Remote Healthcare

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Abstract - Healthcare has a problem, and it goes well beyond the insurance questions and how common people can afford to pay for it.

In India, public healthcare is free - yet years of under-investment in public health means that healthcare facilities are also grossly understaffed and under-equipped. The country also has a massive resource gap of over 4 million health workers and, to compound problems, nearly 60% of existing health workers practice in urban areas.

With 70% of its people living in villages, often far from healthcare providers, it's clear that there's a lot of room for affordable health services to grow in India. There is an overall shortage of medical personnel and rural patients are left to semi- and non-qualified practitioners, creating a huge disease burden.

However, it doesn't have to be that way. It's 2018, and nothing is done in person anymore that can be done remotely.

Remote healthcare promises to increase the contact between a patient and his or her providers, especially for those who live in rural areas or for whom travel to a medical facility is difficult (or even for busy working parents).

Every physician has a smartphone these days, and most people have a smartphone. Couple that with a network that can send anything anywhere in the world with some sort of smart sensor—maybe it's an ECG, or a pressure sensor, or something similar—and now you have the ability to take any kind of patient parameter or image and send it just about anywhere in the world.

Keywords - Health care, telemedicine, bio sensors, e-visits, network solutions, telehealth, e-health

Ⅰ. INTRODUCTION

For generations, medical care around the world has looked more or less the same. Every year, we all make an appointment and visit our doctor. Beyond that, when something goes wrong and we aren’t feeling well, we make another appointment and go back to the office for another visit.

For people who live in rural areas, people whom travel to a medical facility is difficult, or people who may be too busy to make time to go to a medical centre, remote healthcare provides a solution.

Remote healthcare is a form of telemedicine service, which allows constant monitoring of a patient’s condition and the performance of preventive and control check-ups outside the hospital environment. This form of care is made possible by the use of portable medical devices recording specific vital signs. Test results are automatically transmitted to the Remote Healthcare Centre, where they are analysed. If any irregularities are found, medical staff connect the patient remotely with their doctor or a specialist, and in the event of a health emergency or life risk, call an ambulance. Remote healthcare services support diagnostics, complement therapies and impact the effectiveness of treatment and the patient’s feeling of safety by ensuring permanent contact with specialists. They are complementary to the provision of primary care, have proven medical value, and support patient-doctor communication, especially during the medical interview.

Since it can save travel time and expense for providers and patients, remote healthcare can improve the chances that people will receive preventive care and better management of chronic conditions. Remote healthcare can facilitate specialist consultations, whether the provider is across the state or across the world.

Ⅱ. HISTORY

In the early 1900s, people living in remote areas of Australia used two-way radios, powered by a dynamo driven by a set of bicycle pedals, to communicate with the Royal Flying Doctor Service of Australia.

In 1967 one of the first remote healthcare clinics was founded by Kenneth Bird at Massachusetts General Hospital. The clinic addressed the fundamental problem of delivering occupational and emergency health services to employees and travellers at Boston's Logan International Airport, located three congested miles from the hospital. Over 1,000 patients are documented as having received remote treatment from doctors at MGH using the clinic's two-way audio-visual microwave circuit. The timing of Bird's clinic more or less coincided with NASA's foray into telemedicine through the use of physiologic monitors for astronauts. Other pioneering programs in remote healthcare were designed to deliver healthcare services to people in rural settings. The first interactive telemedicine system, operating over standard telephone lines, designed to remotely diagnose and treat patients requiring cardiac resuscitation (defibrillation) was developed and launched by an American company, MedPhone Corporation, in 1989. A year later under the leadership of its President/CEO Eric Wachtel, MedPhone introduced a mobile cellular version, the MDPhone. Twelve hospitals in the U.S. served as receiving and treatment centres.

Ⅲ. EXISTING STATE OF THE ART

Examples of Remote Healthcare practised today:

- Having “e-visits” or face-to-face doctor’s appointments using FaceTime, Skype or other audio-visual methods.
- A provider sending test results to a specialist and later consulting by phone/email.
- A doctor treating a child in a small regional clinic consulting with a paediatric specialist at a large hospital using live video so the specialist can see the patient.
- Providers take continuing education courses online.
- Patients logging into a patient portal for test results.
- Doctors getting access to patients’ medical records via their smartphone (Fig. 1):

Fig. 1.

Ⅳ. CATEGORIES

Remote healthcare can be broken into three main categories: store-and-forward, remote patient monitoring and real-time interactive services.

