

Telemedicine:
A paradigm
shift in
healthcare

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Telemedicine is proving to be the new way of conducting health care in the world. Its applications worldwide, in developed and developing countries are redefining the way health care is delivered to people.

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Health care is one of the determining factors when categorizing different countries on development scale. Based on availability of health professionals, education system, infrastructure capabilities and finally, available government funding, the quality and reach of health care varies greatly from one country to the next. Today, depending on one's location and socio-economic status, the amount and quality of health care available ranges from non-existent to intensive and close monitored. Exhibit 1 depicts the current cost, quality and relative efficacy of health care across different nations. It is clear that not only developing nations need more far-reaching health care systems but developed nations also need to improve the quality of care and bring down the cost to keep their citizens healthy.

None of this should come as a surprise, considering similar health care related issues have been in our world for the past century. Although there have been incredible advancements in technology in the medicine field, these changes were not reflected uniformly across the world. The result is an ever increasing gap between countries and regions that can deliver the best quality of care and countries that struggle to provide primary and specialist care to the majority of their people.

Fortunately, the era in which we are right now creates unprecedented opportunities to improve the current health situation by leveraging advancing technologies to enable for the first time the introduction of a global innovation in the field of medicine and provide improved care to every one regardless of their location and income level. This paper will examine the current health problems in developing and developed nations, introduce the concept of telemedicine, identify some key areas where it is a good fit for aforementioned developing and developed nations, explore its current applications and finally lay out an alternative roadmap to help bring primary health care to a larger percentage of people in developing nations.

State of Health around the World

There is a clear problem with delivery of health care around the world today, people cannot get the health care they should for various reasons. Two factors however are emerging as indicators of increasing health problems in the near future; inverse care and aging population.

Inverse care is the first problem that is threatening the world today. People with the most means – whose health care needs are often less – consume the most care, whereas those with the least means and greatest health care needs consume the least (World Health Organization, 2008). While some countries enjoy the benefits of well-functioning health system, others are in despair. Certain clusters in the world are severely affected by this imbalance. For example, in Latin America where the inverse care is at a peak, some of the currently experienced problems in health care include; low public health investment, which affects the quality of care received by creating inequality in health resources and ultimately results in high mortality rate for preventive diseases and low life expectancy in rural areas.¹

The second big problem that the world is facing, which will exacerbate in the near future, is the aging of the world population. Average life expectancy has risen 20 years from 44 to 64 years worldwide². This shift in world demographics brings with it the need to create a network of health monitoring and more extensive primary and secondary health care services that were not needed previously.

¹ Review of Telemedicine Activities in Latin America
<http://media.americantelemed.org/ATA2009/International/vega.pdf>

² <http://www.census.gov>

Why the current efforts aren't effective?

Many countries are trying to battle the current health care delivery problems around the world with different initiatives at a both government and private sector level. Some of these efforts have resulted in modest advances in the overall health quality in certain regions. However, as a whole, the biggest health care problems of the world today stay unresolved for the past 100 years. To look at the situation at closer level a certain metric could be picked like child mortality rate under five. According to the World Health Organization's latest world health report, if children were still dying at 1978 rates there would have been 16.2 million deaths globally in 2006. In fact, there were only 9.5 million such deaths. This difference of 6.7 million is equivalent to 18 329 children's lives being saved every day, which is a great advancement in absolute numbers, but considering the relative advancements in all other areas in the world, these death numbers are still very high.

When these numbers are explored under a closer inspection it is quite clear that even the current modest advancements in the world are not uniform. The 2008 WHO report points out those advancements in health care in low-income countries are much smaller as a whole compared to rich countries. Exhibit 2 displays the advancements in different countries from 1975 to 2006 while Exhibit displays the best performing countries in reducing child deaths by at least 80% in the same time period.

The clear uneven distribution in health improvements across different countries can be attributed to three different problems with the health amelioration efforts across the globe; disproportionate focus on specialist, tertiary care referred to as "hospital-centric care", fragmentation of the health industry and the pervasive commercialization of health care in unregulated health systems (World Health Organization, 2008).

The first problem contributing to uneven advancements in world health care is hospital centrism. For the larger part of 20th century hospitals have created more and more specialized units and doctors have followed the demand by specializing in very narrow fields of medicine. Although it was beneficial at first, the tipping point has been well crossed. In Thailand, for example, 70% of the doctors are specialist in a field of medicine, leaving very little general practitioners (World Health Organization, 2008). People with lack of access to general physicians crowd the specialists and the result is a less efficient health care delivery system with increased costs. If there were enough general physicians who could act on early symptoms, the cost could be kept lower and the efficiency could be much higher. Even developing countries suffer from the hospital centrism. Lebanon counts more cardiac surgery units per inhabitant than Germany but lacks programs to reduce the risk factors of cardiovascular disease due to lower number of general physicians (World Health Organization, 2008).

