Attempts have been made to assess the positive impact (or lack thereof) of HTM projects, but assessments are not conducted at regular intervals. Despite a lack of impact evaluations, what can be ascertained with certainty in the case of HTM is that *it saves lives.*

The main benefits of HTM for users in developing countries are the increased access and quality of health care. This includes "the potential to help meet previously unmet needs", as well as the fact that it enables "patients to seek treatment earlier and adhere better to their prescribed treatments".[156] The second series of indirect benefits for patients relate to medical professionals in developing countries. As many projects have demonstrated, the established relationships between the medical professionals of different countries through training, education, and consultation are highly beneficial. These increased interactions, in turn, improve the qualifications of many health professionals, thus increasing the quality of care given to patients. As seen in several projects, with the improved capacity to communicate between medical professionals comes a more accurate diagnosis of patients. This reduces the number of patient transfers, which in turn reduces the costs of patient transport. The patients also notice a change; their travel and hospitalisations costs are reduced, which, in the most secluded areas of the world, can be quite substantial.[157]

In addition to the potential health benefits that accompany the utilisation and delivery of HTM, there are long-term development advantages: "the benefits of good health spread beyond a single health generation" and there is a strong link "between health and economic development".[158] Considering this statement, it no longer seems surprising that the MDGs have such a focus on health. In addition, poor health can exacerbate other development problems, such as access to education.[159] Access to health not only helps in the short term, but it also enables access

[155] "Poverty and Health in Developing Countries: Key Actions." OECD Policy Brief. November 2003.
[156] "Telemedicine Opportunities and Developments in Member States 2010". Global Observatory for eHealth series. Vol. 2. World Health Organization, 30 July 2013
[157] Gangeh, Mehrdad Jabbarzadeh. "Telemedicine and Main Issues in Developing Countries: a General Review." University Kebangsaan, Malaysia. Web. 30 July 2012 <http://www.slideserve.com/tate/telemedicine-and-main-issues-in-developing-countries-a-general-review>
[158] "Poverty and Health in Developing Countries: Key Actions." OECD Policy Brief. November 2003.
[159] Banerjee, Abhijit V., and Esther Duflo. Poor Economics A Radical Rethinking of the Way to Fight Global Poverty. New York: PublicAffairsTM, 2011. Print. p. 43

to education and ultimately results in positive demographic changes in the long term.[160] Better health care, through telemedicine, may therefore contribute to increased economic developments levels.

5.2 What Works for Developing Countries

In the previous sections, successful HTM projects were identified. However, analysing the causes behind these successes can be delicate. A potential way forward in understanding the success of these projects might be an analysis of what they have in common. A majority of thriving projects share some key characteristics: a focus on medical aid and thorough information gathering activities.

5.2.1 Focus on Medical Aid

As early as 1995, Coiera stated that "any attempt to use information technology will fail dramatically when the motivation is the application of technology for its own sake rather than the solution of clinical problems".[161] Whether in the middle of a man-made conflict, natural disaster, or in a state plagued by permanent shortages of medical professionals, technology must always serve as a support function and not constitute the central focus of a project. Successful projects have focused on the aid needed and, from there, have identified the appropriate and available technology to use.

The majority of medical areas that have successfully benefited from HTM projects are in the field of secondary care. The initiatives carried out by organisations such as RAFT, MMC, and ISRO have all provided specialised medical care. There are other areas of medicine where projects have shown success using predominantly primary care. In the cases of Haiti in 2010 and Somalia in 2011, primary care was critically needed. Following the Earthquake in Haiti, there was a need for triage among the injured, and for patient transfer assessments. In the case of Somalia, the unstable situation forced foreign medical professionals to diagnose patients at a distance. Regardless of the case, projects succeeded by focusing on the type of medical care that was needed.

In addition to the identification of care needed, successful HTM projects have used the appropriate and available technology. The majority of telemedicine applications are found in teleconsultation, teleradiology, and telediagnostics. For example, in the case of the 2005 earthquake that struck Pakistan, over one million radio images were sent for consultation; additionally, as part of the RAFT project there are over 800 teleconsultations conducted per year.[162,163] Most of these applications use store-and-forward technology, or in other words, emails and other tools that enable the delayed transmission of information.[164] For a majority of projects, the technology used depends on local availability and ease of use. Projects that use more elaborate technologies, such as VSAT equipment, or other satellite connectivity, to communicate and bring the technology to remote areas (such as in the case of ISRO and ATNF in India and Africa), can also be successful. However, the majority of projects do not necessitate complicated technology, which reinforces the rationale of putting medicine to the forefront of the project implementation strategy.

Successful HTM projects have other common traits. The delivery of humanitarian medicine at a distance requires extensive cooperation. As Guedj stated during the aftermath of the 2010 Haiti earthquake, cooperation is essential to enable efficient aid.[165] As early as the 1980s, the issue was already raised. Writing about the Spacebridge experience between the USA and the USSR, Nicogossian and Doarn pointed out that: "even with the official intergovernmental agreement in place, it took approximately 2 months to develop patient consultation protocols acceptable to the Americans, Russians and Armenian medical counterparts".[166] In addition, in situations where a disaster strikes, many actors feel the need to help, and supply medical aid. In the case of the 2005 earthquake in Pakistan, many countries were using telemedicine to help deliver medical care to the disaster vic-

[160] "Poverty and Health in Developing Countries: Key Actions." OECD Policy Brief. November 2003.
[161] Coiera, Enrico "Medical informatics." British Medical Journal, Vol. 310, No. 6991 (May 27, 1995): 1381-1387.
[162] Lam, David M. "Telemedicine in Disaster Management – The Military Viewpoint." 3rd Intensive Balkans Telemedicine and Ehealth Seminar on February 2009 in Skopje. Web. 30 July 2013 <http://www.youtube.com/watch?v=dg0sqyerF0U>
[163] Geissbuhler, Antoine. "Telemedicine for Development and Humanitarian Purposes." European Space Policy Institute, HTM. 14 June 2012 in Vienna
[164] Wootton, Richard. "In what circumstance is telemedicine appropriate in the developing world?". JRSM Short Rep. 1 October 2010. Web. 30 July 2013. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2984368/>
[165] "La Fondation Casques Rouge en Haiti". Dailymotion. Film Web. 30 July 2013 <http://www.dailymotion.com/video/xc8mzv_la-fondation-casques-rouges-en-hait_news#from=embed>
[166] Nicogossian, Arnauld E., and Charles R., Doarn. "Armenia 1988 Earthquake and Telemedicine: Lessons Learned and Forgotten." *Telemedicine and e-Health*. Vol. 17. Issue 9 (2011):741-745. Print.

tims, and they were doing so independently of each other. However, for such initiatives to be optimised, cooperation must arise.

In line with the extensive use of cooperation and coordination, projects must avoid attempting to "reinvent the wheel".[167] In other words, success can be achieved by picking the "low-hanging fruit".[168] Although Banerjee and Duflo wrote about this concept in association with bed nets and vaccines, the same general idea can be applied to HTM. In many projects where teleconsultation and teleeducation are used, the technology employed is very basic. By making use of existing infrastructure, networks and personnel on the ground, projects not only successfully pick the low-hanging fruit, but also help empower local medical professionals. In the early phases of the RAFT project, the majority of teleconsultations emanated from Geneva towards different African countries. However, as previously mentioned, over 80 percent of consultations are now carried out between African countries.[169]

In conclusion, the majority of successful projects are motivated by the need on the ground, and utilise the existing infrastructure and personnel to the greatest extent possible. As Michael Rigby said about telemedicine in developing countries, "the pull of needs, not the push of supply, should be the determinant".[170] With the assessment of the medical need comes an analysis of the available and relevant technology.

5.2.2 Information Gathering

With a primary focus on medicine, successful HTM projects also have data gathering in common. All successful projects share an extensive analysis of both the countries in which the projects are to be implemented, and their national health environment(s).

The country analyses carried out for HTM projects do not differ greatly from their counterparts in other domains. When taking a closer look at the FISSA project or the report written by the Telemed Task Force (TTF) (jointly created by the EC and ESA in 2006), the first set of information gathered by both consists of the same elements. Such projects must gather, prior to implementation, data on the targeted country and its demography, with a particular focus on health-related statistics such as disease prevalence, life expectancy, mortality rates, and malnutrition levels, as well as general socio-economic and political data.[171] Additionally, data should be gathered on ICTs, as these are intrinsically linked to telemedicine in general. For example, the TTF has included data such as ICT policies, competition levels, telecommunication availability and coverage (GSM, Fibre Optic Network, and Satellite), and the general digital opportunities in the targeted geographical areas. Moreover, other project such as ATNF are currently carrying out studies on "attitudes and behavioural responses of the public towards accepting mobile phones as an enabler for healthcare" in India.[172] Accumulating knowledge on ICTs has enabled project managers to make decisions on a well-informed basis, and to use telephones as a tool for telemedicine.

The second set of research carried out by successful HTM projects relates to health in the targeted country or region. While successful projects focus above all on medicine, they also gather data on the general health situation at the ground level. Information on national and/or regional health policies, as well as political will, have been studied by projects such as FISSA and the TTF.[173] On a practical level, a country's infrastructure and resources have also been included in many fact-finding studies. Data on local understandings of the dimensions and determinants of access to health services has proven to be a common feature of HTM projects, as for example in the FISSA project.[174,175] For

[167] Lievens, F, and Jordanova, M. "eHealth: International Initiatives, Structures and Trends." 11th ISfTeH International Conference on 27 November 2006 in Cape Town.
[168] Banerjee, Abhijit V., and Esther Duflo. Poor Economics A Radical Rethinking of the Way to Fight Global Poverty. New York: PublicAffairsTM, 2011. Print.p. 41
[169] "The RAFT network A Telemedicine Network in Africa to Support Healthcare Professionals where they are Most Needed" *RAFT* Web. 30 July 2013 <http://raft.hcuge.ch/10-04-14%20RAFT%20detailed%20description.pdf>
[170] Rigby, Michael. "Impact of Telemedicine must be Defined in Developing Countries." *British Medical Journal.* Vol. 324. Issue 7328 (2002): 47-48. Print.
[171] Cluzel, Jean, Alajouanine, Guislaine and Grebot, Elisabeth, Groupe d'études de l'Académie des sciences morales et politiques, "Les nouvelles technologies de l'information et de la communication au service de la santé en Afrique", Presses Universitaires de France (2003):41-53 and
Asamoah-Odei E., et al. "eHealth for Africa Opportunities for Enhancing the Contribution of ICT to Improve Health Services." *European Journal of Medical Research*. Vol. 12. Supplement 1 (2007): 1-38. Print.
[172] Samal, Itishree. "Apollo to Offer Services on Mobiles, Tablets." *Business Standard* 24 September 2012. Web. 30 July 2013.
[173] Asamoah-Odei E., et al. "eHealth for Africa Opportunities for Enhancing the Contribution of ICT to Improve Health Services." *European Journal of Medical Research*. Vol. 12. Supplement 1 (2007): 1-38. Print.
[174] Peters, D.H. et al. "Poverty and Access to Health Care in Developing Countries." Johns Hopkins Bloomberg School of Public Health. Vol. 1136 (2008): 161-171. Epub.
[175] Cluzel, Jean, Alajouanine, Guislaine and Grebot, Elisabeth, Groupe d'études de l'Académie des sciences morales et politiques, "Les nouvelles technologies de l'information et de la communication au service de la santé

example, in terms of eHealth and telemedicine, projects established by the SAARC have taken into account the importance these countries want telemedicine to have. With the need for cooperation and collaboration, it is important to understand and evaluate the e-readiness of not only specific countries, but also that of their people, and how they will react to telemedicine and eHealth.[176]

Attempting to identify factors of success can be challenging, especially when referring solely to existing literature. Based on evaluation reports and the analysis of existing humanitarian projects, the previous sections have attempted to identify such drivers of success.

5.3 Challenges of Telemedicine in Developing Countries

The analysis of HTM projects, and the associated literature, are key resources in understanding the challenges that these projects may pose. With the delivery of medical care at a distance the first set of challenges has proven to be practical (technological, procedural, and cultural). The second, more general, challenges include political and economic issues.

5.3.1 Practical Considerations

According to the available feedback from various projects, some of the practical challenges projects face are associated with cost, policy, technology (in terms of infrastructure and availability), legal systems, or culture. (See figures 4 and 5)

Technology and infrastructure raise important challenges to address in the remote delivery of medicine, particularly in developing countries. Robustness is key, especially in cases of disaster or where difficult environmental conditions prevail, as was experienced by CNES in French Guyana.[177] Technology must be available and reliable; it also needs to be maintained. Additionally, the compatibility and the interoperability of the equipment need to be verified to ensure the integrity of the data transmitted.[178]

High levels of technology can sometimes be detrimental to projects in the long term. In cases where the technology brought to the project surpasses that of the existing national infrastructure, it may undermine national efforts and may be considered a hindrance to the "further development, support and future collaboration between patients and their local health care system".[179]

The legal aspects of HTM projects can also pose a threat to their establishment. One of the most important obstacles to telemedicine is the lack of an international framework governing its practices.[180] Without an international framework, standard operating procedures, liabilities, and legal considerations have little reference material. Answers to questions surrounding the applicable laws, and who is liable vis-à-vis the patient if something goes wrong, are important for the sustainability of HTM projects. Related to such legal matters is the confidentiality of medical information and its protection.[181] Whereas technology can expand the availability and integrity of medical data, it can also infringe on the confidentiality of this data. All this having been said, most projects have found ways to overcome these legal difficulties, for instance, through agreements with host countries.

en Afrique", Presses Universitaires de France (2003): 68-69

[176] "Africa Urged to Embrace and Use E-Health" *afro.who.int* at Malabo on 30 August 2010.