- STORE-AND-FORWARD

Store-and-forward healthcare involves acquiring medical data (like medical images, biosignals etc.) and then transmitting this data to a doctor or medical specialist at a convenient time for assessment offline. It does not require the presence of both parties at the same time. Dermatology, radiology, and pathology are common specialties that are conducive to asynchronous remote healthcare. A properly structured medical record preferably in electronic form should be a component of this transfer. A key difference between traditional in-person patient meetings and remote healthcare encounters is the omission of an actual physical examination and history. The 'store-and-forward' process requires the clinician to rely on a history report and audio/video information in lieu of a physical examination.

- REMOTE MONITORING

Remote monitoring, also known as self-monitoring or testing, enables medical professionals to monitor a patient remotely using various technological devices. This method is primarily used for managing chronic diseases or specific conditions, such as heart disease, diabetes mellitus (device shown in Fig. 2), or asthma. These services can provide comparable health

Fig. 2.

outcomes to traditional in-person patient encounters, supply greater satisfaction to patients, and may be cost-effective. Examples include home-based nocturnal dialysis and improved joint management.

- REAL-TIME INTERACTIVE

Electronic consultations are possible through interactive remote healthcare services which provide real-time interactions between patient and provider. Videoconferencing has been used in a wide range of clinical disciplines and settings for various purposes including management, diagnosis, counselling and monitoring of patients.

V. ENABLING TECHNOLOGIES

Enabling technologies include, but are not limited to:

- VIDEOTELEPHONY

Videotelephony comprises the technologies for the reception and transmission of audio-video signals by users at different locations, for communication between people in real-time.

At the dawn of the technology, videotelephony also included image phones which would exchange still images between units every few seconds.

Currently videotelephony is particularly useful to the deaf and speech-impaired who can use them with sign language and also with a video relay service, and well as to those with mobility issues or those who are located in distant places and are in need of telemedical or tele-educational services.

- HEALTH INFORMATION TECHNOLOGY

Health information technology (HIT) provides the umbrella framework to describe the comprehensive management of health information across computerized systems and its secure exchange between consumers, providers, government and quality entities, and insurers. Health information technology is in general increasingly viewed as the most promising tool for improving the overall quality, safety and efficiency of the health delivery system. Broad and consistent utilization of HIT will:

a) Improve health care quality;
b) Prevent medical errors;
c) Reduce health care costs;
d) Increase administrative efficiencies;
e) Decrease paperwork; and
f) Expand access to affordable care.

Interoperable HIT will improve individual patient care, but it will also bring many public health benefits including:

a) Early detection of infectious disease outbreaks around the country;
b) Improved tracking of chronic disease management; and
c) Evaluation of health care based on value enabled by the collection of de-identified price and quality information that can be compared.

VI. NEXT-GENERATION DEVICES

We’re not talking about yesterday’s heartbeat monitors or apps anymore, either. Today’s connected ECGs, for example, can send real-time updates via the patient’s smartphone, delivering constant updates to their doctor that are recorded for later analysis. Doctors are even implanting monitors—including replacement hips and knees that have sensors built in—that can measure pressure, blood flow, and more, all in real-time without any action on the patient’s part at all.

In other words, the implant itself can measure the stability of the implant. It can also measure heat, so it knows if you're getting an infection. All this tells the physician that they've implanted it successfully.

All of this is based on microelectronic technology (MEMS), which has been in development since the early 1990s. What was originally dedicated to electronics has become focused on ways to implant those microscopic devices in the body. So now we have access to tiny sensors for artificial hips, artificial knees, pacemakers, and more that can connect directly to our smartphones and send data anywhere in the world.

Networking pioneers are also getting into the act, working with home systems and any type of health care that happens beyond the four walls of the doctor’s office. Companies like Cisco and Philips are currently working on collaboration platforms for the healthcare market. This includes Spark, which is a cloud-based service that integrates distributed software with the company’s own custom-designed hardware; and Cisco Extended Care, which adds software-as-a-service functionality to much of the third-party equipment that doctors and patients already use.

It’s all about video integration, including both scheduled and non-scheduled consultations, as well as on-demand video visits, all that can be tied into third-party tools in ways that make it both seamless and scalable.

This allows for a patient to create a video with their provider—whether that’s a doctor or another type of clinician. So, the beauty of the system is that it really allows customers to use any investment they've made, whether it's a collaboration software package or hardware, in their own environment, but also allow patients with no infrastructure of their own, just their mobile devices or their desktops, to really enable that video intersection with a provider remotely.