The second big problem is fragmentation in health care and the largest group of victims are people in rural areas. In the near past, to combat the spread of various diseases, many developing countries have created containment/healing initiatives a short term strategy. However, a failure to expand these efforts to cover all aspects of primary health care has left many regions without comprehensive primary health care. This has severely restricted citizens' access to primary health care and resulted in progression of many treatable diseases to fatal stages.

Lastly, in many low-income developing countries health sector has been privatized and has moved towards a pay for service structure. This commercialization effort however has reached unheard levels and the cost of basic health care has skyrocketed, further fueling the spread and progression of easily treatable diseases.

Most health care improvement efforts by countries do not focus on the aforementioned problems but try to pick a local region or a disease and improve the situation in a single spot. Although possible and

somewhat effective, trying to correct an entire health ecosystem in this manner is a very long and inefficient process at a larger scale. Instead what is needed is a new way of delivering health care to people in rural areas, increase access to primary care physicians to spot the early signs of problems and slow down the advancement of treatable diseases.

Some of the problems mentioned above could be addressed with the help of telemedicine. In the remainder of this paper the concept of telemedicine and its current applications around the world, its impact at a global scale will be discussed, in the conclusion section a new approach will be suggested that could potentially increase the number of people receiving primary care in developing countries around the world.

What is telemedicine?

In its broadest terms telemedicine is a recombinant innovation that is described as any sort of health care that is delivered through the use of telecommunication technologies such as telephone, email or video (Brown, 2005). It may be as simple as two doctors exchanging information and opinions about a case to performing remote surgery using robotics technology.

There are two generally defined ways of conducting telemedicine; real-time and store-forward. Real-time model brings together to participants in the health ecosystem such as patients and doctors, or doctors with other doctors and allows information and service exchange instantaneously. The store and forward model collects data regarding a patient and sends the information to a health care specialist later on for review and consultation.

While the possible applications of telemedicine to different specialties is very broad, the most commonly applied areas are; tele-pathology, tele-cardiology, tele-radiology, tele-surgery, tele-

ophthalmology, tele-dermatology and tele-psychiatry. There are three main uses of telemedicine in aforementioned areas; tele-health care, tele-education and tele-home health care (Brown, 2005).

Tele-health care primarily focuses on prevention and treatment of disease (doctor to patient). Tele-education focuses on transfer knowledge across different geographic areas focusing on medicine across different health care providers (doctor to doctor). Disaster management primarily is concerned with providing immediate care to the victims of wars, natural disasters etc via mobile health stations with satellite uplinks to larger health facilities. Finally, tele-home health care focuses on delivering health care for the elderly and patients with chronic diseases that require constant monitoring and timely intervention (patient to doctor) (Indian Telemedicine Network, 2009).

Figure 1 illustrates an overview of telemedicine ecosystem by identifying main technologies, participants, uses and tools in the system.

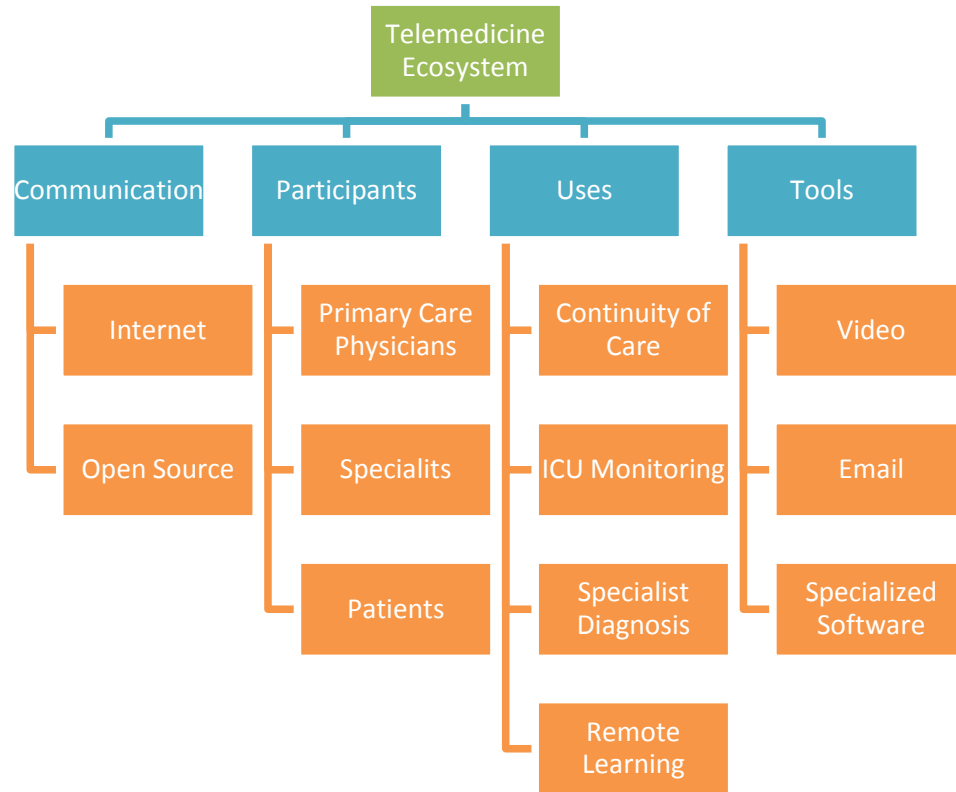


Figure 1

Enablers of Telemedicine

Telemedicine is a recombinant innovation; it relies heavily on innovations in the fields of communication, computers, software, education and finally robotics. The natural question one might ask is: why now? Specific advances in four different areas over the years that made telemedicine possible are; connectivity, open technology standards, user interface revolution and finally the new generation of computer savvy doctors.

