HealthCare Using Technology

Gayathri Mohan \textit{EXTC, MUMBAI UNIVERSITY, KALINA, INDIA} \hspace{1cm} Neeraja Ganesan \textit{COMPUTERS, MUMBAI UNIVERSITY, KALINA, INDIA} \hspace{1cm} Krutika Gulvady \textit{EXTC, MUMBAI UNIVERSITY, KALINA, INDIA}
geyathrim@ieee.org \hspace{1cm} neer.ganesan@gmail.com \hspace{1cm} krutika.gulvady@gmail.com

\textbf{Abstract} - The paper will deal with two major advancements in healthcare with the help of technology: -
\begin{enumerate}
\item TeleMedicine
\item Neuroprosthetics
\end{enumerate}
Telemedicine consists of transferring medicine using any form of media i.e. telephone, satellite etc. The paper will contain details about its various forms, advantages, disadvantages along with details on Telepediatrics, Teleradiology etc. Neuroprosthetics is an area of neuroscience concerned with neural prostheses, that is, artificial devices used to replace or improve the function of an impaired nervous system. The paper will contain descriptions of the advantages, types, obstacles, advancements (Cochlear implants etc).

\section{I. INTRODUCTION}

In 1900, an American man could expect to live on average until he was 45 years old. By 1940, that life-expectancy number had jumped to 62 years, while for women the average number increased from 51 years to 66 years. That unprecedented advance in public health was largely the result of the spread of disease-fighting technologies like vaccines, antibiotics and improved sanitation. A similar “very auspicious moment” is at hand in public health, according to Thomas Goetz, executive editor of Wired and author of a new book, “The Decision Tree: Taking Control of Your Health in the New Era of Personalized Medicine”. Two of the technologies are being discussed here.

Telemedicine is a rapidly developing application of clinical medicine where medical information is transferred through interactive audiovisual media for the purpose of consulting, and sometimes remote medical procedures or examinations. Neuroprosthetics involves the replacement of damaged or impaired body parts that are connected to the nervous system.

\section{II. TELEMEDICINE}

Telemedicine is the use of electronic information and communication technologies to provide and support healthcare when distance separates the participants. It is a system that connects primary care physicians, providers, specialists and patients and has existed for a number of years in the form of the telephone and fax machines. In recent years, with the improvements made in access, technology, and communications systems, telemedicine has expanded and, in a time of limited resources, has become a feasible alternative for smaller and rural medical facilities to provide routine and specialized services. Particularly in rural areas, it offers the potential of both improved access to care and improved quality of care.

Telemedicine may be as simple as two health professionals discussing a case over the telephone, or as complex as using satellite technology and videoconferencing equipment to conduct a real-time consultation between medical specialists in two different countries. Telemedicine generally refers to the use of communications and information technologies for the delivery of clinical care.

Care at a distance (also called in absentia care), is an old practice which was often conducted via post. There has been a long and successful history of in absentia health care which, thanks to modern communication technology, has evolved into what we know as modern telemedicine.
A. Types of Telemedicine

Regardless of the purpose, Telemedicine can be broken into three main categories: Store-and-forward, Remote monitoring and Interactive or Real-time services. The choice of method depends on what information needs to be transmitted, the availability of the appropriate telecommunications resources and the urgency of the reply.

B. Real-time

Interactive telemedicine services provide real-time interactions between patient and provider, to include phone conversations, online communication and home visits. Real-time telemedicine allows participants to send and receive information almost instantly with negligible delay. Many activities such as history review, physical examination, psychiatric evaluations and ophthalmology assessments can be conducted comparably to those done in traditional face-to-face visits. A common example of real-time telemedicine is a discussion about a patient over the telephone. In addition, “Clinician-interactive” telemedicine services may be less costly than in-person clinical visits.

Videoconferencing is another example although it requires more expensive equipment. Videoconferencing has the added benefit of being able to view live video images.

The advantage of real-time telemedicine is that decisions may be made immediately at the time of the session, and if additional information is required, the clinician can request it immediately. Real-time telemedicine can be valuable when a patient in a remote location is linked up to their specialist via videoconference for a clinical consultation.