[177] "Telemedicine kit". *Medes.fr*. (2005). Web. 14 December 2013 <http://www.medes.fr/home_en/telemedicine/facilities/telemedicine_kit.html>

[178] Asamoah-Odei E., et al. "eHealth for Africa Opportunities for Enhancing the Contribution of ICT to Improve Health Services." *European Journal of Medical Research*. Vol. 12. Supplement 1 (2007): 1-38. Print.

[179] Lam, David M. "Telemedicine in Disaster Management – The Military Viewpoint." 3rd Intensive Balkans Telemedicine and Ehealth Seminar on February 2009 in Skopje. Web. 30 July 2013 <http://www.youtube.com/watch?v=dg0sqyerF0U>

[180] Eccles, Nora. "Telemedicine in Developing Countries: Challenges and Successes." *Harvard College Global Health Review*. 1 February 2012. Web. 30 July 2013 <http://www.hcs.harvard.edu/hghr/print/spring-2011/telemedicine-developing/>

[181] Gangeh, Mehrdad Jabbarzadeh. "Telemedicine and Main Issues in Developing Countries: a General Review." University Kebangsaan, Malaysia. Web. 30 July 2012 <http://www.slideserve.com/tate/telemedicine-and-main-issues-in-developing-countries-a-general-review>

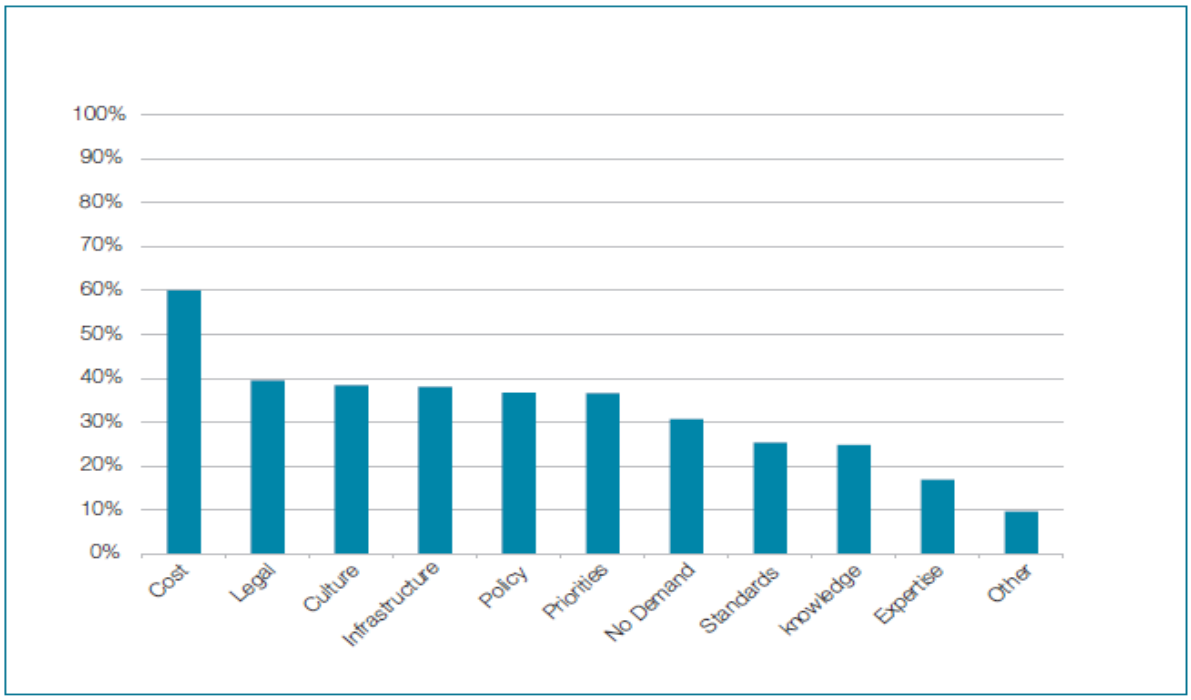

Figure 4: Barriers to telemedicine globally (WHO, 2013)[182]

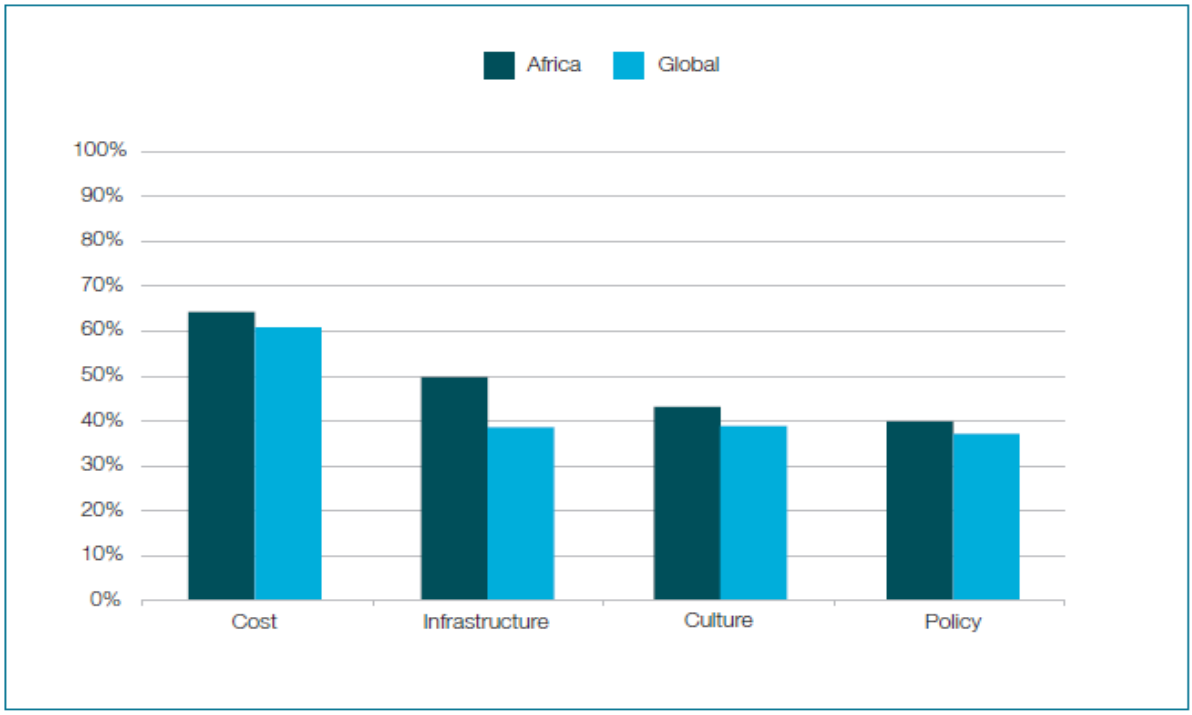

Figure 5: Barriers to telemedicine for the African Region (WHO, 2013)[183]

[182] "Telemedicine Opportunities and Developments in Member States 2010". Global Observatory for eHealth series. Vol. 2. World Health Organization. (30 July 2013): 67-68
[183] Ibid.

On a different note, cultural aspects are also critical to the success or failure or such projects. National and regional cultures need to be acknowledged as potential barriers to HTM, especially by actors from industrialised countries. In the case of Africa, there has been criticism of the lack of preparedness on the part of foreigners to interact successfully with local cultures, as expressed in the following argument:

> » "If a western multinational company or a governmental department is sent to the Middle East or Asia, they have induction programs for the employees they intend to send there: in order for them to make it clear that there is a culture that is completely new to them. But when those same Western companies are sending people to Africa, that appreciation is not there. […] Our culture is neither respected nor even acknowledged".[184]

Language and culture can also constitute barriers, as the Pan-African e-Network has acknowledged.[185] The cultural relationship to health, if not assessed, can be a threat to the success of a project. For example, there may be superstitions associated with certain diseases.

Perceptions about medical care can also constitute a barrier to the proper delivery of treatment. There are examples of mothers not trusting the effectiveness of simple solutions, such as Oral Rehydration Solutions (ORS) for the prevention of diarrhoea in children, trusting instead to a more elaborate procedure such as an injection.[186] Additionally, medical professionals may also be uncomfortable with the impossibility of being face-to-face with their patients, and instead, having to use technology they may not be accustomed to.[187]

Some have pointed to the possibility of relationships among developing countries being easier to cultivate than those between industrialised countries and developing countries.[188] However, the basic issue remains that very few developing countries have medical resources to spare. Therefore, HTM often involves the assistance of doctors from industrialised countries. Moreover, whether the doctor providing the primary care consultation is from Bolivia or Sweden, when the patient is located in Malawi, it may be of little difference in cultural terms, as both the Bolivian and the Swedish doctor would operate in entirely foreign circumstances. Still, there should always be an understanding that assistance by doctors from industrialised countries can be characterized as patronising or even neo-colonialist. Therefore, cultural sensitivity is a must for doctors and institutions from industrialised countries involved in HTM.

5.3.2 General Considerations

Many other issues can be detrimental to HTM projects, such as unfavourable political and economic situations. Additionally, there are a number of challenges that can impede the long-term sustainability of these projects.

A first challenge to HTM projects is political. According to the WHO, and as seen in figure 4, policy constitutes the fifth barrier to telemedicine worldwide. Additionally, less than 15 percent of countries in the Eastern Mediterranean region, in Southeast Asia, and in Africa report having policies on telemedicine.[189] As the partners in HTM projects are so interconnected, if one or more actors do not possess policies on the matter, the project might fail.

A second potential barrier to the development and establishment of HTM projects is the cost. According to the same study by the WHO, cost constitutes the first barrier to telemedicine worldwide (see figure 4).[190] In other words, cost is a barrier for telemedicine, especially in developing countries, where the projects are most often needed (see figure 5). In cases where HTM projects use sophisticated technologies and complex equipment, as in many disaster relief projects, the cost may be detrimental to the sustainability of these projects in the long term.

Third, many projects are set up, but not all of them pass the pilot stage. There is a huge "dropout rate" for HTM projects when moving from the pilot stage to sustained operations. According to research carried out by the WHO, low-income countries have the smallest

[184] O'Malley, J.P. "There is a continued imposition of Western culture on Africans." NewAfrican. June 2013, N. 529, pp.74-77
[185] Challapalli, Sravanthi. "Doctors is in… tele-con." *Hindu Business Online* 31 January 2013. Web. 30 July 2013.
[186] "ORS is a mixture of salt, sugar, potassium chloride and an antacid to be mixed with water and drunk by the child". Banerjee, Abhijit V., and Esther Duflo. Poor Economics A Radical Rethinking of the Way to Fight Global Poverty. New York: PublicAffairsTM, 2011. Print. p. 41
[187] Gangeh, Mehrdad Jabbarzadeh. "Telemedicine and Main Issues in Developing Countries: a General Review." University Kebangsaan, Malaysia. Web. 30 July 2012 <http://www.slideserve.com/tate/telemedicine-and-main-issues-in-developing-countries-a-general-review>
[188] Geissbuhler, Antoine, et al. "Telemedicine in Western Africa: lessons learned from a pilot project in Mali, perspectives and recommendations." *AMIA.* Annual Symposium Proceedings. (2003):249–253. Print.
[189] "Telemedicine Opportunities and Developments in Member States 2010". *Global Observatory for eHealth series.* Vol. 2. World Health Organization, 30 July 2013
[190] Ibid.

number of established telemedicine projects.[191] Depending on the medical specialty, the number of established projects may vary. However, regardless of the specialty, low-income countries count the smallest number of established projects.[192] Not only do a majority of projects fail to progress beyond the pilot stage, but little evaluation has been done to identify the reasons for the failure of projects. The process of successful progression from pilot projects to larger scale implementation is still unclear.[193] Additionally, even when it has been successfully carried out, there can be a lack of up-to-date information on the follow-up phases of a project.[194]

There are, however, some elements that have been recognised as challenges to long-term sustainability. For example, the Pan-African e-Network has listed ego[centrism] as a potential barrier.[195] Edworthy has argued that a heavy "reliance on foreign non-governmental organisations may provide a short lived stability to the situation".[196] Peters has mentioned that excluding local populations can shorten the lifespan of projects. This last idea can be connected to that of having to know the targeted user group of the project very well. One final consideration is financial. With projects not generating enough studies on cost-effectiveness, or long-term implementation, securing funding for the long-haul can represent a challenge.[197]

HTM projects have shown that they can have a positive impact on extended and improved access to medical care. The field's literature has shown that, by following a "pull of needs, and not the push of supply", by putting medicine first, and by conducting appropriate research, HTM projects have the potential to not only increase worldwide access to healthcare, but also further its development. However, political, legal, technical, cultural, and economic issues can all constitute barriers to the development and long-term establishment of HTM projects. Moreover, it is important to note that a gap remains in HTM: the remote delivery of primary care for countries in permanent situations of hardship.