Connectivity

With the introduction of dial up internet in the 1980s no one could have predicted the usage of internet as an entire new medium over which many activities like retail, banking, multimedia and lately medicine take place. The main catalyst for the internet however has been the introduction of broadband in the early 2000s. The ability to have a wide bandwidth has the biggest impact on telemedicine. Current health care related file sizes that need to be transferred across continents can be very large. For

example, an MRI or CT scan result file can range from 40 megabytes to 800 megabyte. Transfer of such large files is not feasible using slower, so called narrowband, internet connections. Luckily broadband penetration has been increasing all over the world and the price of broadband connectivity is getting cheaper over the years. Exhibit 6 displays the connectivity speeds and relative pricing of broadband connections around the world. While it is clear that while are at an advantage by providing cheaper bandwidth due to infrastructure advantages, almost the entire world is moving past the narrowband days towards faster internet connectivity.

In parallel to faster wired broadband there are also promising technological advancements in communications that can deliver high speed wireless connectivity to developing countries at a fraction of the cost using common computer hardware. WildNet³ is one such research project that brings broadband wireless connectivity over 50-100km ranges at a fraction of the cost. Projects like WildNet especially prove useful in countries where infrastructure work to bring wired broadband would require enormous investments in physical cabling across long distances in rural areas. WildNet is currently deployed in India⁴ to enable connectivity in a telemedicine related project, proving very cost effective in bringing connectivity to rural areas that would otherwise not get access to high speed internet for decades.

Open Standards

The next revolution that has enabled telemedicine and paved the way to many innovations is the open standards in both software and hardware. With the introduction of open communication protocols such as TCP/IP and HTTP, open source operating systems such as Linux, and finally open-source applications such as iCons in Medicine⁵ it has become possible to create open health care software standards which could be adopted, extended and improved by a community of individuals, organizations and

³ <http://cater.cs.nyu.edu/wiki/index.php/WiLDNet>

⁴ https://www.usenix.org/events/nsdi08/tech/full_papers/surana/surana_html/index.html

⁵ <http://www.iconsinmed.org>

governments. It would not have been possible to create systems that span countries and organizations to work seamlessly without the help of open source software and hardware.

UI Revolution

We have come a long way in the way we interact with computers. From the command line interfaces in the 1980s to the graphical revolution of the 1990s and lately in the way we use the web every day. Regardless of culture and language barriers, almost all computer users recognize the metaphors used in computer user interfaces. Although this might seem like a miniscule issue, it is one of the most critical factors determining the adoption of telemedicine considering the users of telemedicine software and hardware range from end users in their homes, to nurses and doctors in hospitals and special telemedicine centers.

Computer Savvy Doctors

The last factor that has enabled the telemedicine revolution around the world is the adoption of computers by doctors. As the new generation of doctors emerge from around the world, they are mostly computer savvy and do not require additional training to use telemedicine related computer software and hardware. The upcoming generation of doctors will be even more technology savvy and will not hesitate to integrate telemedicine with even more mobility such as smartphones and hand held computers. The adoption of computers and related mobile technologies has been and will be extending the provider base in telemedicine, further enabling the scaling of telemedicine around the world.

Why Telemedicine might be the answer?

Telemedicine is a very large field and its application can vary greatly based on the needs of a specific geographic region or sub-field. The needs of people in developing and developed countries are different

when it comes to delivery of a more efficient health care system. In this section possible areas of application of telemedicine will be explored in countries that belong to these two categories.

Developed Countries

Developed Countries don't suffer as much from deaths at birth or diseases related to malnutrition like developing countries do. However, another challenge is present for them and that is their ageing population and the problems they face. By 2050 the world will have about 2 billion people over the age of 60. One, often under-stressed, problem that the new generation faces is chronic conditions that need continuous care and monitoring. In the industrialized world, as many as 25% of 65–69 year olds and 50% of 80–84 year olds are affected by two or more chronic health conditions simultaneously (World Health Organization, 2008).

Chronic conditions require continuous care and monitoring. Diabetes for example is a chronic disease that requires frequent checks to control blood pressure, yearly eye and foot exams, constant monitoring of blood glucose levels and administration of insulin based on changing blood glucose levels and diet information (Mayo Clinic, 2008). Most of these checks and tests can be virtualized since they rely on test data rather than physical inspection of the person by a doctor. By leveraging the power of computers and connectivity, most diabetes patients can manage their condition easier and free-up resources by using telemedicine mutually benefiting both the doctors and the patients in the health ecosystem.

