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Optimizing Supply Chain for Healthcare Delivery to Remote Areas

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ABSTRACT

Currently 3.4 billion people live in remote and rural areas. Physical, geopolitical, and financial impediments create an environment where it is difficult to access healthcare. After examining the major extrinsic and intrinsic factors in healthcare delivery to rural areas, we extrapolate how existing technology and supply chain management can be leveraged to create cost effective, large scale, and ultimately self-sustaining strategy.

FIGURE 1

Map of Global Rural Population Distribution

The maps displayed on the World Bank website are for reference only and do not imply any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.
INTRODUCTION

There are two main factors that generally dictate one’s ability to get health care services. Those two factors are affordability and accessibility. For those in living in urban areas, or developed rural areas, the focus is primarily on the financial impact of accessing healthcare. However, for the other half of the world the accessibility issue is one of physical and geopolitical nature, though in the end underlying costs also play a secondary factor. In these rural areas, even routine medical exams like physicals, vaccinations, and simple neo-natal care like vitamin supplementation are difficult to acquire.

Identifying issues that contribute to the difficulties associated with healthcare delivery is easy. There were plenty of issues we already anticipated, and many arose during our research into our white paper topic. The real difficulty was identifying the starting point from where a solution could begin to be engineered. With the global economy being so integrated, the various aspects within the healthcare delivery system are also interlaced in a manner where addressing one issue may improve another. Consequently, our approach was to identify a “tide to raise all ships” strategy in solving the global issue of healthcare in remote areas.

EXISTING OPPORTUNITIES

Supply Chain
With so many developments happening within the realm of supply chain and technology, the first goal was to identify what research already existed. Extensive literature, in regards to both new technology and supply chain management process, was reviewed to determine feasibility of implementing an integrated process and technology solution.

The article, “Systematic Motorcycle Management and Healthcare Delivery: A Field Trial”, discusses the role that supply chain plays in delivering healthcare to remote villages in Africa, and how means of delivery are best managed. This was an academic journal article that reported on a trial conducted in 8
different remote regions of Zambia. The aim was to see how effective it would be to deliver healthcare
to nearly 2 million individuals in an area that is considered 60% rural. The study follows a company
called Riders for Health (Riders), a British company focused on social responsibility. The company
provides and maintains high quality transportation, including long range motorcycles, to government led
healthcare agencies so that those agencies then may be able to deliver the necessary care. In addition to
maintaining the fleets, the company also provides driver/rider trainings and fuel. The idea behind this
was that Riders acted as a health system supply chain intervention manager, training the medical
providers to be self-reliant and able to make certain repairs on site. The study found that this systematic
fleet management, in all its facets, resulted on average in a 5-10 fold increase in patient visits,
immunizations, growth assessments, and outbreak monitoring. Furthermore, the study found that the
associated costs of this supply chain management did not increase the overall average cost per
healthcare delivery incident. Moreover, unlike the control group, which exhibited a near 20%
breakdown rate of vehicles, the Rider vehicles continued to be 100% operable, even after the increase in
usage.

An important note, one that will be applied to our overall discussion of finance, is the fact that this study
was funded by The Bill and Melinda Gates Foundation. However, the foundation had no influence on the
data collection or analysis. This is important because the premise of our overarching goal is based on the
fact that certain individuals or companies will recognize the intangible value of this endeavor, and thus
will provide investments without any expected returns being guaranteed. Ultimately, in addition to
providing evidence of the philanthropic willingness that exists in the world, the study also demonstrated
the high efficiency that preventative maintenance and operational process management has on delivery
vehicles. The downstream and upstream effects of decreased cost and far greater accessibility to remote
locales corroborates the feasibility of such an approach on a global scale.
Robotics
Advancement over the past decade in remote access technology has been exponential. Every year people are figuring out new ways to leverage existing technology in new fields, whether it is for purposes of optimizing telecommunication, or to improve scalability of products. In order to better predict what opportunities will exist in the future of healthcare delivery, we first want to understand what is currently available.