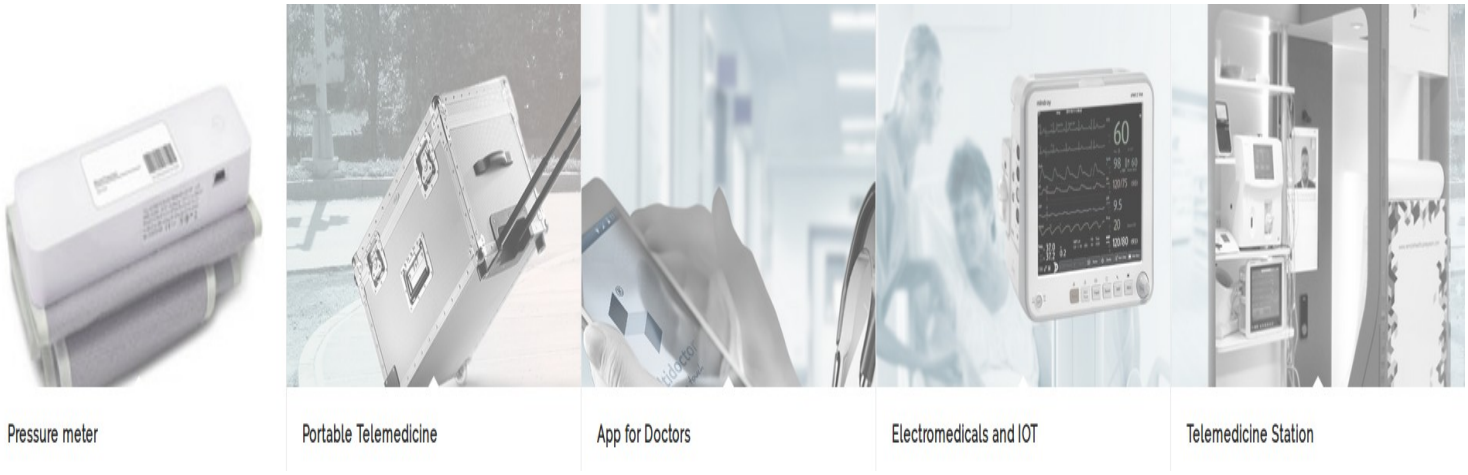

Fig. 3. Remote healthcare devices

In India, the health care system is struggling with rising costs and uneven quality so it is important to achieve the best outcome at the lowest cost, with the help of technology. Both the World Health Organization and India's Rural Health Mission consider the use of technology imperative to bringing better health care to India's most vulnerable people. The challenge is to effectively tap into the $125 billion health care industry. And building a technology driven health care delivery business that makes a difference in the health of the people living in rural areas is the right thing to do.

VII. ADVANCED AND EXPERIMENTAL SERVICES

Remote surgery (also known as telesurgery) is the ability for a doctor to perform surgery on a patient even though they are not physically in the same location. It is a form of telepresence. Remote surgery combines elements of robotics, cutting edge communication technology such as high-speed data connections, haptics and elements of management information systems. While the field of robotic surgery is fairly well established, most of these robots are controlled by surgeons at the location of the surgery.

Remote surgery is essentially advanced telecommuting for surgeons, where the physical distance between the surgeon and the patient is immaterial. It promises to allow the expertise of specialized surgeons to be available to patients worldwide, without the need for patients to travel beyond their local hospital.

Fig. 4.

Performance of surgical procedures where the surgeon is not physically in the same location as the patient is usually done using a robotic teleoperator system controlled by the surgeon (chamber shown in Fig. 4). The remote operator may give tactile feedback to the user. Remote surgery combines elements of robotics and high-speed data connections. A critical limiting factor is the speed, latency and reliability of the

communication system between the surgeon and the patient, though trans-Atlantic surgeries have been demonstrated.

VIII. BENEFITS BEYOND OUTCOMES

The upside for patients as a result of all this is clear: better care, and better health outcomes, without having to go to the doctor’s office or hospital every day.

But remote healthcare, which includes connected monitoring devices, is rapidly transforming the medical industry as well, allowing doctors to see and treat far more patients than ever before, while lowering costs across the board. All this is growing fast. Over the last two years, Medicare reimbursements for telemedicine services increased 25 percent to become a $2 billion annual market.

For doctors, the real excitement is that these tools allow them to be in two places at once. Keeping an eye on a patient via video, looking at their medical records on their smartphone, studying their X-rays and CT scans from wherever they are, and completing almost any other tasks that are part of their regular work. Those who have a background in a medical field may be surprised to know how many opportunities there are to complete their healthcare job remotely from home without ever having to work onsite.

On top of that new convenience, a stay in the ICU today costs patients—and their insurers—a lot of money. On average, the fees start at ₹3460 per day and go up from there. The catch for hospitals is that they constantly need to be cycling patients through their facilities in order to free up bed space for others. There is never enough supply to keep up with demand, even at today’s prices. Factoring in our aging population, and the need for qualified, and affordable medical care has become acute.