Developing Countries

Developing countries face many challenges due to the available money for health care and the ratio of health care specialists to patients. For many governments especially in sub-Saharan Africa and Latin

America healthcare spending is an afterthought since they face many other pressing issues such as civil wars, public unrest, etc. In these countries charities try to deliver basic health care to millions of people in need.

Health care requires years of education which is harder to afford for many in these developing countries, making the situation worse by increasing the gap between health care suppliers and patients. Although the most immediate solution would be relocation of existing practitioners to these areas, it might not be realistic due to political and socio-economic factors in these countries.

Considering these factors, many charity organizations and foundations have been trying to bring tele-medicine to developing countries to provide primary and sometimes specialist care to many people. Swinfen Charitable Trust⁶ is one organization that encourages collaboration among volunteer specialists who offer their services free of charge to patients in developing countries. Primary care physicians can consult with specialists across the world to get an expert opinion on cases they need help with. The system has proved successful in many developing and war weary countries such as Iraq, Afghanistan etc.

By providing specialist care that might not be otherwise available to some developing countries, charities and organizations hope to increase the quality of care in these countries while enabling some knowledge transfer between specialists and general practitioners such that a greater number of people could be treated by general physicians with the transferred knowledge.

Another area that developing countries currently benefit from is remote learning for physicians in very poor countries who might not have wide access to medical knowledge and mentoring otherwise. The International Virtual e-Hospital Foundation IVeH⁷ is a good example of knowledge transfer centric organizations, it tries to rebuild the medical system in Kosovo after the war. Based

⁶ http://www.swinfencharitabletrust.org/index.php?option=com_content&view=article&id=45&Itemid=54

⁷ <http://www.iveh.org/>

in Alaska, it enables physicians to get educated on new trends and extend their expertise in different fields by participating in remote learning programs hosted primarily in the U.S.

Why Developing Countries are a better fit?

Although both developing and developed countries provide opportunities to apply telemedicine in different ways, developing countries provide a more suitable environment for advances in telemedicine. There are mainly three enabling factors; effects of health care demand on government, less stringent legislation around health related technologies and infrastructure opportunities for governments.

Firstly, the health care provider to patient ratio in developing countries is so low that many governments are receptive of a great percentage of opportunities that promises betterment in the health system. With decreased government resistance to introduce novel technologies and processes, developing countries present a fertile ground for health care innovation testing ground for many organizations in developed countries.

Secondly, most governments in the developing parts of the world including Latin America, Southeast Asia and Sub-Saharan Africa have very little, if any, legal and bureaucratic barriers that stand in the way of introduction of new technologies, making it easier for larger corporations such as Siemens, Philips, GE to initiate and implement pilot projects. This decreases the cost of lobbying and makes it more appealing for corporations to roll out their new health care technologies in the aforementioned regions of the world.

Lastly, many developing countries are experiencing infrastructure related needs that make it more appealing for the local and state governments to get involved in health care related experimental technologies that promise an infrastructure upgrade in the telecommunication field. Most telemedicine technologies require high speed, broadband internet connectivity to function properly. Corporations

and organization that want to roll out these services in these regions also commit to an upgrade to the communication infrastructure that will be permanent even if the health care technology fails. Governments, realizing this side effect are less hesitant to slow down or stop the adoption of telemedicine.

When above three conditions are taken into account, it is more beneficial for innovative health care companies and the governments of developing countries to work together to implement new telemedicine initiatives in the next couple of decades.

How is telemedicine implemented around the world?

There is tremendous use of telemedicine around the world today and the annual spending is predicted to approach 3.6 billion dollars annually by 2014 (Marketwire, 2009). Many not-for-profit, and for-profit organizations are already in the telemedicine industry and others are quickly entering the market. One of the latest entrants into the market has been Intel and GE with their latest announcement to collaborate on creating home monitoring systems that report back vital signs and other measurements to monitoring centers (Don Clark, 2009). It is clear that many health and technology companies are seeing a bright future in the market to invest in it for the long term.

There are two categories in which telemedicine is currently implemented around the world; developing countries and developed countries.

Developing Countries and Telemedicine for Primary Care

One of the main problems in delivering health care in developing countries is the imbalance in patient to doctor ratio as mentioned before. As it is displayed in Exhibit 5 with the ever growing population some countries like Cuba enjoy a ratio of 1:170 while others like Lesotho in the sub-Saharan Africa have a mere 1:20,000 ratio. It is clear that countries that have a very low ratio cannot deliver even the basic care to their citizens partly due to an absence in the work force in health industry.