One of the most interesting developments that has recently been studied to determine feasibility, is the use of robotics in healthcare delivery to remote areas. A group of Canadian researchers used a robot called RP-7 (remote presence- 7th iteration), for 15 months, to provide care for the Inuit communities in remote parts of Newfoundland and Labrador. “The RP-7 is controlled wirelessly by a laptop computer (control station) equipped with headphones, microphones and a joystick to maneuver the robot in real time. The RP-7 is 165 cm in height and has a wheeled triangular base of 63x76 cm, roughly comparable to the size of a human. The robot can travel at speeds of about 3 km/h and has an 8-h rechargeable battery.” (3, p. 2) The robot is also equipped with a flat screen monitor with PIP enabling teleconferencing between physicians and patients. The robot has a movable swivel head with sophisticated digital cameras, a digital stethoscope and is equipped with Wi-Fi and privacy handsets. By providing secure communication and hard copies of orders and recommendations along with the consulting physicians’ signature are enough to provide a service at as comparable of a level to an in person visit as possible.
FIGURE 2

The RP-7 Robot Features

The results of the study were very promising, both for the efficacy of the service provided and the cost benefits that were elucidated from the use of the RP-7. Many of these benefits are directly measurable, but opportunity costs should also be considered. Below is a table outlining the 100 total patients and
what type of service they initially required, as well as the final outcome. Based on the independent data collected in the end of the trials, 84% of the patients reported that they were “very comfortable” in their interactions with the assessing physician using the RP-7 robot. Furthermore, the impacts on air transportation and associated costs was mitigated dramatically. The study found that 60% of eligible consultations that would have required air transport to a referral center—better staffed and medically equipped location. The most impressive figure was observed with respect to emergency cases. Of the 14 emergency/urgent cases, 7 were effectively managed on site, leaving 7 more patients requiring transport. However, of those 7 emergent/urgent patients still requiring transport, 6 were managed and stabilized to a point where they were able to take a regularly scheduled flight. This means, of the 14 emergency situations only 1 required Medivac. (3, P.4-5)

TABLE 1

Study Population Statistics and Outcomes

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Medivac</th>
<th>Scheduled flight</th>
<th>Number of transport required</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial consult</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Follow-up</td>
<td>9</td>
<td>3</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>Emergent/urgent</td>
<td>1</td>
<td>6</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>9</td>
<td>28</td>
<td>47</td>
</tr>
<tr>
<td>% of total</td>
<td>21</td>
<td>19</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>

It is important to note that this study was done in conjunction with the presence of nurses, and the RP-7 robot was intended to be supplementary to the existing medical staff. However, it is important to understand that incentives play a large role in recruiting healthcare providers to remote regions, as such doctors are less likely to travel to remote locales. This means a physician’s presence needs to be facilitated remotely. The RP-7 robot provided this necessity, and was very effective, with 100% of nurses saying this alternative was superior to any regular teleconferencing. Interestingly, 80% of nurses
believed that the robot went beyond its set expectations, and actually helped facilitate the conversation with the patient. Thus, when considering options for managing the delivery of healthcare to remote areas, it will be important to remember that many of the suggested solutions are intended to act as supplementation in mitigating existing issues, not to make those issues acutely obsolete.

**Technology**

“The cost of tele-medicine for the US veterans’ administration is $1,630 per patient per annum. This is substantially less than skilled nursing facility programs and nursing home care which costs $100,000 per annum.” (4) This trend, of cost effectiveness in utilizing telemedicine, is not only being recognized healthcare professionals and research scientists. Insurance companies are also recognizing that, much like in the example of Riders in Zambia, preventative maintenance in healthcare would yield tremendous savings long term for the companies themselves. With the mobile health market (M-Health) growing exponentially, data collection and availability has also become more centralized, and accessible. Levering new developments in big data analytics, tools like IBM Watson, are using their large analytical capabilities to integrate existing reports and knowledge into predictive outcomes. This has the potential to be applied to other aspects of medicine, specifically the physical or virtual/physical hybrid delivery methods to rural areas. Specifically such integration of databases and the subsequent analytics could provide insights into the supply chain management aspect of healthcare delivery as well. Better identification of geographically localized medical trends and medical needs can enable for time and cost efficient sharing of resources amongst various health care service providers. Our proposal will be one that promotes collaboration amongst different entities, and as such a coalition of providers and manufacturers would work best with a centralized system.
RECENT DEVELOPMENTS