What remote healthcare does is, now these patients can be monitored—all of their physiological parameters can be measured remotely, including blood pressure, ECG and more—and their physician can have a direct video feed to that patient, along with their medical records.

With that ability, that doctor can now keep track of and treat a couple hundred patients at a time, all in a way that is cost-effective, scalable and doesn’t compromise patient health. This technology allows medical professionals to make decisions that both to save money for their patients while also offering the highest level of care, without having to worry about overhead or bed space or any of the considerations they face today.

Studies have shown that a telehealth system can save every hospital system in the country ₹28,000 per patient. That is game-changing.

IX. USES AND LIMITATIONS

Remote healthcare is being used effectively for monitoring patients with hypertension, diabetes, congestive heart failure, wound care and chronic obstructive pulmonary disease (COPD). It is especially well suited to treat conditions such as allergies and asthma, chronic bronchitis, conjunctivitis, urinary tract infections, rashes, prevention and wellness services. Specialists in many fields from dermatology and neurology to ophthalmology and endocrinology practice different forms of remote healthcare. Often, they are located in urban areas and consult with rural facilities through the use of various forms of technology that permit face to face consultation with providers and patients.

Remote healthcare should not be used for the treatment of any condition where a face-to-face exam is required due to severe symptoms (such as bleeding or chest pain) or when immediate and aggressive treatment is needed. In these cases, patients should see their provider or go to an emergency room.

Fig. 5. Six reasons why it is worth investing in remote healthcare

X. RESEARCH FOR THE FUTURE AND CHALLENGES

Not all practices offer e-visits, yet. With the promise of better access to care without the inconvenience/expense of traveling to an appointment, states and insurance companies are under pressure to define policies governing e-visits and reimbursement.

Practices that do offer e-visits tend to provide them only to established patients for whom follow-up visits do not require a physical exam. There are companies that offer e-visits, usually by phone, for some non-emergency illnesses but these do not allow you to select your practitioner or develop a professional relationship as you would with a primary care provider. Prescription medications may be available during an e-visit, but that decision is at the discretion of the provider and usually won't include non-therapeutic drugs or controlled substances.

Future work also includes working closely with healthcare service delivery partners and e-governance players to define and implement large scale projects; enhancing the technology with further diagnostics as well as ground-level delivery processes to capture them better; identifying and building relations with partners having complementary solutions (hardware and software); integrating a mobile based Bluetooth enabled telemedicine solution, as even 32 kilobits/s bandwidth is not available in all of rural India; and changing the business model to include software-as-a-service.

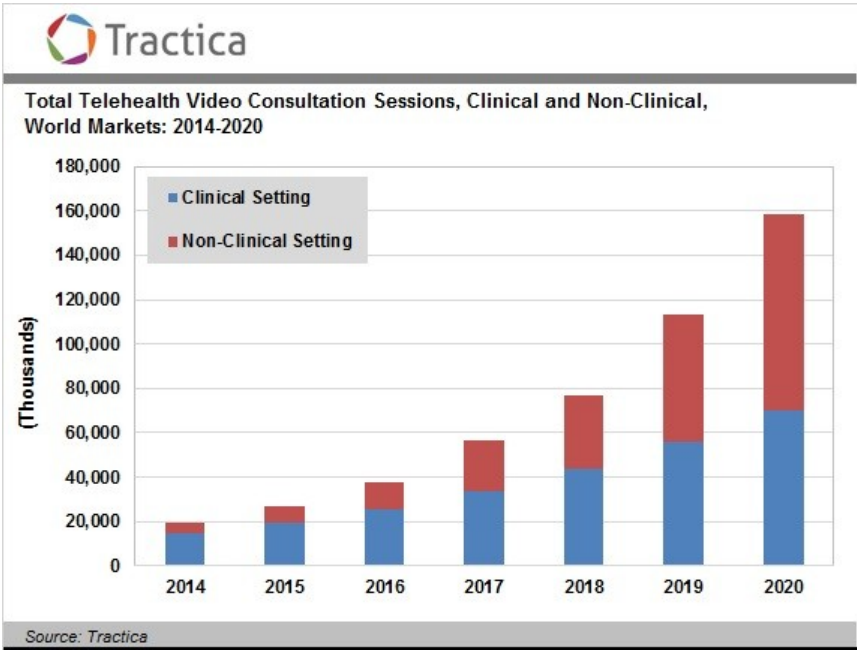

Fig. 6.

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