Realizing this imbalance many countries like India, Lesotho and Bangladesh resort to telemedicine. By leveraging the power of computers and communication doctors can provide the necessary care to people who are not otherwise in geographic reach of health professionals. Although it may not be physically possible to re-locate the health care work force in the country to different regions based on pandemics and changing health needs of the nation, doctors can consult and even operate on patients in remote parts of the country, or even across countries in certain cases. The removal of geographic barriers enables certain countries to create the elasticity in the supply of health care that was not previously possible.

India is one of the countries that has embraced the concept of telemedicine to improve the health care delivered to its citizens. Currently, there are projects in India that range from tele-ophthalmology project to rural telemedicine network project. These projects are mainly under the supervision of Ministry of Health of the Indian Government and get financial, political and logistical support from the government. The results of the telemedicine movement in India are very clear. There is currently an implemented telemedicine network which connects 315 hospitals of which 271 are distant/rural hospitals while 44 are specialty hospitals, there are even mobile hospitals that provide health services via telemedicine in rural areas of the country (Ch, 2008).

The other area that is crucial in development and adoption of telemedicine is education. India is also investing in educating the next generation of doctors to be effective users of telemedicine tools. Some of the examples include certificate courses offered by the Apollo-Anna University in Chennai and National Institute of Health & Family Welfare funded Tele Training Centers (Ch, 2008).

Developed Countries and Telemedicine for Home Monitoring and Secondary Opinion

While developing countries are in need of primary care and resort to telemedicine for immediate delivery of basic health care services to a greater population, telemedicine finds other uses in more developed countries. There are three primary implementations of telemedicine in the developed world; home monitoring, ICU monitoring and secondary medical opinion.

Home Monitoring

The world population is ageing and not everyone needs to or can be cared for in hospitals. The elderly and people with chronic diseases need to constantly check for different indicators of health problems and a health provider needs to evaluate these measurements and checks to decide whether or not a hospital visit or in-patient care is needed. Currently this process is a manual one and consumes a lot of time both on the patient and the physician end. Home health monitoring services provide a viable and automated alternative to this process. By utilizing the same protocols and software used in telemedicine most vital signs including readings taken from blood glucose meters, blood pressure meters can be constantly monitored by remote health care providers.

This model provides a tremendous advantage over the conventional ways of health delivery to this segment for two main reasons; timeliness of care and cost. In the current model, it takes a one provider visit cycle, usually 3 weeks to 1 month to act upon irregularities in checks that could be precursors to a severe health problem. By automating and closely monitoring these values virtually from anywhere in the world, providers can be more proactive and deliver timely care. On the other hand, by keeping the chronic diseases under control and taking action with early signs of problems both the patients and insurance companies benefit from the lower costs per patient. In private health systems such as the one in United States, cost factor plays a major role in adoption of home monitoring systems.

Some large companies, realizing the value of these systems, are entering the market. Philips has entered the market by developing in home monitoring devices such as smart beds that can alert the breathing

patterns and other vital signs of senior citizens with chronic heart diseases and notify the necessary parties when irregularities occur (Capell, 2009). In addition to large companies, there are currently many smaller software companies offering these services such as Buddy Check Network, LifeWatch USA etc.

Clearly the in home health monitoring systems are just another way of keeping an eye on people who might be in need for immediate health care and private market is moving in this direction.

Remote Intensive Care Unit (ICU) Monitoring

Another niche that benefits immensely from remote monitoring are hospitals with intensive care units.

Patients in intensive care units require very close monitoring by nurses. Unfortunately, the number of nurses available does not scale to the number of patients in ICUs. Only 10 to 20 percent of hospitals employ intensivists who are responsible for patients in ICUs. A Health Resources and Services Administration report to Congress in 2006 predicts that the demand for intensivist demand will be 129% of available supply by 2020 (Popely, 2009).

Technology comes to help again by leveraging the power of telemedicine. Today, in many hospitals, just like traffic controllers, intensivist-led teams monitor ICU patients' heart rates, blood pressure, respiration and other vital signs from thousands of miles away. These teams form centers, called eICUs, that work in hand in hand with hospitals to provide the continuous monitoring in order to help intervene earlier before the patient suffers from complications (Popely, 2009).

All of this is made possible by the infrastructure such as broadband connections and computer hardware and software developed by Philips VISICU (a subsidiary of Philips). According to Philips data facts⁸ 300,000 patients have been monitored using the system in 200 hospitals which corresponds to about 10% of all adult ICU patients in the U.S.

⁸ <http://visicu.mediaroom.com/index.php?s=40>

Although this model has to overcome trust issues mentioned by patients, as more and more lives are saved due to the usage of the service, eICU concept is gaining acceptance. Most hospitals don't let remote intensivists make decisions on interventions and use the service as an alerting mechanism that in turn enables the in-house staff to make the decision due to trust element. As remote systems become more common and more legislation is established around telemedicine, it is likely that total care will be provided by remote eICU specialists and nurses alone will be able to carry on the physical tasks in hospital ICUs.