Drone Technology
Remote healthcare delivery requires a plan to incentivize medical professionals to come to a particular location. In order to accomplish this some sort of infrastructure needs to be established, including basic medical tools and portable apparatus. Once the personnel and the minimal infrastructure is in place, the final component for the effective provision of healthcare is medication. Once a diagnosis has been provided and the population of a particular location has been examined and recorded in detail, their health maintenance may become reliant on steady supplies of medications. Whereas individuals, robots, and bulky equipment will require a transport via planes, trains, automobiles, and even motorcycles, medication is generally very compact and light, and a different form of delivery could be utilized. With drones becoming a household toy, there are limitless applications for this technology, and Keller Rinaudo recognized this five years ago, and this summer his company will begin to deliver medication to remote areas of Rwanda. (5)

The company, Zipline, is a five year old startup with a fleet of drones dubbed Zips. The genesis of the company came from the Rinaudos’ interactions with researchers on a trip to Tanzania. “He met a researcher who had built a database that allowed health workers to send text alerts whenever they lacked blood or other medical supplies.” (5) These databases will also be part of our integrated solution proposal for remote healthcare delivery, but this excerpt serves as support for the existence of these databases already. Nonetheless, the experience motivated the founders to develop a drone that would be able to deliver medicine via air drop. It’s estimated that in one day a single drone will be able to do 50-150 deliveries in Rwanda. This of course will be scaled down for larger areas, but the numbers still indicate the ability to handle large volumes and distances. The zips are able to cover 45 miles in less than 30 minutes, and according to The Atlantic, the cost for each drone is the same as a motorcycle. This
means that in terms of cost, a fleet of motorcycles could be diversified to include drones, and maintenance and training could become more comprehensive to address both machines.

Analysis of these technologies’ viability and reach was also viewed through the geopolitical scope. Flying in war zones could be problematic. The size of the drone must be such that it is not too big to cause someone to mistake it for a fighter drone. This will impact the load capacity somewhat, but companies like Wings for Aid, have begun to form strong relationships with countries around the world, especially in Africa.\(^6\)

**Medical Training**

Technology and supply chain processes can be optimized to the highest efficiency possible, however this alone is not enough to genuinely impact the way healthcare is delivered to remote areas. The other factor that needs to be considered is the staffing of on-site locations in various remote regions. This includes both medical professionals, as well as people involved in maintenance of instruments, transportation, and other operational aspects. As already discussed, incentivizing individuals to work in remote areas is difficult, but not impossible. Most of the world assumes that these remote regions do not have individuals capable of providing the necessary services because these regions lack of infrastructure. Such an assumption would imply that all the staffing must be outsourced. This however is not the case, and such an assumption would be detrimental to the quest for sustainable and cost effective solutions to remote healthcare delivery.

Fortunately, there are already organizations that have been created to combat this notion, and to increase the quantity and quality of trained medical professionals in rural areas. “THEnet (Training for Health Equity network), is a group of eight medical schools worldwide that have been established with a social accountability mandate. The World Health Organization (WHO) defines the social accountability of medical schools as ‘the obligation to direct their education, research and service activities towards addressing the priority health concerns of the community, region and the nation that they have a
mandate to serve’ ”(7, p. 2). This coalition of medical schools that focuses on increasing rates of
retention and performance from medical professionals in remote regions of Africa, Asia, Australia, Latin
America, and even North America. One of the main principles of the coalition is to recruit students from
the communities with the greatest health care needs. This endeavor has been accomplished through the
development of promotional campaigns to recruit specific students, as well as augmenting the medical
school programs to include in some cases a year of experience working in remote and rural regions. It is
important to note that most of these doctors and medical professionals are not specialized, but are
trained as general practitioners. This is important because the culture that accompanies medical
professionals is one that often places far greater social status on specialists. This of course means that
many of the best doctoral candidates choose to specialize. Removing this culture and its subsequent
stratification within the various medical disciplines, will have the potential to incline more qualified
candidates to consider a general medicine focus. Naturally, the other biggest impediment to sufficient
training is the lack of on-site infrastructure at the remote locations, for students to continue training
whilst providing medical care.