[191] Ibid. and Wootton, Richard. "The Possible Use of Telemedicine in Developing Countries." *Online Journal of Space Communication*. Issue 14 (2009): n. pa. Web. 30 July 2013.
[192] "Telemedicine Opportunities and Developments in Member States 2010". *Global Observatory for eHealth series.* Vol. 2. World Health Organization, 30 July 2013
[193] Asamoah-Odei E., et al. "eHealth for Africa Opportunities for Enhancing the Contribution of ICT to Improve Health Services." *European Journal of Medical Research*. Vol. 12. Supplement 1 (2007): 1-38. Print.
[194] Cluzel, Jean, Alajouanine, Guislaine and Grebot, Elisabeth, Groupe d'études de l'Académie des sciences morales et politiques, "Les nouvelles technologies de l'information et de la communication au service de la santé en Afrique", Presses Universitaires de France (2003)
[195] Challapalli, Sravanthi. "Doctors is in… tele-con." *Hindu Business Online* 31 January 2013. Web. 30 July 2013.
[196] Edworthy, Steven M. "Telemedicine in Developing Countries." *British Medical Journal.* Vol. 323. Issue 7312 (2001): 524-525. Print.
[197] Gangeh, Mehrdad Jabbarzadeh. "Telemedicine and Main Issues in Developing Countries: a General Review." University Kebangsaan, Malaysia. Web. 30 July 2012 <http://www.slideserve.com/tate/telemedicine-and-main-issues-in-developing-countries-a-general-review>

6. Considerations for Primary Care in Humanitarian Telemedicine

HTM has been proven to contribute to increased levels of access to medical health care. Many projects have focused on secondary care and, as previously shown, there have been many successes in the provision of that type of care. However, it is important to recognize that primary care HTM can also help harvest "low hanging fruit". While that is the case, some factors must be taken into consideration with respect to the development of such projects.

6.1 Relevance of Primary Care Humanitarian Telemedicine

Most developing countries suffer from a severe shortage of medical professionals. While primary care HTM has been mostly applied in disaster situations, it generally represents the first step of the medical process. When symptoms occur, the first medical professional sought, in most cases, is the general practitioner. Through primary diagnostics, many strategies of treatment can be formulated, and in the large majority of cases, the treatment remains exclusively in the hands of general practitioners. Where primary care is not available, avoidable deaths multiply.

6.1.1 Need for Primary Care

According to the WHO the health gap was still widening in 2005. Not only was it widening between rich and poor countries, but also within them.[198] The poorest are therefore increasingly suffering from health inequalities. Along with this unequal distribution of health, these countries are witnessing an increased burden of chronic, or non-communicable, diseases, which is adding to their continuous fight against communicable diseases. Exacerbating this difficult medical context is the systematic lack of medical professionals in many of those countries.

Infectious and Non-Communicable Diseases

Communicable, or infectious, diseases are "caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi; the diseases can be spread, directly or indirectly, from one person to another".[199] On the other hand, *non-communicable diseases* (NCDs), "also known as *chronic diseases*, are not passed from person to person, […] they are of long duration and generally slow progression [as opposed to short-term or acute]. The four main types of non-communicable diseases are cardiovascular diseases (such as heart attacks and stroke), cancers, chronic respiratory diseases (such as chronic obstructed pulmonary disease and asthma) and diabetes".[200] While there have been findings confirming that "noncommunicable chronic diseases can stem from infectious agents", the division explained above, formulated by the WHO, will be retained for this report.[201]

Globally, 65 percent of deaths are due to non-communicable diseases, all ages included. The burden of non-communicable diseases is high worldwide and indiscriminate with regards to geographical location (see figure 6). However, in 2008, 90 percent of deaths from infectious illnesses occurred in low- and middle-income countries.[202]

According to the most recent statistics on health, there are over 40 million people who die each year of non-communicable diseases.[203] All ages included, the low and middle-income groups account for over 50 percent of the deaths incurred by such diseases. The recorded increase of non-communicable diseases in many parts of the developing world is also likely to increase further in the years to come. Economic development, as well as progress in the on-going fight against infectious diseases – for example, polio vaccinations, which have now dramatically reduced the incidence of the disease – might

[198] "MDG Health and the Millennium Development Goals." World Health Organization. 2005. 30 July 2013 <http://www.who.int/hdp/publications/mdg_en.pdf>

[199] "Infectious diseases." *World Health Organization*. Wweb. 30 July 2013 <http://www.who.int/topics/infectious_diseases/en/>

[200] "Noncommunicable diseases." *World Health Organization*. Web. 5 December 2013 <http://www.who.int/mediacentre/factsheets/fs355/en/>

[201] O'Connor, Siobhan M., et al. "Emerging Infectious Determinants of Chronic Diseases". Emerging Infectious Diseases. Vol.12 No. 7 (2006): 1051-1057

[202] "Chronic diseases." *World Health Organization*. Web. 30 July 2013 <http://www.who.int/topics/chronic_diseases/en/>

[203] "World Health Statistics 2013." World Health Organization. 2013. Web. 30 July 2013 <http://apps.who.int/iris/bitstream/10665/81965/1/9789241564588_eng.pdf>

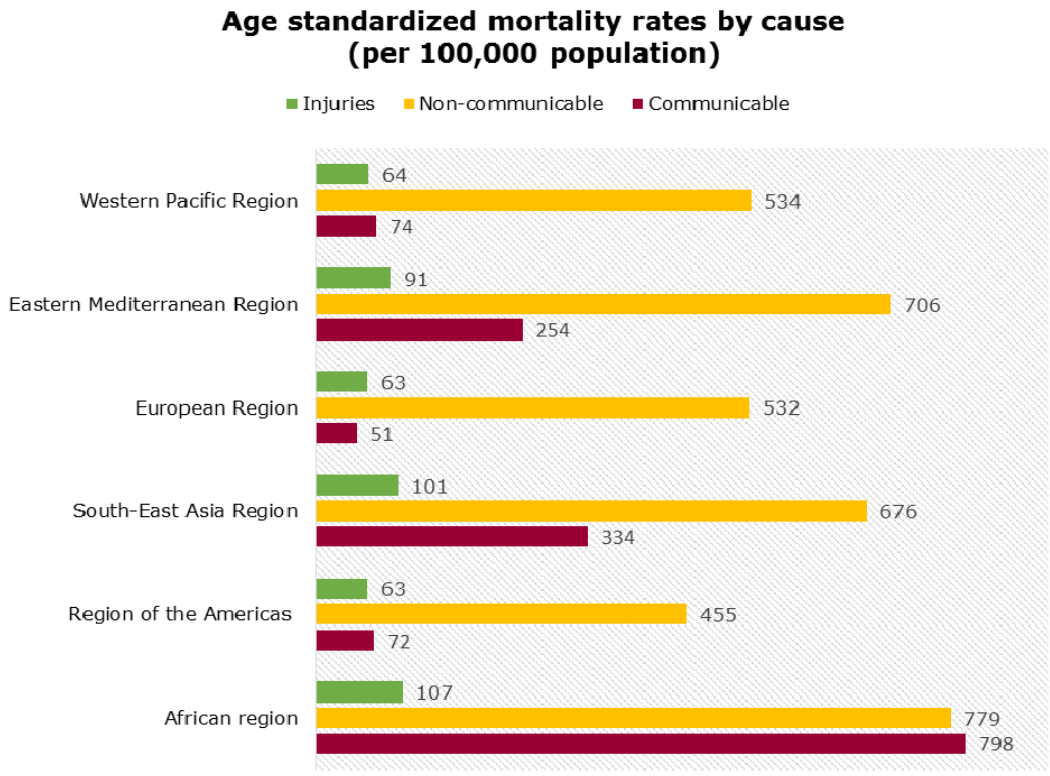

Figure 6: Mortality rates by cause (Source: adapted from the World Health Statistics 2013, who.org)

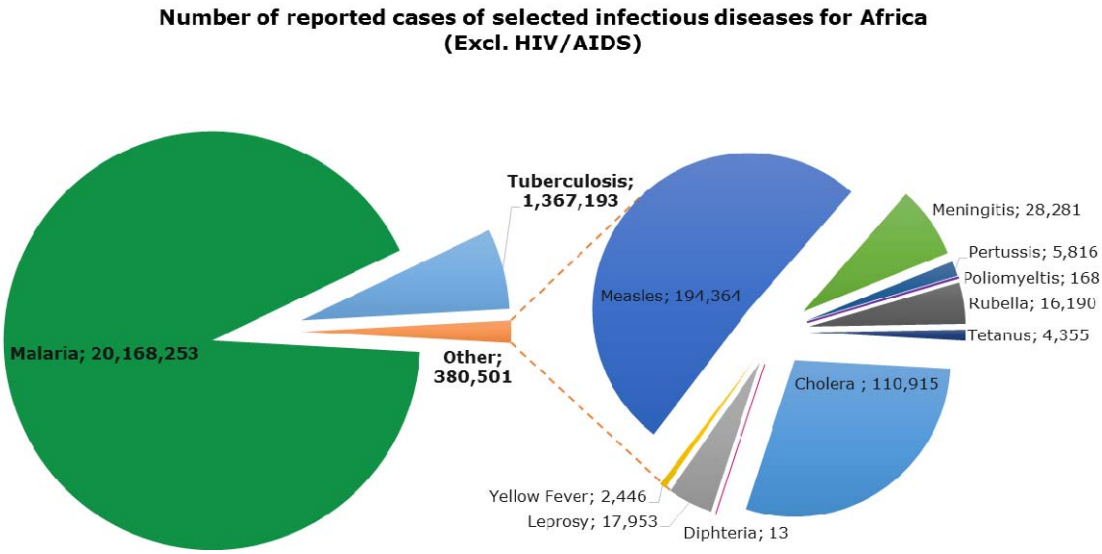

Figure 7: Cases of selected infectious diseases for Africa (Source: adapted from the World Health Statistics 2013, who.org)

play a role in the increased attribution of deaths to non-communicable diseases.[204] Therefore, as countries develop, their disease burden shifts from "diseases of poverty" to "diseases of wealth".[205] However, this phenomenon is more difficult to pinpoint in Africa, where, according to WHO officials, 63 percent of mortality is still caused by infectious illnesses. Additionally, it is very likely that China, and the East Asian region as a whole, may account for a large proportion of the rise in chronic diseases. With 400 million people having been raised out of extreme poverty in China since 1980, it is clear that the burden of disease in that country has

[204] "Poliomyelitis" *World Health Organization.* Web. 4 December 2013 <http://www.who.int/mediacentre/factsheets/fs114/en/>

[205] Doyal, Lesley, and Margaret Hoffman. "The growing burden of chronic diseases among South African Women". CME. Vol.27 No. 10 (October 2009).

shifted dramatically.[206] Additionally, this may very well skew the total worldwide sample.

The increasing burden of chronic diseases does not mean that communicable diseases are no longer to be dealt with. In Africa, for example, *infectious diseases are still the leading cause of mortality* (798 per 100,000 people in the region).[207] In the Southeast Asian region, there is a 30 percent probability of dying due to communicable diseases and, in the Eastern Mediterranean region, an almost one in four statistical probability of doing so. The battle against communicable diseases is ongoing, and it is certainly not over. As figure 7 shows, the number of reported cases of selected infectious diseases is still very high, reaching close to 22 million. Additionally, infectious illnesses generally affect the most vulnerable members of society: the youth and the poor, who are also those most in need of development interventions. Moreover, the infectious diseases represented in figure 7 do not include people who are also diagnosed with HIV/AIDS, which represents a considerable proportion of the infectious disease burden on the continent (with 34 million known cases).[208] Although the prevalence of chronic diseases is increasing in many regions, the burden of infectious diseases, in particular HIV/AIDS, malaria, and tuberculosis, is worrisome, and still warrants acute attention from the medical community.

Mortality Rates

In the past 20 years, mortality rates worldwide have decreased (see figures 8 and 9). However, health inequalities between world regions have not. Most developing regions have very high mortality rates when compared to those of their industrialised counterparts. The African, Southeast Asian, and Eastern Mediterranean regions incur, respec-

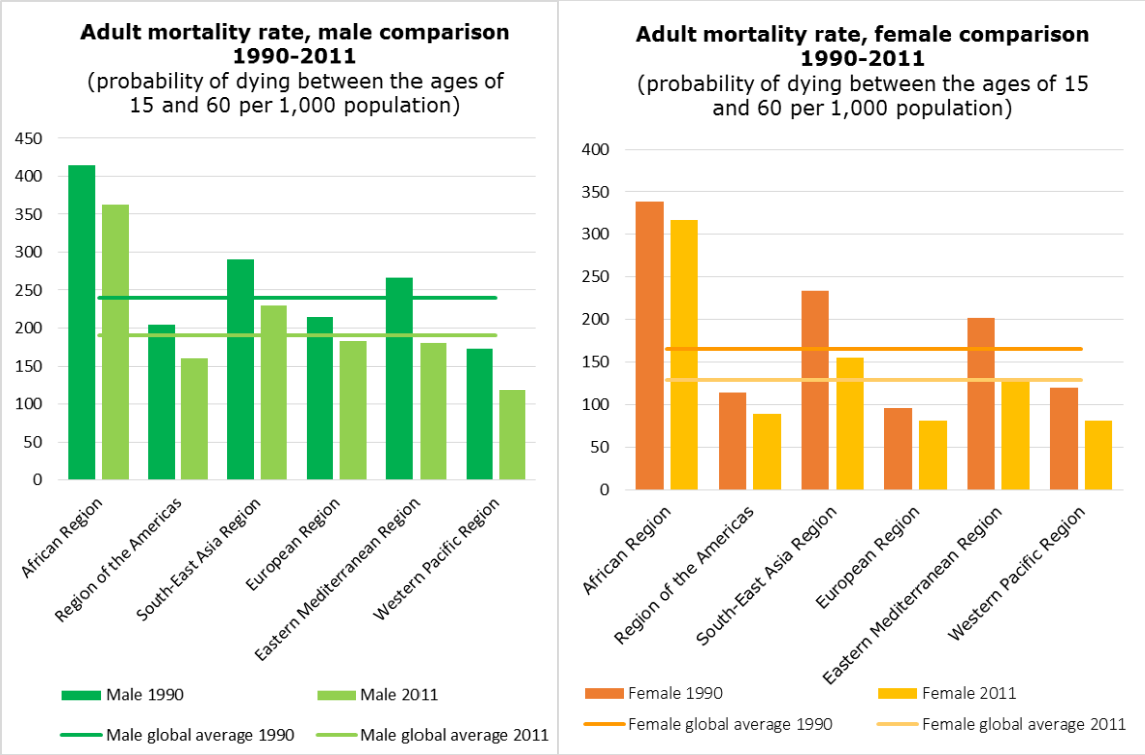

Figure 8 (left): Male mortality rates comparison worldwide
(Source: adapted from the World Health Statistics 2013, who.org)