Secondary Medical Opinion via Telemedicine

Another model that is more suited in developed countries is telemedicine consultation between primary care physicians and experts in rural areas. This model of health care is different than the traditional model where patients are brought to the experts via telemedicine directly. This new model especially works well in remote areas where there is a shortage of expert opinion but the number of primary care physicians is sufficient to see the patients in person. One example of this is seen in New Mexico at the Hepatitis C clinic in University of New Mexico (UNM) hospital in Albuquerque. The patient population with Hepatitis C virus is around 30,000 while the clinic at the hospital can physically treat about 70 to 90 patients a year. Instead of trying to bring together the few specialists at the hospital with rural residents, the new project connects local general physicians in rural areas with the experts. They discuss the cases and possible treatment options. Through this practice, knowledge is transferred along with the direct treatment of low-income families. Since the experts don't directly deal with the patients, this model scales much better and this project has been able to bring hepatitis C care to about 3,500 people in the area (American Hospital Association, 2009).

A new idea for telemedicine in developing countries

Although the use of telemedicine in developing countries is increasing, there are still enormous unmet health care needs which can be partly addressed by developed countries. One of the requirements to

become an accredited doctor in the United States and many other western countries is the completion of a period of training called residency. During this period, recent graduates work under the supervision of other mentors and start treating patients at hospitals. With a simple modification to basic residency requirements residents could spend a comparably small amount of their required residency time consulting with patients in developing countries via telemedicine. This new approach could help with the immense shortage of any sort of medical personnel in developing countries. At the same time, such training would familiarize the new wave of doctors with telemedicine early on, further fueling the adoption of telemedicine within their home countries. Although a small percentage compared to the actual needs of developing countries, a practice like this could potentially save thousands maybe hundreds of thousands of lives in developing countries. When it is human lives that's at stake, every little effort would bring us closer to a healthier world population.

Conclusion

It is clear that telemedicine, a recombinant innovation harnessing the power of telecommunications, education and health care, has found many applications both nationally and internationally. With ranging use from simple consultations to remote surgeries it is helping developed countries keep their citizens healthier longer and scale to millions, while providing the basic care to developing countries.

Skepticism around its effectiveness is fading away with each additional successful application of telemedicine around the world. With clever use of telemedicine in the coming years, more people could benefit from the global health care knowledge and skillset in both primary and secondary care, creating a healthier world population.

Appendix

Exhibit 1

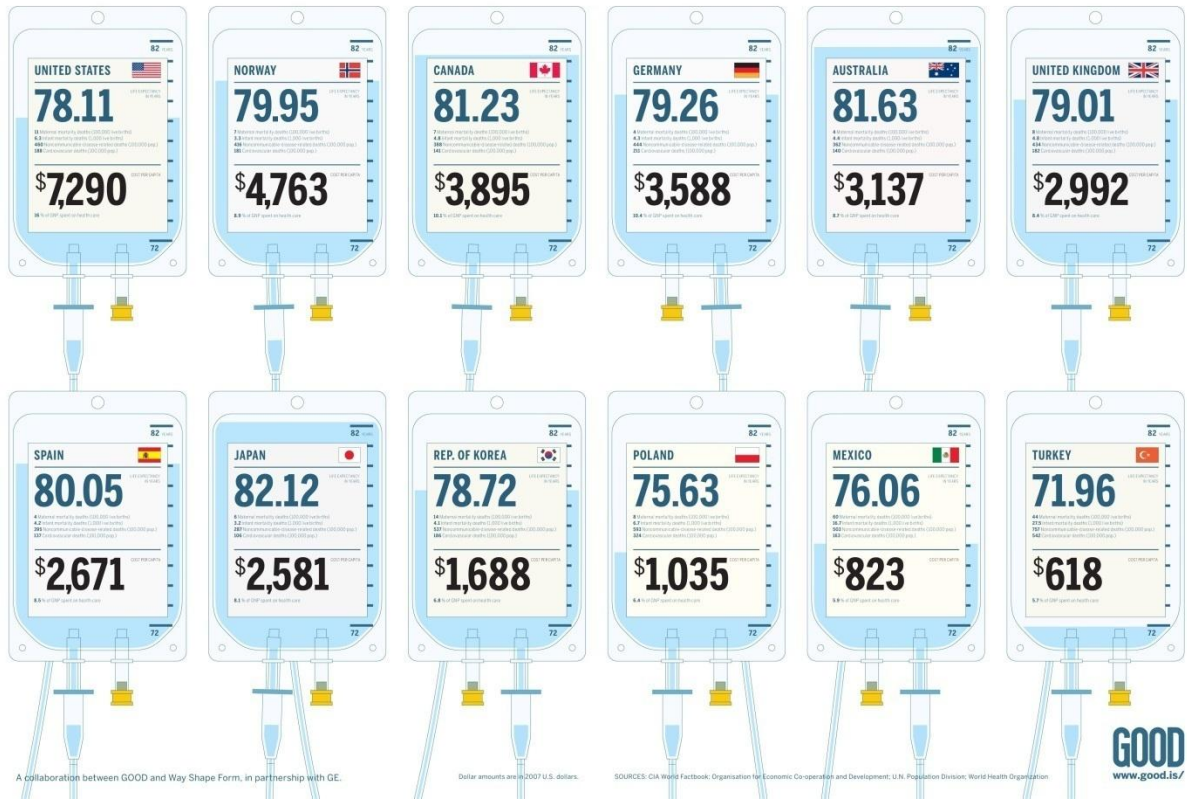
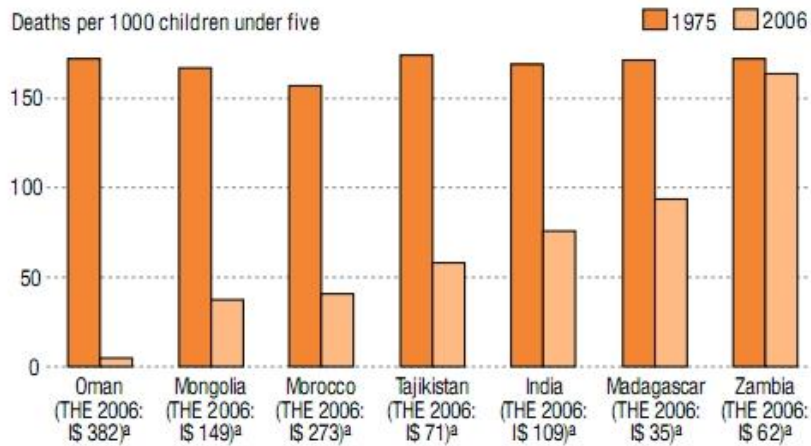