RECOMMENDATIONS

Applying the Research
Healthcare is something we often take for granted in the western world. Sure, there are always
impediments to receiving appropriate healthcare, but those usually relate to finances and not physical
accessibility.

With today’s technology, medical knowledge and information sharing is at our fingertips. According to
the International Telecommunication Union downloaded statistics, as of 2014 there are over 7 billion
mobile subscriptions globally. That essentially means that at least 92-95% of the world has cellular and
broadband service availability in some capacity (8). GE has manufactured handheld ultrasound machines
for doing women’s screenings outside a hospital setting. Virtual and VOIP (Voice over IP) consultations
are already being utilized all over the world, including U.S. where patients can discuss courses of treatment with their doctors. So, if the information sharing technology is available, and the instruments for providing the services are being innovated to become simultaneously more portable and cost effective, than the limiting factor becomes the delivery of the service.

The idea of remote healthcare delivery has interested us for a while, but the vast number of issues and solutions made it difficult to ascertain a starting point for our strategy. What initially started as an idea of how to create a cost effective and fast response emergency life flight service, evolved into finding a synergistic resource and relationship management service strategy. Our research has provided insights into the already existing technologies and services that focus on providing healthcare to remote regions. The issue is that a lot of the available resources are decentralized, and the reasons are countless. From privacy issues regarding health records and test results, to proprietary internal operation processes of different services, there is simply no one entity that is able to handle the different forms of remote medicine. We have come to understand that the tangible aspects—people, equipment, and transport are one part of the optimization in healthcare delivery. The other part is the supply chain management of these various resources. Coming to the realization that single service would not be physically or financially viable, at least at inception, we had a paradigm shift. Instead we have realized that the best solution is to first centralize all the information and available services into one source, from where relationships can start forming amongst the various participants. In effect what we are proposing is developing a brokerage firm that deals in establishing relationships between different vendors, medical schools, hospitals, and innovative companies. These relationships will promote resource and information sharing, that we hope to funnel into our own native database. Of course logistics and ethics of gathering this data would be explored much more in depth, however the viability of such a database is not being questioned, it already exists in some forms.
CONCLUSION

There are many other opportunities to leverage technology that were not discussed in this paper, but are still very applicable. Ingestible sensors, or “smart pills”, are your own personal internal monitor for vitals. Proteus Digital Health, made waves when in 2015 it got market clearance from the FDA for selling such a device. Utilizing a world of connectivity, such ingestible sensors could be a cost cutting form of monitoring that will enable for a more preventative medicine strategy than an acute crisis management strategy. This will have drastic impact on lowering costs, and such technology will only increase in power and reach. Our research corroborated the notion that an integrative solution of training, maintaining, and resource sharing is the only approach that could be effective in reducing costs. Moreover, this approach would be setting up many of the remote locales for a sustainable future.

Riders recognized how supplying vehicles along with all-inclusive support could improve the healthcare delivery to rural areas. THEnet recognized the importance of training individuals from the affected communities so that they can return and help improve the quality of healthcare. Drones and robots have been created with the specific purpose of delivering medication or treatments and consultations. Cost-benefit, reduction in lead times, and increase in efficiency have been evident in all of these endeavors. The integration of all of these existing opportunities will have its own set of challenges. It is our strong belief that a brokerage company, an agent to multiple entities is the only way that a large scale action on remote health care delivery can be successful.
REFERENCES

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