Figure 9 (right): Female mortality rate comparison worldwide
(Source: adapted from the World Health Statistics 2013, who.org)

[206] Ravaillon, Martin, and Shaohua Chen. "Fighting Poverty: Findings and Lessons from China's Success". World Bank. 2012. Web. December 5 2013 <http://go.worldbank.org/QXOQI9MP30>

[207] "World Health Statistics 2013." World Health Organization. 2013. Web. 30 July 2013 <http://apps.who.int/iris/bitstream/10665/81965/1/9789241564588_eng.pdf>

[208] Global Health Observatory (GHO) "HIV/AIDS". *World Health Organization*. Web. 18 October 2013 <http://www.who.int/gho/hiv/en/index.html>

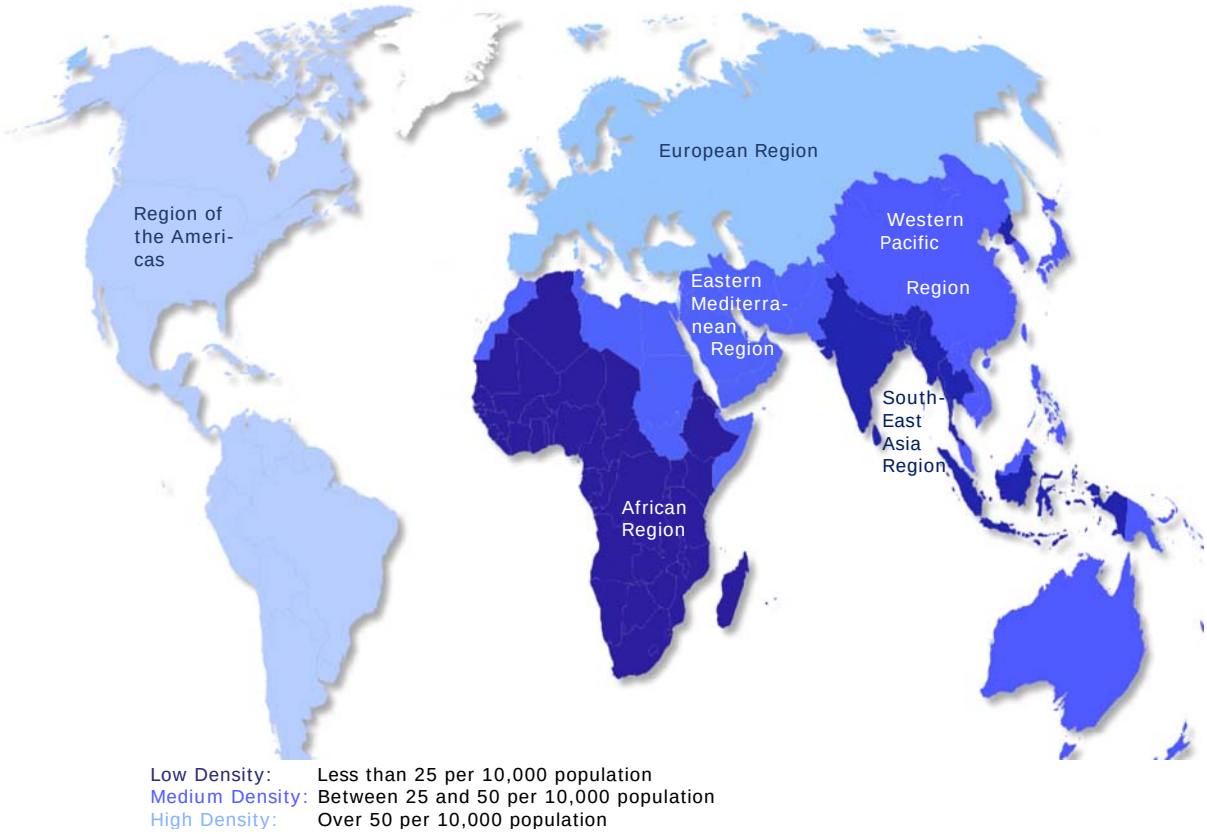

Figure 10: Density of health professionals by WHO Regions (Source: adapted from the World Health Statistics 2013, who.org)

tively, the highest death rates. More specifically, as seen in figures 8 and 9, the adult female mortality rate in Africa is three times higher than in the Americas, Europe, and the Western Pacific region, while the adult male mortality rate is twice as high.

These high mortality rates, caused mostly by communicable diseases, are one of two factors contributing to world health inequality; the second is the shortage of medical professionals in the poorest regions, including doctors, nurses and midwives. The combination of these factors leads the "demand for healthcare [to rise] faster than the supply of [medical professionals]".[209]

Health Professionals Inequality

In 2004, the WHO categorised the worldwide density of health workers. The regions with the lowest count had under 25 health workers per 10,000 inhabitants; the regions with a "medium" count had between 25 and 50 health workers per 10,000 people; those with the highest density of health workers counted over 50 health professionals per 10,000 people.[210] As shown in figure 10, the world regions that have the lowest density of doctors, nurses, and midwives are Africa and South-east Asia, with respectively 11.6 and 15.4 health workers per 10,000 people. The low- and middle-income country groups both suffer from critically low densities of health workers, with 20 and 21.2 medical professionals per 10,000 people, respectively. The high-income group, on the other hand, counts close to 100 health workers per 10,000 people.[211] Given the inequalities that arise from the uneven distribution of healthcare professionals between industrialised and developing countries, it is important to realise that HTM offers a tool to alleviate these inequalities.

Although the ratio of deaths attributed to communicable diseases compared to non-communicable diseases is decreasing, infectious diseases are still a burden in developing regions, and particularly in Africa. Moreover,

[209] "Squeezing out the Doctor." *The Economist* 2 June 2012: 25-27. Print.

[210] "Human Resources for Health Overcoming the crisis Joint Learning Initiative." World Health Organization. Web. 30 July 2013 <http://www.who.int/hrh/documents/JLi_hrh_report.pdf>

[211] "World Health Statistics 2013." World Health Organization. 2013. Web. 30 July 2013 <http://apps.who.int/iris/bitstream/10665/81965/1/9789241564588_eng.pdf>

chronic diseases warrant different kinds of treatment, and rather than lightening the workload for doctors, it requires them to acquire additional medical knowledge. Additionally, chronic illnesses are much more expensive to treat than their communicable counterparts. This is due to the nature of these treatments, which are often much more advanced technologically and must often be administered over long time-periods (e.g. chemotherapy vs. ORS). Additionally, the treatment of chronic illnesses generally yields much less benefit in terms of disability-adjusted life years (DALYs) as they are generally used for older people, with fewer healthy years ahead of them. A DALY is a way to measure both the quantity and the quality of life of a population. According to the WHO, one DALY can be thought of as one lost year of "healthy" life.[212] This changing health landscape in developing countries, as well as the critically low density of healthcare professionals, which might further decrease in the future,[213] demonstrates the desperate need for more primary medical care in these settings.

6.1.1 Opportunities for Primary Care Telemedicine

An opportunity arises for countries to cooperate to reduce this worldwide unequal distribution of health care professionals. For example, Europe has over 110 doctors, nurses and midwives per 10,000 people, representing the region with the highest density of health professionals in the world.[214] As the data for the USA is averaged with that of Latin America, the latter skews the results. Indeed, while the USA has a total of 122.4 health professionals per 10,000 people, the regional average is 91.9. Telemedicine, provided by the countries with the highest density of health care professionals, to those with the lowest, therefore offers the possibility to help "fill [the health] vacuum".[215] Primary care via telemedicine can help not only with "children mortality, infectious diseases, and malnutrition and dehydration", but also with non-communicable diseases.[216] Primary care has proven to be pivotal in the early detection and treatment of both chronic and communicable diseases.[217] The delivery of primary care at a distance would therefore not only enable a broader reach and improved treatment, it would also enable the prevention, detection, and management of diseases.[218] As stated by Ganapathy - the President of ATNF – technology should be used to provide basic health care facilities, and not only specialised care.[219]

Although there are more successful examples of secondary care HTM projects, the potential for that tool to be used in primary care is substantial. The few examples of remote primary care confirm that it can work both with basic and elaborate technologies and, as expressed by Fischer, "as long as questions can be asked and answered, primary care can be delivered at a distance".[220] Indeed, as the Medical Home programme in Mexico has shown, two-thirds of patients' concerns can be addressed over the phone by a doctor.[221] At its most basic, primary care can be delivered through the use of a telephone, as seen in a programme supported by the Bill and Melinda Gates Foundation which, through the use of mobile phones, has enabled the delivery of advice and reminders to pregnant women.[222] Most successful cases of remote primary care delivery have the use of mobile phones in common, both in industrialised and developing countries. In addition, there are cases where primary care is delivered through the use of more elaborate technologies. These technologies are fully compatible with more basic ones, as demonstrated by the ATNF, which is now conducting a pilot project dealing with patients needing constant close-up monitoring. The ATNF has developed the MDAU, which "when connected to the internet-enabled computer, can record and transmit an [...] ECG, blood pressure, pulse rate, temperature, and heart and respiratory sounds". In addition, when needed, the doctor's prescription can also be sent to

[212] "Metrics: Disability-Adjusted Life Year (DALY)". World Health Organization. 2013 For further information on DALYs, as well as an example of their computing visit the University of Ottawa's Faculty of Medicine's article on the subject at <http://www.med.uottawa.ca/sim/data/DALY.htm>
[213] "Squeezing out the Doctor." *The Economist* 2 June 2012: 25-27. Print.
[214] "World Health Statistics 2013." World Health Organization. 2013. Web. 30 July 2013 <http://apps.who.int/iris/bitstream/10665/81965/1/9789241564588_eng.pdf>
[215] Abiodun, Adigun Ade. "Space Applications and the Special Role for Telemedicine." European Space Policy Institute, HTM. 14 June 2012 in Vienna.
[216] Fischer, Gabriele. Personal Interview. 15 May 2013
[217] Van Schayck, Onno CP, et al. "Early detection of chronic obstructive pulmonary disease (COPD): the role of spirometry as a diagnostic tool in primary care." *Primary Care Respiratory Journal.* Vol.12. Issue 3 (2003):90-93
[218] "Noncommunicable diseases". *World Health Organization.* Web. 30 July 2013 <http://www.who.int/mediacentre/factsheets/fs355/en/>
[219] Sanghavi, Varsha. "The Visionary Who Became Father of Telemedicine." *Healthcare Executive* November 2012: 56-60. Web. 30 July 2013 <http://www.telemedicineindia.com/hosmacemag.pdf>
[220] Fischer, Gabriele. Personal Interview. 15 May 2013
[221] "Squeezing out the Doctor." *The Economist* 2 June 2012: 25-27. Print.
[222] Ibid.

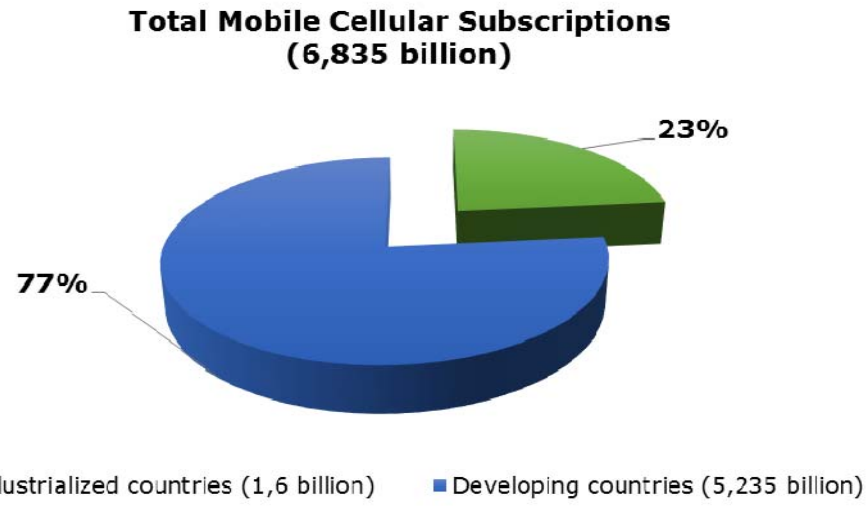

Figure 11: Worldwide Mobile Subscriptions (Source: adapted from Global mobile statistics 2013 mobithinking.com)

the nearest Apollo pharmacy and delivered to a patient's door.[223] Primary care can therefore be delivered through such basic technology as a phone or a computer, and if needed, a camera.[224]

In the case of Africa, ESA, as part of its telemedicine opportunity study, gathered information on the fibre network interconnections and satellite connectivity in order to assess coverage. Their report showed that connectivity or interconnections are still quite scarce, particularly inland. It also highlights the plans to expand coverage to West, Central and East Africa.[225]

Beyond land-based networks, the use of satellites is also a potential solution for connectivity, as shown by projects carried out by CNES and ISRO. In the case of CNES, its telemedicine "suitcase" has enabled both remote monitoring and diagnosis in French Guyana through satellite-enabled communication technology. In the case of ISRO, while the format differed, the technology was also satellite-enabled. Remote diagnoses have even been delivered through a VSAT-equipped tele-clinic van (HoW). Therefore, whatever the means of delivery, connectivity can be achieved even where land connections do not exist.