Figure 2 - <http://www.healthymagination.com>

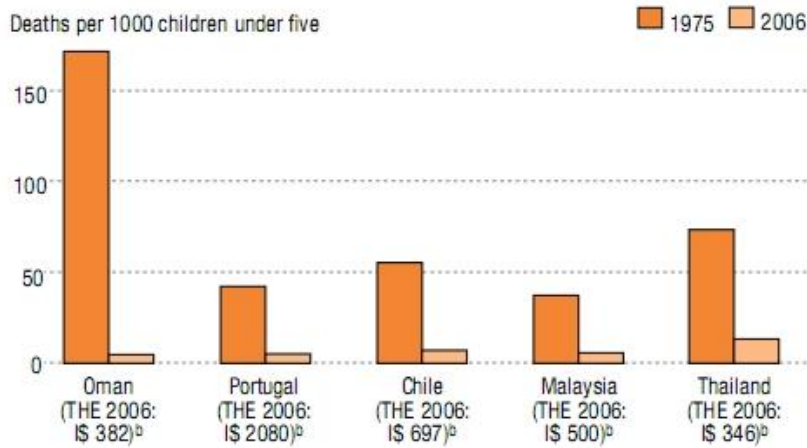
Exhibit 2



^a Total health expenditure per capita 2006, international \$.

<http://www.who.int/whr/2008/en/index.htm> 1

Exhibit 3



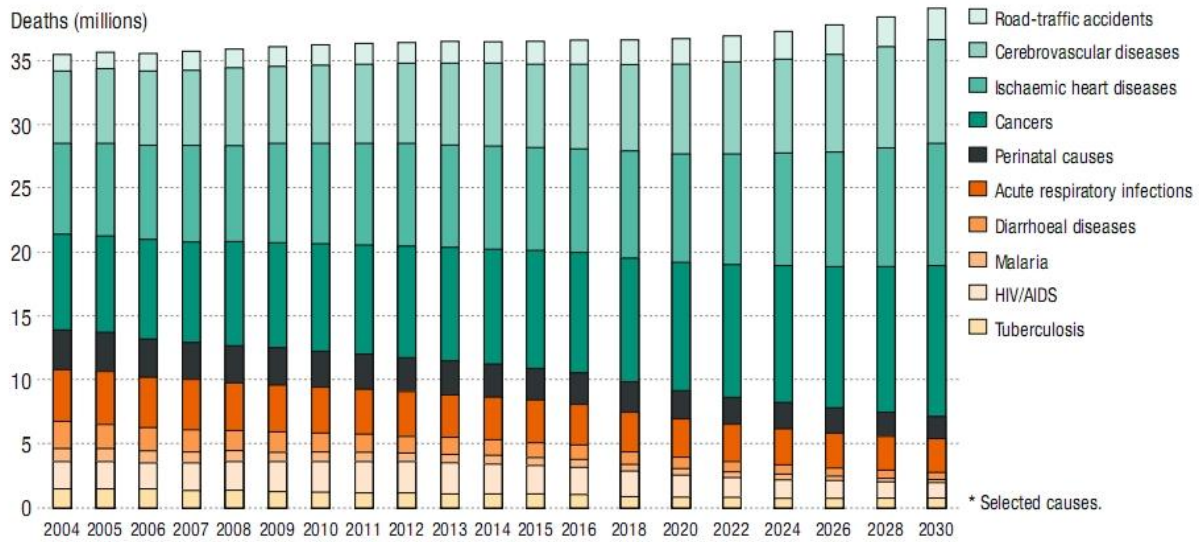
^a No country in the African region achieved an 80% reduction.