As Figure 11 shows, over 75 percent of the total worldwide mobile phone subscriptions are in developing countries.[226] Not only are the majority of subscriptions in developing countries, but at least half of their total populations have subscriptions. The cases of Africa and the Asia Pacific Region are particularly evocative; while their populations are respectively 1 billion and 4,2 billion, their mobile phone subscriptions amount respectively to 545 million and 3,547 billion.[227] In other words, over 50 percent of the population in Africa, and over 80 percent of the population in the Asia Pacific Region, have a subscription to mobile phones. This data must, however, be understood critically. Although the number of subscriptions might be high, it does not take into account the potential for multiple subscriptions by one individual, obsolete subscriptions, or specific areas with very limited coverage.[228] The statistics found in the World Disaster Report 2013 show this caveat. Indeed, as shown in figures 12 and 13[229] here-

[223] Bollineni, Raja. "Apollo Telemedicine Networking Foundation (ATNF)" *Access Health International* (2011). Web. 30 July 2013 <http://healthmarketinnovations.org/sites/healthmarketinnovations.org/files/CaseStudy_ATNF.pdf>

[224] Eccles, Nora. "Telemedicine in Developing Countries: Challenges and Successes." *Harvard College Global Health Review*. 1 February 2012. Web. 30 July 2013 <http://www.hcs.harvard.edu/hghr/print/spring-2011/telemedicine-developing/>

[225] Asamoah-Odei E., et al. "eHealth for Africa Opportunities for Enhancing the Contribution of ICT to Improve Health Services." *European Journal of Medical Research*. Vol. 12. Supplement 1 (2007): 1-38. Print.

[226] Samal, Itishree. "Apollo to Offer Services on Mobiles, Tablets." *Business Standard* 24 September 2012. Web. 30 July 2013.

[227] "Population of Africa 2013"*World Population Review.* Web. 30 July 2013. <http://worldpopulationreview.com/population-of-africa/> "People – Demographic Trends." *United Nations* ESCAP. Web. 30 July 2013 <http://www.unescap.org/stat/data/syb2011/I-People/Population.asp>

[228] "*World Disaster Report Focus on technology and the future of humanitarian intervention".* International Federation of Red Cross and Red Crescent Societies (IFRC). *(*2013):30-31

[229] Figures 12 and 13 are taken from: "*World Disaster Report Focus on technology and the future of humanitarian intervention".* International Federation of Red Cross and Red Crescent Societies (IFRC). *(*2013):16

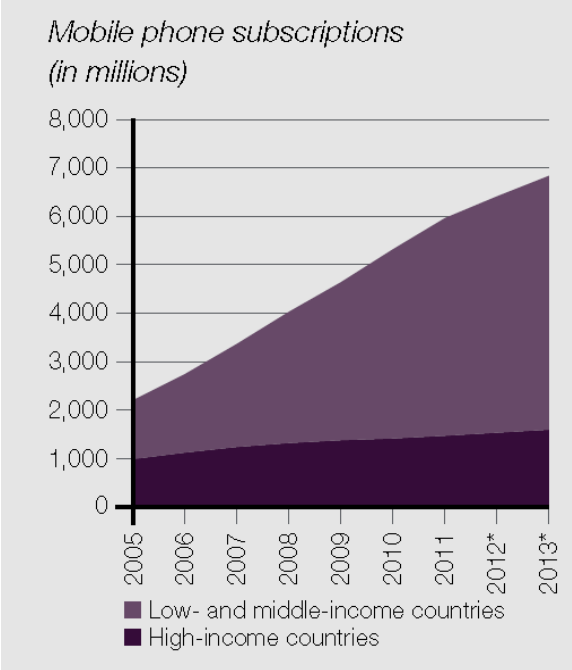

Figure 12: Mobile phone subscriptions
(source Red Cross, Disaster Report 2013) *=estimates

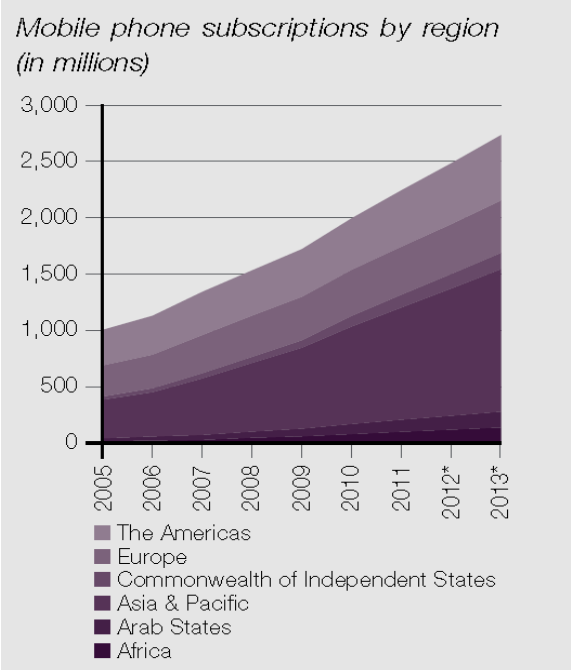

Figure 13: Mobile phone subscriptions by region
(source Red Cross, Disaster Report 2013) *=estimates

under, the results differ greatly according to whether the subscriptions are categorised by income, countries or regions. Globally, however, subscription-rates are rapidly increasing in most countries and regions, and this presents a key opportunity for telemedicine. Mobile phones are already used in some regions to monitor and diagnose medical conditions and diseases. Additionally, there are projects that have been developed in which, through micro-financing, mobile phones have been made available to wider populations through sharing schemes or rentals, even in remote areas.[230]

One of the previously mentioned lessons learned consists of assessing medical need before technology: primary care is such a need. The increasing burden of chronic diseases, in addition to the existing burden of infectious illnesses, and the lack of medical professionals in developing countries, set the foundation for a deeper global health gap. With the greater supply of medical professionals in the industrialised states, and the benefits that added primary care could bring to the developing world, there is a "low-hanging fruit" to be picked, which would also increase "North-South" cooperation.[231] With regards to technological opportunity, this can be achieved even with basic equipment, such as mobile phones.

6.2 Industrialised/Developing Country Humanitarian Telemedicine Primary Care: Considerations and Potential Way forward

Few existing HTM projects deal with primary care directly. Moreover, HTM projects provided by industrialised countries to countries in permanent need of medical care are have not been reported or documented. Building on the previously discussed need for primary care, and on existing technological opportunities, the following section will first look into the opportunities and challenges that might arise with such projects. A potential way forward will then be explored, with a proposal to practically test these same opportunities.

6.2.1 General Project Considerations

Many questions arise when discussing primary care HTM, in terms of feasibility and sustainability, as well as challenges. The experiences of secondary care HTM projects are

[230] Fox, Killian. "Africa's mobile economic revolution". The Observer, The Guardian. 24 July 2011. Web. 18 November 2013 <http://www.theguardian.com/technology/2011/jul/24/mobile-phones-africa-microfinance-farming>

[231] Kasturirangan, Krishnaswamy. "The Power of Telemedicine to Bring Medical Care to Underserved Communities." European Space Policy Institute, HTM. 14 June 2012 in Vienna.

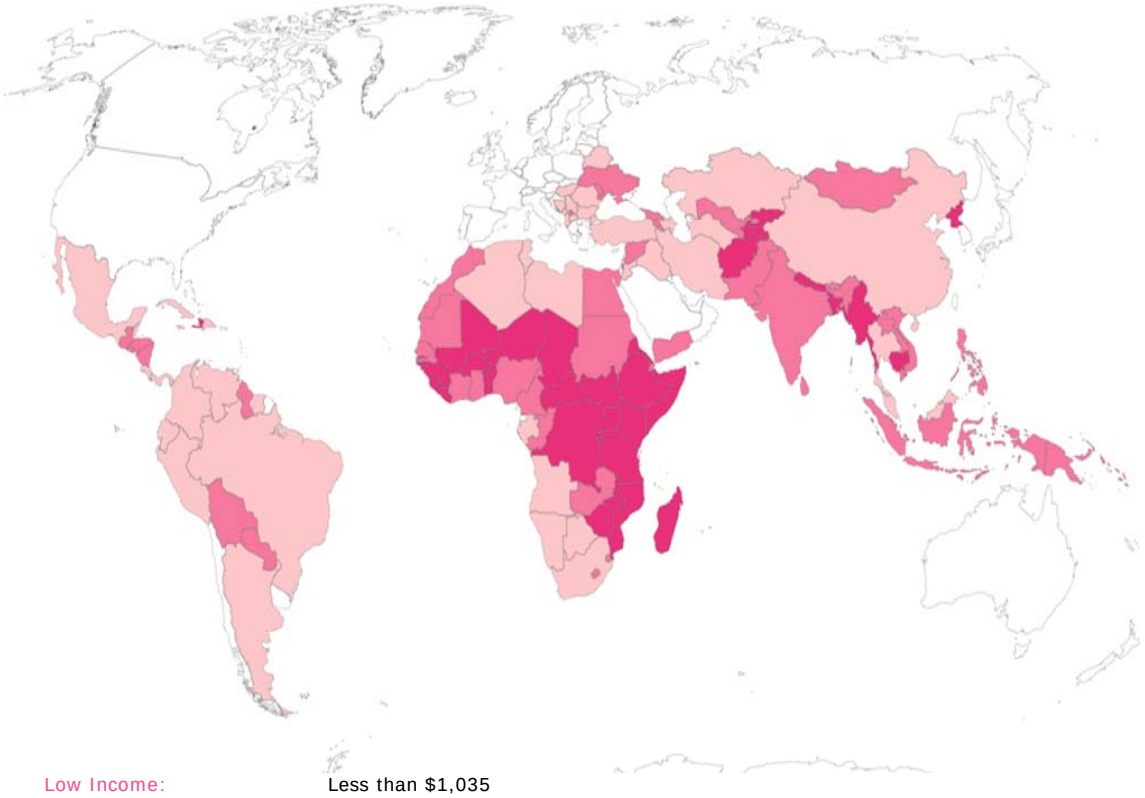

Figure 14: World Bank Low and Middle Income Country Groups (Gross National Income per Capita) (Source: adapted from the worldbank.org)

useful, but do not answer all questions. Primary care raises considerations of its own, and there is virtually no guidance to be had from existing or completed projects of this nature. Despite the lack of literature on this topic, the following sections aim to explore potential opportunities and challenges that could arise from primary care HTM projects, by exploring previous general HTM initiatives.

Feasibility and Sustainability Questions

As with any other project relating to HTM, those aiming to provide primary care must be investigated on the basis of their feasibility (technical and economic) and sustainability. Generally, questions such as: "Who are the stakeholders and users? What is the timeline of the project? How will the project be organised and financed? What is the goal of the project? Why will it be viable for the users, for the stakeholders? Where should it take place? What are the project's needs?" should be answered before proceeding with the development of a project.

As shown in figure 14, a variety of countries is in need of aid. Although they all have certain degrees of need, they do not necessarily invite the same approaches. Many considerations regarding the feasibility and sustainability of a primary care project can be addressed with the help of secondary care HTM projects. Issues such as the "technological readiness" (availability and affordability of required ICT, and the hardware and software needed to implement the proposed project), "learning readiness" (programmes and resources to provide training to healthcare providers in using the technology), political context, and the levels of acceptance of the project among the local population are to be considered.[232] In terms of sustainability, there is a need to address the logistics, finance, and possible maintenance of the project. Equally important, general cooperation, especially between developing and industrialised countries, is essential.[233] The direction of the project should be identified, in its important parts, based on cooperation levels. Will the project adopt a model such as that of RAFT, which is self-standing but incorporated

[232] Khoja, Shariq, et al. "E-Health Readiness Assessment Tools for Healthcare Institutions in Developing Countries." *Telemedicine and e-Health.* Vol. 13. Issue 4 (2007): 425-431. Print.
[233] "Cybersanté: où en sommes-nous?" Bulletin de l'Organisation Mondiale de la Santé. Vol. 90. Issue 5 (May 2012): 321-400. Print.

into the national health institutions, or that of MSF, which is more independent from national institutions? The level of involvement of the host country in telemedicine, and its willingness to include it into the national health system, can easily determine the best strategy for a project. All of the above are but a sample of general considerations for primary care HTM projects.

In terms of culture, questions such as: "what type of consultations are suitable for teleconsulting? Is it suitable for initial consultations or do patients find telemedicine technology more suitable for follow-ups?"[234] and "Who and where are the users?"[235] are crucial for an effective approach to understanding the need for primary care. These questions could very much be determined by the local health culture with regards to primary care. What are the usual habits of the users? What are their traditional medical practices? Is the first point of access to a health care provider located at a distance? As for structure, a clear picture of the field-based implementing body, along with the required technology and human resources (medical and technical training) needs to be obtained.[236] Moreover, with the physical absence of the doctor, social questions become crucial.[237] Can the ground personnel needed to operate the equipment double as medical and/or cultural middlepersons? Additionally initial research and analysis should determine whether they are needed on a permanent basis or only for the initial phase of a project. With regards to format, the deep involvement of local actors might be especially important if the patients are to be referred to specialists. The importance of engaging with partner hospitals hosting specialists, or with other telemedicine programmes with the relevant specialities, would then be crucial. Finally, assessment, evaluation and feedback would be particularly important for primary care projects, as a deficiency exists in these areas, and addressing it would greatly benefit HTM in general.

An additional important aspect to consider for the development of a prototype humanitarian primary care telemedicine project is its size. Prototype projects must deal with one problem at a time. As Duflo and Banerjee have argued, "start to think of the challenge as a set of concrete problems that, once properly identified and understood, can be solved one at a time".[238] Not only should this advice be heeded during the establishment of such projects, but it should also be followed along the entire prototyping phase. During this phase of a project, one tries to identify problems by experimenting, and ideally, identifies what works best. Indeed, it centres on the concrete possibilities arising from this area of medicine, especially in *primary care*.

Challenges

Some of the challenges that such projects might face are set out in schematic form in table 1.

The main concern surrounding primary care telemedicine in terms of medical culture is that, as part of medical care, there is generally a doctor at only one end of the communication. When two or more medical professionals are in contact, although they may come from different countries and speak different languages, they share a background as medical practitioners. Between a patient and a medical professional, not only does the language differ, but so do their cultural approaches to medicine. This difference in cultural approaches can be detrimental to health initiatives if they are not taken into consideration and if trusted facilitators are not introduced. However, this problem also exists when a foreign doctor provides on–the-ground primary care to a patient, and it might be somewhat alleviated by the possible presence of a trained nurse. The doctor-patient relationship can vary significantly between cultures and primary care projects may face questions regarding, for example, the "effects this mode of healthcare delivery has on the relationship".[239] For "many doctors, telemedicine seems to depersonalise the relationship and sabotage trust".[240] There is, nevertheless, an increasing number of doctors located in industrialised countries who are getting more familiar with these technologies, as the increasing number of projects shows. This cultural aspect, however, should be taken into consideration when contemplating the remote delivery of primary care. Additionally, throughout prototyping, the patients' and doctors' satisfaction levels should be assessed, as was done in the case of OVH in Cambodia. In this particular case,

[234] Mair, Frances, and Pamela Whitten. "Systematic Review of Studies of Patient Satisfaction with Telemedicine." *British Medical Journal*. Vol 320 (2000): 1517-1520. Print.
[235] Crigger, Bette-Jane. "e-Medicine: Policy to Shape the Future of Health Care." *The Hasting Center Report*. Vol. 36. No.1 (January-February 2006): 12-13
[236] Abiodun, Adigun Ade. "Space Applications and the Special Role for Telemedicine." European Space Policy Institute, HTM. 14 June 2012 in Vienna.
[237] Fischer, Gabriele. Personal Interview. 15 May 2013
[238] Banerjee, Abhijit V., and Esther Duflo. Poor Economics A Radical Rethinking of the Way to Fight Global Poverty. New York: Public Affairs, 2011. Print. p. 3
[239] Mair, Frances, and Pamela Whitten. "Systematic Review of Studies of Patient Satisfaction with Telemedicine." *British Medical Journal*. Vol 320 (2000): 1517-1520. Print.
[240] Chen, Pauline W. "Are Doctors Ready for Virtual Visits?" *The New York Times* 7 January 2010. Web. 30 July 2013

Sample of Potential Challenges	
Finance / budget	• Potential for high set-up and running costs • Potential difficulties in securing sources of funding
Structure	• Lack of appropriate infrastructure • Risk of starting on too large of a scale • Choice of appropriate structure (mobile, fixed, paid service or free, synchronous or asynchronous communications) is challenging • Logistical considerations are particularly important in a developing country setting
Stakeholders	• The choice of partners should be based on the objectives and necessities of the project (local populations, local governments, NGOs, development experts, international health organisations, etc.)[241]
Legal	• Data ownership, protection and confidentiality insurance • Potential liability of doctors, insurance • Legal framework to be applied
User needs and requirements	• User needs and requirements determine the format of the project
Medical	• Determining the amount of information sufficient for the doctors • Doctors' adaptability to less extensive technologies
Technology	• Appropriate technology levels for the project • Interoperability of software between actors • Appropriate internet connectivity • Resistance to change from clinicians to integrate new ICT technologies and working methods in their practices • Technological training needed for eventual middleperson.
Culture	• Local relation to primary care • Local acceptance of the ICT-based services
Assessment and evaluation	• Need to assess the effectiveness of the project to improve its outcome • Need to make the project scalable and replicable in other contexts
Sustainability	• The choice of format might represent difficulties, for example, institutional anchoring locally or with a specific organisation, • Other considerations include organisational models, technical and clinical solutions, integration strategy, network expansion, technology, and exit strategies.[242]

Table 1: Sample of potential challenges associated with primary care HTM projects

patients' satisfaction, and their willingness to pay for a service that was previously free, showed not only satisfaction with the service, but also acceptance of the new medical delivery system.[243] However, as Wootton has put it, "it is much harder to change attitudes and organisations than simply to deliver new equipment".[244]

Unlike culture, perceptions can arise as a result of the past actions of a third party. As expressed in an interview for the magazine New African in June 2013, "although colonisation does not exist today – in terms of physical ownership of countries – the mentality of the Western world in relation to Africa is still very colonial".[245] This perception is widespread in the developing world. For example, in the context of polio vaccinations carried out in Pakistan, they were perceived to be "harmful, or even a Western plot to

[241] "Satellite-enhanced eHealth for sub-Saharan Africa Programme (eHSA)." *European Space Agency*. Web 4 December 2013 <http://iap.esa.int/showcases/third-party-collaboration/ehealth-for-ssa-5>

[242] "Long-running telemedicine networks delivering humanitarian services: experience, performance and scientific output". *Bulletin of the World Health Organization*. Vol. 90 No. 5 (2012): 341-347D

[243] "Operation Village Health" *Centre for Connected Health* Web. 30 July 2013 < http://www.connected-health.org/programs/remote-consults--virtual-visits/center-for-connected-health-initiatives/operation-village-health.aspx>

[244] Wootton, Richard "Telemedicine." British Medical Journal, Vol. 323, Clinical Review (September 8, 2001): 557-560

[245] O'Malley, J.P. "There is a continued imposition of Western culture on Africans." NewAfrican. June 2013, N. 529, pp.74-77

sterilise Muslims".[246] Such negative perceptions of foreign aid may prove to be a threat to the safety of the personnel on the ground. For this reason, cooperation and dialogue with national governments and other powerful groups in local society are necessary in order to reduce the possibility of problems. Additionally, there might be reservations on the side of local doctors. In the case of secondary care "there is a long history of telemedicine networks being used to support doctors, particularly in low-resource settings".[247] In primary care, however, the main support provided is directly to the patient, and generally has no interaction with local doctors. Although this might indirectly help overworked doctors, they might consider themselves excluded from the projects, and their area of expertise as being taken over by external parties.

A final set of challenges for the sustainability of such projects arises with regards to their financial and technological situations: "turn-key-projects that will forever depend on donors' support" should be avoided, unless durable financing can be secured.[248] This challenge is not exclusive to primary care projects, as a number of secondary care projects have operated for decades with a dependence on foreign funding.

It is easy to point to the possible imperfections of primary care HTM, yet criticism often fails to consider the alternative, which is often no health care, and all the consequences that such situations entail.

6.2.2 Prototyping: Potential Way forward

Is primary care HTM possible between industrialised and developing countries, or are there insurmountable obstacles to such projects? This is a question that must be answered before permanent projects are implemented. A possible way of answering this question is to set up a prototype for this type of project.
The approach that is presented here follows the idea of "field experiments" expressed by Duflo,[249] who states that "field experiments, when the collaboration with the partner is very close, offer much more flexibility and make it possible to give primacy to the hypothesis to test, rather than to the program that happens to have been implemented".[250] Therefore, the prototype can be brought forward and, through further experimentation, challenged or optimised.[251] However, the question remains, what would such a prototype look like?

Donor Country Side

On the *donor side*, a structure that could be used to provide consultations at a distance is a hospital hub based in a large hospital of an industrialised country (see table 2). As the cases of ATNF or RAFT have shown, this structure offers the best medical coverage, as a resource pool of health professionals is present "at the scene". Although telemedicine has the potential to allow doctors to connect from any location, as a first step to test this type of intervention, a centralised group of doctors would be more practical. Therefore, a large hospital would be a sensible choice. Additionally, the space needed for the doctors to carry out their consultations would necessitate only limited physical investments. An existing room might be sufficient, as shown in the Altiplano project, which is based out of La Paz, Bolivia.[252]

In addition, some potential issues can already be identified. Specifically, they relate to: (1) logistics, (2) culture, and (3) technology. Logistically, questions of availability and scheduling should be considered. Coordinating with several doctors at different times of the day may be difficult, especially since they may be located in different time zones. Additional concerns regarding such projects are cultural. Even with the knowledge that the circumstances differ between two settings, how does a doctor become accustomed to the local conditions? How is a relationship based on trust built when the relevant actors do not know each other? This issue is linked to HTM in general, but is particularly important in primary care as the patient/doctor relationship is a direct one. Finally, the doctor will have to adapt to the means available on the ground. Unlike doctors who go directly to the

[246] Farmer, Ben. "Health Workers Attacked in Pakistan for Polio Vaccinations: 'We thought it was the last day of our lives'." *The Telegraph* 23 December 2012. Web. 30 July 2013.
[247] Wootton, Richard, et al. "Experience with low-cost telemedicine in three different settings. Recommendations based on a proposed framework for network performance evaluation" Global Health Action. Vol. 4 (2011):7214. Print.
[248] Abiodun, Adigun Ade. "Space Applications and the Special Role for Telemedicine." European Space Policy Institute, HTM. 14 June 2012 in Vienna.
[249] Duflo, Esther. "Field Experiments in Development Economics". Massachusetts Institute of Technology. Prepared for the World Congress of the Econometric Society (January 2006) Web 4 December 2013 <http://economics.mit.edu/files/800>
[250] Ibid. p.18.
[251] Ibid. p.20.
[252] "Pan American Telemedicine Network Project Proposal" PDF. *ITU.* Web. October 17 2013 <http://webcache.googleusercontent.com/search?q=cache:poP6k-Wjjh0J:www.itu.int/ITU-D/CDS/gq/generic/asp-reference/file_download.asp%3FFileID%3D1206+&cd=1&hl=en&ct=clnk&gl=at>

Donor Side Characteristics	
Structure	• Hospital hub • Urban
Doctor Presence	• Volunteer basis • For a few hours per week/month
Opportunities	• Resource pooling • Common coordination place, easier for initial set up • Limited additional set-up costs for the prototype.
Challenges	• Logistics, coordinating the doctors, scheduling • Availability of doctors, ensuring a location for the teleconsultation • General trust and human connection dynamic • The doctor might not have direct experience in the field, and may not understand the local context • Switching between daily job (in which they have access to high levels of technology) to the remote consultations (in which the technology available is more basic)

Table 2: Summary of donor's side characteristics.

field and are immersed in the local environment, in telemedicine projects like those discussed in this document, doctors are only in contact with the local environment several hours per week. While they have access to modern, technologically equipped infrastructure during most of their daily work, the technology available for the telemedicine consultations and diagnoses might be more basic. Therefore, a certain amount of adaptability between their daily practice and the provision of HTM primary care is necessary.

The Host Country Side

In order to test the theoretical possibility of delivering HTM primary care, the structure in the host country must be assessed. Three general modes appear feasible: mobile, fixed, and fixed alongside local healthcare providers. Other models may appear with further field development. However as a theoretical starting point, only the three aforementioned models will be considered. They are explained in the following paragraphs (see table 3 for a detailed comparison of the three prototype proposals).

1. *The mobile unit.* This format takes its roots in projects such as the ATNF's HoW and CNES' telemedicine "suitcase". In both cases, the receiving side of the intervention is mobile, and it reaches the most remote patients.

   For the purpose of the prototype, the mobile unit's format would follow that of the ATNF's HoW, where it would be equipped with the technology relevant for primary care, such as a camera with audio and visual capabilities. In terms of the communication technologies that could be used, as many remote geographical areas lack connectivity, a need for mobile satellite-enabled connections would arise. This solution would also make the mobile unit technologically self-standing and self-reliant. The main characteristic of the mobile unit is its capability to reach the most remote patients. In essence, the prototype could be rolled out in a rural environment, where no other similar services are available.

   In terms of partnerships involved, although this format offers the most independence, it would need to include at least one middleperson on the ground. Beyond the need to pilot the mobile unit, and for technical and medical knowledge, the most important element the person on the ground would need is a deep understanding of the local conditions. The person on the ground is essential for such a project as he/she helps the doctors understand local conditions and enables the trust of patients in doctors located thousands of miles away. With medical care originating from a hub in an industrialised country, the need for local populations to understand and trust what the doctor recommends is paramount. The middleperson could therefore be a nurse or a medical auxiliary from a local or international organisation. This person would have sufficient knowledge of the area, the population, and humanitarian aid. In addition there would be a need for a partnership with regards to the acquisition and set-up of the mobile unit and its communication structure.

2. *The fixed remote unit.* As opposed to the mobile unit, this format is characterised by a unit at a fixed location in the host country. The medical care would be de-

livered at that specific unit, located in a remote geographical setting. The main characteristic of this type of initiative is its ability to reach patients in areas where the same medical services are not provided, which entails, in most cases, a rural area. In terms of enabling the delivery of consultations, the fixed location could use existing terrestrial connectivity or, if it is not available, satellite-enabled connectivity.