^b Total health expenditure per capita 2006, international \$.

*International dollars are derived by dividing local currency units by an estimate of their purchasing power parity compared to the US dollar.

<http://www.who.int/whr/2008/en/index.htm> 2

Exhibit 4



<http://www.who.int/whr/2008/en/index.htm> 3

Exhibit 5

NUMBER OF INHABITANTS PER DOCTOR

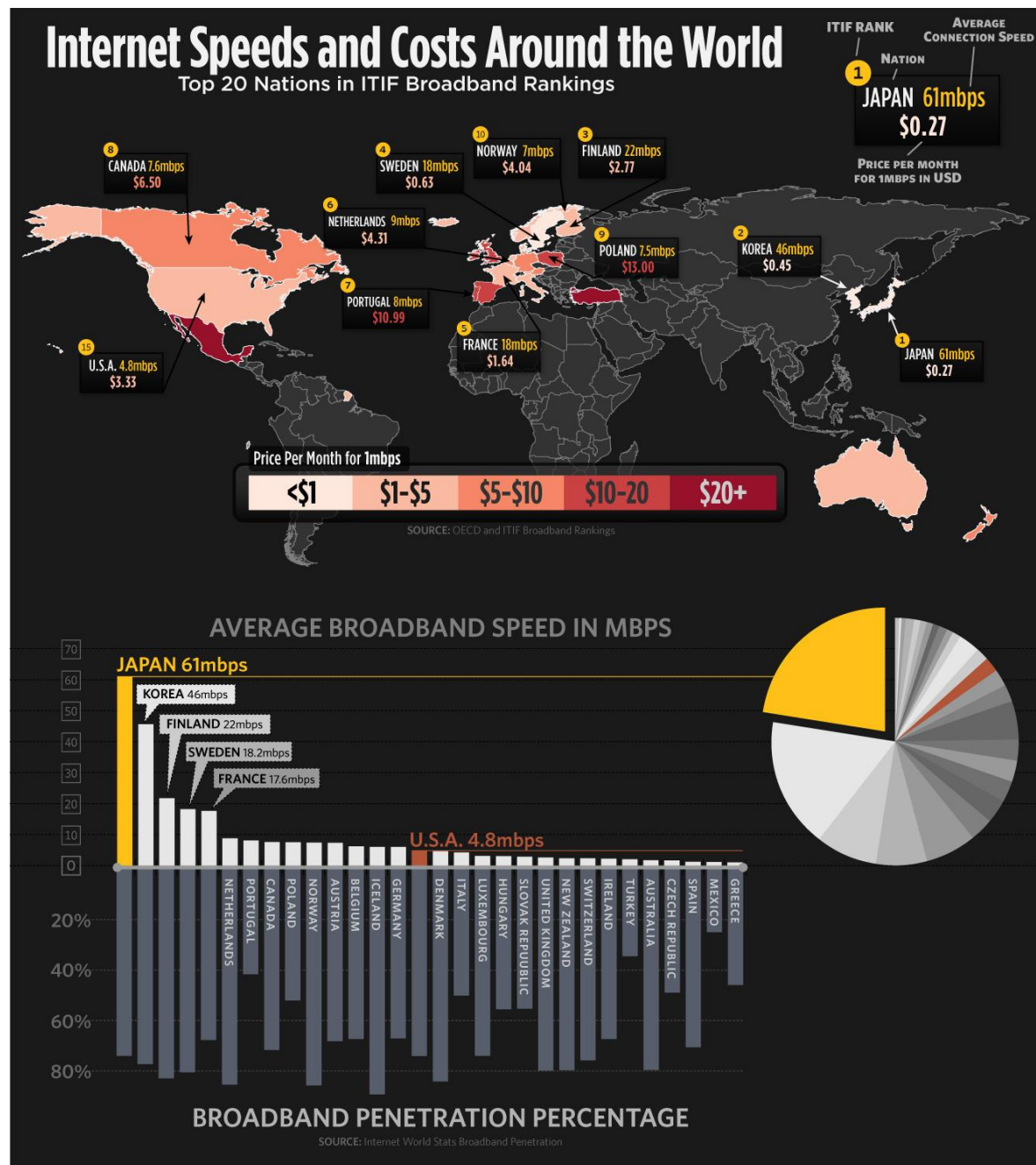
Source: The World Health Report 2006

Not everybody in this world can see a doctor when in need. This is even more so in areas where people suffer from famine, war and diseases. Doctors of the world aim to provide everybody in the world with at least the most essential medical care. Help the people the world is slowly forgetting.

www.doctorsoftheworld.nl

<http://adsoftheworld.com/media/print/doc 1>

Exhibit 6



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