In terms of partnerships, as for the mobile unit, there is also a need for a middleperson on the ground. As the project would take place in a remote location, with no other health facilities in surrounding areas, the ground liaison would be paramount. The individual in charge of those tasks, like the one described as part of the mobile unit, would need to possess technological and medical knowledge. The middle person could therefore be a nurse or a medical auxiliary with the appropriate technological knowledge. In addition to this middleperson, there could also be a case made for the part-time participation of a local representative. The latter could help in securing cultural acceptance, in addition to assisting with the other tasks. In this respect, the project could work with an existing local point of contact of an established organisation, or a local member of a national institution.

In terms of partnerships, there would be a need for close collaboration with local actors (government and/or non-governmental), as well as with partners in charge of enabling the communication connection from the fixed remote unit.

3. *The fixed point alongside local healthcare.* This format is predominant in secondary projects, as FISSA, MSF, RAFT, and MMC have shown.

   This prototype structure is the most integrated into the local national healthcare system. As it would be established alongside the local healthcare system, it could be in either a rural or urban geographical area, depending on the local health infrastructure. Another characteristic of this type of healthcare delivery is its stationary structure. In terms of communications technology, the local infrastructure might have access to terrestrial connectivity, which could be used. However, should this technology become unavailable, the option to use satellite-based technology would be an, albeit costly, alternative. As for the patients, the reach would be the same as that of the local infrastructure. Moreover, the consultation room for the patient could be set up inside the local healthcare facility.

   Although this format would allow for strong local collaboration, there would still be a need for a middleperson with some health and technical knowledge to be present, such as a nurse or an auxiliary. In terms of partnerships, due to the strong structural dependence of the unit on the local health infrastructure in which it is located, there would be a need for close collaboration. In addition, cooperation with local political and health authorities would be needed to set-up the prototype.

All three prototypes presented above have the potential to answer the theoretical question as to whether the delivery of primary care HTM is possible between doctors in industrialised countries and patients in developing ones.

Prototype Comparison

A number of opportunities and challenges arise with each format of healthcare delivery. Three main comparison points emerge from their preliminary analysis: (1) the patient aspect, (2) the ease and acceptance of the potential prototype, and (3) its sustainability (see table 3 below for detailed comparison of the three prototype proposals).

	1. Mobile Unit	2. Fixed Remote Unit	3. Fixed Point alongside Local Healthcare
Main characteristics	• Mobile • Basic medical equipment • Technologically self-standing • Reaches the user wherever he/she is located • Rural • Presence of middleperson (with both medical and technological knowledge)	• Specific location • Stationary structure • Basic medical equipment • Technologically self-standing possibility • Reaches remote locations, but not everywhere • Rural • Presence of middleperson (with both medical and brief technological knowledge)	• Specific location • Stationary structure • Technologically linked to the local health infrastructure • Reaches the same users as the local health infrastructure • Urban or rural • Presence of middleperson (with minimal medical and technological knowledge)
Technology used	• Predominantly satellite-enabled technology	• Satellite, unless an already existing terrestrial connection is available, or unless the existing technology is insufficient	• Terrestrial connection or satellite if there is no local connection possibility (increased flexibility)
Type of Potential Partners involved	• Delivery of consultations: Hub hospital doctors • Medium of delivery: Private space sector, national or international organisations (health, development or space-related) • Middleperson: dedicated personnel or national institution personnel • Development experts: NGOs, academia…	• Delivery of consultations: Hub hospital doctors • Medium of delivery: Private space sector, national or international organisations (health, development or space related) • Middleperson: dedicated or national institution personnel • Further partnering possibility with aid workers on the ground is possible • Development experts: NGOs, academia…	• Delivery of consultations: Hub hospital doctors • Medium of delivery: Private sector, national or international organisations (health or development related) • Local national government or other national institutions • Middleperson: dedicated or national institution personnel. • Further partnering with the existing doctors at the hospital • Development experts: NGOs, academia…
Opportunities	• Best geographical reach • Best patient reach • Best patient diversity • Technological autonomy • Great ease of use for the patient (as opposed to walking to the nearest identical service)	• Good geographical reach • Good patient reach • Good patient diversity • Technological independence • Ease of use for the patient (as opposed to walking to the nearest identical service)	• Integrated approach with local health initiatives and infrastructures • Potential for increased local patient acceptance • Low cost • Less technology and maintenance involved

Challenges	• High cost • High need for technological knowledge (use and maintenance) • Local patient acceptance risks • High asset risks • Difficult local integration	• Medium cost • Need for technological knowledge (use and maintenance) • Possible local patient acceptance risks • Possible asset risk • Potential local integration issues	• Poorer geographical reach • Poorer patient reach • Poorer patient diversity • Possible technological problems emanating from technological dependence • Possible rivalry seen by local doctors
Assessment of prototype and theory	• Mild difficulties • Difficulties establishing a control group	• Purest form • No other available service in the area, resulting in a lower possibility of treatment combination • Direct effect can be observed as the service is in a fixed location. • Easier establishment of a control group population	• Greater difficulties • Prototype alongside existing health care professionals and facilities, high probability of combining with another health service, distinction between the two services' effect is rendered difficult

Table 3: Prototype comparison, host country side

1. *The Patient.* As shown in section 6.1, there are a number of people that are in need of medical aid, and none so much as those living with infectious diseases. Not only are these the leading cause of mortality in many areas, and on the African continent in particular, but they also disproportionally affect the most vulnerable members of society.

   Bearing this in mind, in terms of reaching a diversity of patients, both geographically and socioeconomically, some prototypes present better opportunities than others. On the one hand, in the case of the mobile unit, the geographical reach would be the best, as the prototype would enable it to cover significantly greater ground. More importantly it would present the advantage of reaching patients that do not live in proximity to health care facilities, and suffer from this geographical divide. It would also present the opportunity to reach a greater diversity of patients, both socio-economically and, potentially, medically.

   The prototype operating alongside existing healthcare facilities would be the least advantageous in terms of patient reach and diversity. Indeed, the patients likely to benefit from the project would be those already using, and/or able to reach the existing healthcare infrastructure. Without the possibility of reaching those most in need, this type of prototype does not represent the best case for patient focus.

   The middle ground is covered by the fixed remote prototype proposal. It enables reaching a greater variety of patients, socioeconomically, and perhaps medically, who otherwise might not have access to health care facilities. This prototype, however, would not be as far reaching as the mobile unit prototype proposal. On the other hand, it would present the advantage of being able to build up an identifiable presence in a local community, and therefore possibly engender more trust.

2. *Technology.* HTM relies intrinsically on technology, and stemming from this relationship, several issues may arise, such as technological dependence and costly maintenance.

   As HTM primary care relies heavily on the possibility of diagnosing a patient directly from a remote location, the technological capabilities enabling this connection are essential. In this respect, technological independence allows for both the security and consistency of the connectivity between the parties. With regards to the proposed prototypes, both the mobile and fixed remote units would rely on their own established connectivity (satellite-enabled). This allows not only a consistent service, but also independence from existing terrestrial connectivity, which

might not always be available or reliable. In addition, as previously stated, both projects enable greater reach, and therefore give patients from remote areas better access to services (more so in the case of the mobile unit).

However, there is a counterpoint to acknowledge with regards to such reliance on outside technology. First, the middleperson on the ground would require greater technological knowledge, which would imply additional training (greatest for the mobile unit). In addition, the maintenance of such technologies might hinder the project as a whole. Not only is this higher level of technology susceptible to break down, but equipment malfunctions and connectivity problems could arise and affect the remote diagnosis of the patients. Unlike the mobile and fixed remote units, the embedded prototype will likely require less maintenance and technological knowledge. It could also be cheaper, as implementation would require less new infrastructure. Furthermore, should a technological problem occur, the close geographical proximity of the partners would potentially allow for quicker solutions.

3. *Sustainability.* Although the proposed prototypes are intended to test a theoretical framework, sustainability should also be prioritised in this process. There are several issues of sustainability that arise in each of the three prototypes: asset sustainability, financial sustainability, and collaboration sustainability.

   What is understood by asset sustainability is the potential threats posed to physical assets. Whereas bad weather, equipment deterioration, and possible breakdowns of the equipment may occur in all three prototypes, there remain differences between each. For the mobile unit, these considerations are greater than for the other two prototypes, due to its mobile nature. In addition, with the potential high level of technology on the unit, as well as the mobile nature of the project, the probability of equipment theft and violence is higher. Both the fixed remote unit and the embedded prototype, due to their unique geographical location and closer contact with the local population, have a lesser probability of encountering such issues. However, in these prototypes as well, such risk is not inexistent, and should not be ignored.

   In terms of financial sustainability, the level of technology used, along with the establishment of new infrastructure, may impact the various prototypes differently. On the one hand, in the case of the embedded prototype, if local connectivity is available and reliable, there would only be a need to bring in hardware. In addition the infrastructure would not have to be built from scratch. On the other hand, in the case of the mobile unit, all the equipment, infrastructure and technology will have to be brought in, generating higher costs. Again, the fixed remote unit represents the middle ground. Although the technological elements and possible maintenance costs in this prototype are higher than in the embedded prototype, its fixed position and relatively simple technological requirements in terms of primary care-enabling assets make it less costly than the mobile unit. These financial considerations are important to identify, as they may hinder the sustainability of a project: stakeholders may not wish to prolong their investment in prototypes or future endeavours if their cost is too high.

   Finally, collaboration with local actors, as argued extensively in this report, is essential for sustainability. If a prototype is to take into account the possibility of longer-term implementation, ground cooperation and collaboration should be fostered. In the case of the embedded prototype, the very close nature of the collaboration needed to make the project viable presents the advantage of generating a more sustainable relationship. Meanwhile, the mobile unit prototype does not present the opportunity for such an integrative and cooperative approach. In addition, close collaboration with local actors has the potential to create greater acceptance of the prototype. The proposed embedded prototype would not only allow for a collaborative transition and a greater *acceptance* into local health systems, but also might increase the likelihood of endorsement by local health practitioners, thus facilitating local patient acceptance. In the case of the fixed remote unit, the possibility for follow-ups, and the constant presence in the same location, might encourage local patients to get better acquainted with the system. This would be reinforced with the presence of an additional, part-time, local point of contact, as it could potentially open the door for greater cooperation and therefore increase sustainability.

In conclusion, all three prototypes have distinct potential opportunities and pitfalls, and deciding on a format for testing will not only involve the trade-offs presented in the previ-

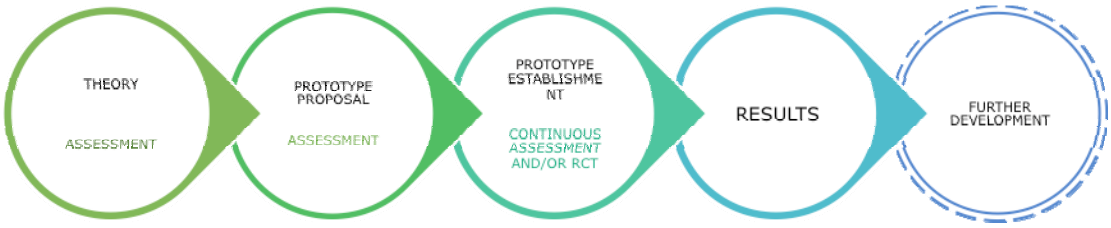

Figure 15: Assessment in the prototype process, inspired by Duflo (2006)[253]

ous paragraphs, but it must also be influenced by the possibilities for assessment and testing.

Assessment Opportunities

The three prototype options are proposed as a way of testing a theoretical proposal. The previous section laid out the opportunities and challenges associated with each of the prototypes, and compared them. However, in order to identify which prototype would be preferable, the assessment opportunities for each one must also be considered.

Duflo (2006) explained that if field experiments include sequential experimentation, there is a potential for each set of results to provide inputs for new rounds of experiments.[254] Indeed, this design "offers interesting possibilities in that the experiments become more relevant as the underlying theory becomes more pertinent, and the richness of the data collected allows the researcher to use the data in many other ways than conducting a simple test of the theory".[255] Although the testing of the theoretical framework proposed would not necessarily generate other prototypes, the lessons to be learned through continuous assessment are relevant and should be considered. In other words, and within the context of the proposed prototypes, continuous assessment and data collection during all phases of concept testing (see figure 15) not only allows for a continuous challenge of the prototype experience but also for its improvement, and for a possible transition to further developments.

As the prototypes would be launched initially to demonstrate a concept, their results would need to be measured. A potential way to carry this out could be through the application of control trials, or as the Abdul Latif Jameel Poverty Action Lab (J-PAL) have called them, Randomized Evaluations. The definition they provide for this concept will be the one retained for this report, and is as follows:

> "The main purpose of randomized evaluations is to determine whether a program has an impact, and more specifically, to quantify how large that impact is. Impact evaluations measure program effectiveness typically by comparing outcomes of those (individuals, communities, schools, etc.) who received the program against those who did not. There are many methods of doing this. But randomized evaluations are generally considered the most rigorous and, all else equal, produce the most accurate (i.e. unbiased) results".[256] (See figure 16 for the link between evaluation and randomized evaluation proposed by J-PAL)

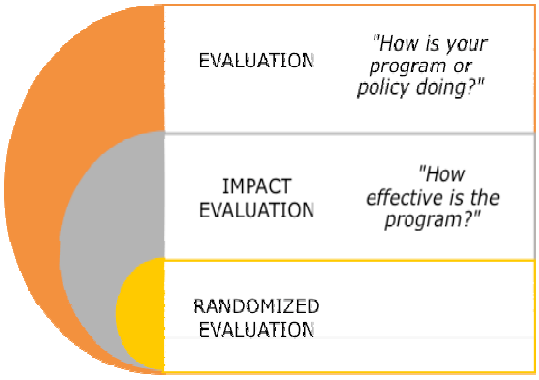

Figure 16: J-PAL evaluation hierarchy[257]

The evaluation framework proposed by J-PAL (which follows that of Rossi, Freeman, and Lipsey) offers the advantage of being specifically centred on development issues and, as such, could be beneficial to the evaluation of the prototypes discussed as part of the current project.[258] However, other frameworks also present advantages. Indeed, Wotton et al. proposed a framework for network per-

[253] Duflo, Esther. "Field Experiments in Development Economics". Massachusetts Institute of Technology. Prepared for the World Congress of the Econometric Society (January 2006):20 Web 4 December 2013 http://economics.mit.edu/files/800
[254] Ibid.
[255] Ibid.
[256] "Methodology Overview". Abdul Latif Jameel Poverty Action Lab (J-PAL). Web. November 27 2013 <http://www.povertyactionlab.org/methodology>
[257] "What is Evaluation?" Abdul Latif Jameel Poverty Action Lab (J-PAL). Web. November 27 2013 <http://www.povertyactionlab.org/methodology/what-evaluation>
[258] Ibid.

formance evaluations (See table 4) specific to telemedicine. By merging the latter framework into the one proposed by J-PAL, there is an opportunity to improve the evaluation of prototypes dealing with primary care HTM between industrialised and developing countries.

Requester's Perspective
1. Rate of query arrival (new cases)
2. Proportion of failed queries
3. Time to first reply from an expert
4. Quality of replies
5. Ease of system use
Coordinator's Perspective
1. Rate of query arrival
2. Time required
3. Resources available
4. Feedback from experts/feedback on patient satisfaction
5. Ease of system use
Expert's Perspective
1. Rate of requests received (for those who received queries)
2. Time required to answer
3. Relevance to own expertise
4. Feedback on patient outcomes
5. Ease of system usage
Societal Perspective
1. Clinical effectiveness
2. Cost-effectiveness
3. Integration into the health care system, for example, involvement of local people

Table 4: Framework for network performance evaluation (Wootton et al. 2011) [259]

The ease of assessment and evaluation varies depending on the format of the prototype. Testing the theory as thoroughly as possible is not equally feasible in all three cases. In the case of the mobile unit, its mobile nature might make it harder to assess its direct effects on an aggregate scale. In addition, keeping track of the patients, and allowing for follow-ups, would be more challenging than in the fixed remote unit. Also, the geographical locations in which the service would be offered might vary too much to create a valid control group (those who do not receive the service) to measure its effects.

As for the prototype embedded in the local healthcare infrastructure, assessments and evaluations might also pose challenges, albeit of a different nature. The presence of similar services in nearby locations would render the identification of the effects of the prototype difficult. Indeed, patients who do not use the unit would still have access to similar services. Therefore, separating the effects of the prototype from those of existing services might be challenging. Additionally, should the service be perceived as a competing one by local healthcare providers, especially following the evaluation, a bias might emerge against the prototype, potentially skewing the results.

The fixed remote unit is the prototype presenting the easiest solution for an evaluation. As the service would take place in a rural area with few, if any, similar forms of healthcare, the concerns arising from the embedded solution are not applicable. In addition, being located in a stationary geographical location might present an opportunity for better patient tracking and follow-up than with the mobile unit. Moreover, the control group could be more easily selected as other similar geographical locations probably exist.

The ideal or purest form of prototype for assessment and evaluation does not, however, necessarily present the most sustainable characteristics. On the one hand, with the embedded prototype, there is an opportunity to establish local collaboration and therefore probably a higher degree of sustainability. On the other hand, the mobile unit allows for the widest reach of patients geographically, medically, and socio-economically. Both varieties of prototype could be included in a longer strategy of implementation and project establishment, but if the intent is to test a theory in the purest and least biased form possible, the fixed remote unit may present the best case.

This section has assessed the general considerations for projects that wish to deal with primary care HTM. It highlighted opportunities and challenges in terms of feasibility and sustainability. However, before engaging in such projects on a larger scale, the feasibility of delivering primary care through telemedicine between industrialised and developing countries should be assessed. In order to do so, three prototype proposals were formulated. These were inspired by existing and successful secondary care HTM projects, and showed that with each opportunity comes a set of challenges. For each prototype format, sustainability, patient reach, technology, and assessment opportunities were compared. From the analysis, one model has shown to hold more potential for theory testing: the fixed remote unit.

[259] Wootton, Richard, et al. „Experience with low-cost telemedicine in three different settings. Recommendations based on a proposed framework for network performance evaluation". Global Health Action 2011, 4:7214. Print.

7. Conclusion and Recommendations

7.1 Conclusion

The use of technology, in whatever form it may have taken, has greatly benefited the medical world over the years. Through new tools, new software, and new equipment, medical developments have been affected by technology, and none more than the remote delivery of medical care. Telemedicine is intrinsically linked to technology and the advancement of communication technologies. Telemedicine has grown from the use of smoke signals to ward off populations from disease-infected areas to the ability to offer live medical consultations thousands of kilometres away. Telemedicine now encompasses applications such as telecare, telesurgery, and teleradiology, involving health professionals all around the world. The discipline has evolved to the point that countries are integrating the concept of telemedicine into their national health policies and practices. Not only has there been a significant number of programmes developed in national institutions, but telemedicine is also the subject of much discussion and debate internationally. The World Health Organization, the United Nations, the European Union, and regional institutions such as SAARC are all increasingly involved in telemedicine and telehealth projects, initiatives, and policies. However, telemedicine is not only of interest to nation states and health organisations. As some of the important accomplishments in telemedicine have utilised space-based facilities, the space world has been keen to develop projects in the area. The United Nations Office for Outer Space Affairs, the European Space Agency, as well as national space agencies such as CNES, DLR, ISRO, NASA, and ROSCOSMOS have all been involved in projects relating to telemedicine.

While telemedicine is being used in industrialised states, there is deep interest in its potential use for developing countries, and the humanitarian aid it could help deliver. HTM would not only enable the broader reach of medicine, but it could also give patients access to improved care. The aid can be delivered from industrialised states, as well as between developing countries, and can provide primary and secondary care to developing countries that are in permanent need of medical aid or in a situation of humanitarian crisis. The majority of HTM projects that have been set up deal with the delivery of secondary care, and the teletraining of health professionals. Successful examples of projects initiated both by industrialised and developing states can be found, demonstrating that successes have taken many forms. Thus, HTM has the potential to positively impact the societies and countries in which it operates, but only if the lessons learned from past and current experiences can be implemented. Telemedicine may rely extensively on technology, but the medical aspect should represent the primary focus of any HTM project. Focusing on the medical aspect of such projects can help reduce many of the challenges they face. In addition, all projects should undergo a strict continuous analysis (legal, cultural, structural, political, and economic) in order to mitigate the risks they are faced with.

Equally important, the need for primary care projects is vital. Not only is there a void in this particular area, but there is also a strong need for its development. The unequal distribution of health care workers between high-income and low-income countries, as well as the increased demand for health care in the latter due to shifting disease burdens, constitutes a strong case for primary care HTM projects. Not only are these projects warranted, but they could also be practically and readily implemented. However, projects need to be prototyped and assessed, following which necessary changes, dictated by experience, must be made, if such projects are to last and have a positive impact. To this end, this report has put forward three possible prototypes to test the theory: a mobile unit, a fixed remote unit, and a unit alongside local healthcare facilities.

It is the intention of the European Space Policy Institute (ESPI) to organise a conference in the near future in order to foster discussions on HTM, and to discuss which prototype might be more appropriate. It is hoped that, following the conference, a phase of prototyping can take place, and that data on its impact can be collected. This would help define sustainable models for HTM projects in the field of primary care.

7.2 Recommendations

From the analysis provided in this report, lessons can be extracted and formulated for the purpose of HTM. Considering that telemedicine is a field ripe for development, that it has proven successful in developing countries, and that there is a vacuum with regards to primary care, it is recommended that:

1. *Primary care HTM should be further explored.*

   The field of HTM has mostly flourished with regards to secondary care. Primary care, which is of critical importance for patients in the rural areas of developing countries, has not witnessed the same level of innovative HTM. Therefore, testing the potential of such projects is a timely opportunity. Controlled evaluations are a particularly pertinent way of testing this.

2. *HTM, fostered by technological advances, should continue to be utilised to improve health care for those most in need.*

   With the field of information and telecommunication technology developing at great speed, and the populations of many developing countries experiencing poor health outcomes, there is much potential for using ICT and space-based infrastructure for solving pressing health problems in the developing world. In a number of cases, such as the VSAT enabled ones taking place in the Indian subcontinent, telemedicine initiatives whereby doctors based in urban centres administer medical care to patients in rural areas have worked very effectively.

3. *As humanitarian projects based on partnership with local actors are generally more successful and sustainable, HTM projects should follow this lead.*

   While involving local populations and authorities in project delivery and empowering them in that process can be costly due to cultural and language barriers, projects that do so have a higher likelihood of succeeding in the long term.

4. *A number of important cultural considerations, from host and donor populations, should be accounted for.*

   A number of issues can arise due to socio-cultural differences as part of development projects, and this is no different when these are health-based. Cultural considerations with regard to medical care differ markedly between industrialised and developing countries. These must be accounted for as part of any project administering health services.

5. *In order to make such projects successful, the medical needs of end users must be prioritised.*

   While, as mentioned in (4), cultural issues arise in the field of medicine, the medical needs of end-users must be prioritised. If this is not the case, they may forego the available care, which would represent a failure for the endeavour.

6. *Every low-hanging fruit should be considered.*

   Many successful HTM projects use existing or basic technologies to enable the telemedicine link between parties. These should be sought after primarily before developing and importing expensive and hard-to-manage systems and technologies.

7. *To test the validity of primary care HTM, pilot projects need to be developed.*

   The report highlights the potential of primary care HTM projects to be successful. However, this cannot be demonstrated without concretely testing them with the use of a prototype. Carrying out a pilot project would effectively test the potential of such projects to succeed on a larger scale.

8. *Evaluation is critical for the success of such projects.*

   While carrying out a pilot project may validate primary care HTM projects in certain settings, accurately measuring its success will indicate whether such a project should be scaled up and/or replicated across other settings, and whether it represents a sound investment in the field of development. More generally, there is a need for increased feedback in HTM.

List of Acronyms

Acronym	Explanation
3G	Third Generation
AIDS	Acquired Immune Deficiency Syndrome
APRSAF	Asia-Pacific Regional Space Agency Forum
APSCO	Asia-Pacific Space Cooperation Organisation
ARTES	Advanced Research in Telecommunications Systems
ATNF	Apollo Telemedicine Networking Foundation
CNES	Centre National d'Etudes Spatiales (National Centre for Space Studies)
CRED	Centre for Research on the Epidemiology of Disasters
CT	Computed Tomography
D-CAP	Disaster Cardiovascular Prevention Network
DALY	Disability-Adjusted Life Years
DISHA	Distance Healthcare Advancement Project
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Centre)
DMS	Disaster Management Support
EC	European Commission
ECG	Electrocardiogram
eHSA	eHealth for sub-Saharan Africa
ESA	European Space Agency
ESPI	European Space Policy Institute
EU	European Union
FISSA	Force d'Intervention Sanitaire Satellitaire Autoportée (Satellite Self-Supporting Sanitary Intervention Force)
GSM	Global System for Communications
HIV	Human Immunodeficiency Virus
HoW	Hospital-on-Wheels
HTM	Humanitarian Telemedicine
IAP	Integrated Applications Promotion
ICT	Information and Communication Technologies
INSAT	Indian Satellite System
ISDN	Integrated Services Digital Network
ISfTeH	International Society for Telemedicine and eHealth
ISRO	Indian Space Research Organisation
J-PAL	Abdul Latif Jameel Poverty Action Lab
LAN	Local Area Network

Acronym	Explanation
M.D.	Medicinae Doctor (Doctor of Medicine)
MDAU	Multi-parameter Digital Acquisition Unit
MDGs	Millennium Development Goals
MEDES	Institut de Médecine et de Physiologie Spatiales (Institute for Space Medicine and Physiology)
MMC	Medical Missions for Children
MoU	Memorandum of Understanding
MRI	Magnetic Resonance Imaging
MSF	Médecins Sans Frontières (Doctors Without Borders)
NASA	National Aeronautics and Space Administration
NASRDA	National Space Research and Development Agency (Nigeria)
NATO	North Atlantic Treaty Organization
NGO	Non-Governmental Organisation
NRC	NATO-Russia Council
OECD	The Organisation for Economic Co-operation and Development
OMECA	Organisation Mondiale des Experts-Conseils-Arbitre (Experts-Consulting-Arbitrating World Organization)
ORS	Oral Rehydration Solution
OVH	Operation Village Health
PDA	Personal Digital Assistant
RAFT	Réseau en Afrique Francophone pour la Télémédicine (French-speaking African Network for Telemedicine)
RCT	Randomised Control Trials
ROSCOSMOS	Russian Federal Space Agency
SAARC	South Asian Association for Regional Cooperation
SAHEL	Satellite African e-Health Validation
TTF	Telemed Task Force
US	United States
USA	United States of America
USD	United States Dollar
UN	United Nations
UNOOSA	United Nations Office for Outer Space Affairs
UN SPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response
USSR	Union of Soviet Socialist Republics
VHA	Veteran Health Administration
VSAT	Very Small Aperture Terminal
VVIP	Video-conferencing and Voice over IP
WHO	World Health Organization

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