C. Store and forward applications

The alternative to real-time telemedicine is "store and forward" telemedicine whereby information is encapsulated and then transmitted to the recipient for subsequent reply. Store-and-forward telemedicine 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. This method is generally cheaper and more convenient. Examples include correspondence via E-mail, fax or the post. The main advantage of this form of telemedicine is that the recipient of the information can examine the material at their convenience. A common example of pre-recorded telemedicine is Teleradiology, in which a digital X-ray image is transmitted to a radiologist for reporting.

D. Remote Monitoring

Remote monitoring, also known as self-monitoring/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, or asthma. These services can provide comparable health outcomes to traditional in-person patient encounters, supply greater satisfaction to patients, and may be cost-effective.

E. Reasons for doing telemedicine

The purpose for which telemedicine is used may be categorized as one or a combination of the following: Clinical, Educational and Administrative.

For Clinical Services, sessions generally include interaction between clinicians (and may include or exclude the patient). For example, a primary health care provider could telephone a specialist to discuss appropriate clinical management of an unusual case. Alternatively, a digital image of an X-ray could be sent via email to a specialist to assist with diagnosis.

For Education, sessions may include the delivery of lectures and workshops to multiple sites using techniques such as videoconferencing, teleconferencing and web-casting. In Queensland for instance, most videoconferencing equipment is currently used by hospitals for educational purposes. Educational sessions may involve the delivery of a pre-recorded lecture (videotape or DVD) to a group of students at a remote site, or an interactive workshop conducted via videoconference involving several different sites simultaneously.

For Administrative Applications, communication between different sites for management meetings, interviewing interstate/international candidates for position vacancies, and keeping in contact with regional sites are all different types of telemedicine activity.

In all cases, telemedicine is used to facilitate a service or activity for which the parties would normally have to travel.

F. Benefits of Telemedicine
Telemedicine allows patients to receive medical care in their own community. But it is most beneficial for populations living in isolated communities and remote regions and is currently being applied in virtually all medical domains. This increases the financial viability of rural medical facilities and strengthens the rural economy by keeping the flow of resources in local communities. Telemedicine assists in providing special care services to rural areas and provides more efficient use of medical resources which may lessen the amount of travel time for both patients and the specialist. Should the patient be required to be transferred to an urban facility, they have already met the physician who will be caring for them. Physicians and on-site care providers benefit as they receive quick and efficient consultations. The sense of isolation experienced by rural physicians is also reduced. The formation of health care networks between rural and urban facilities provide benefits to both. Urban based facilities provide accessibility of health care to rural areas. However, there are telemedicine networks where the excess capacity of rural facilities can be tapped into to benefit urban patients. It is possible that during peak times rural physicians may be accessed via telemedicine to provide more timely care to patients waiting in congested urban emergency rooms.

G. The Advantages of Telemedicine

Obviously this widely used practice can be very rewarding especially when you consider sharing valuable medical information with doctors in other countries around the world and in all areas of the profession. We don’t know everything about the medical problems out there today and with all of the new diseases and health issues emerging this is a way to learn faster in an effort to save lives and minimize risk or discomfort to the patient any longer than absolutely necessary.

Another valuable way telemedicine can be of use is for military personnel. They are often times located in areas of the world that telemedicine is the only way to diagnose and treat them. The fact is that telemedicine can go anywhere. It is both versatile and effective.

H. The Disadvantages or Challenges of Telemedicine

Several obstacles remain with regard to the effectiveness of telemedicine:

1) Personal one on one time is reduced considerably. Conferences and video can’t replace valuable time between doctor and patient or more personal discussion that doctors and physicians might otherwise have with each other.

2) Legal complications are raising another red flag. Laws and a set code of rules and ethics first need to be applied before telemedicine can be used regularly in various capacities. As physicians are licensed by states, they face legal problems on crossing the state lines. It is necessary in order to fully benefit from telemedicine that states engage in interstate provision of service. Currently, interstate agreements vary greatly. Several states maintain that physicians must be licensed in both the sending and receiving states. Other states have entered reciprocity agreements with neighbors.

3) Services and monetary issues need to be resolved with the increase in fluency of telemedicine. This can prove to be a difficult determination.

4) Cost is a significant barrier to access. It has been estimated that the startup cost for a rural facility can be $100,000. In addition to start up costs, consideration must be given to the charge by the consultation team. Reimbursement has been another obstacle in providing telemedicine services.

5) Clinical risk and over dependence on telemedicine system is to be considered. Liability is an obstacle in providing telemedicine. Due to the risks involved with what is reliable and unreliable, information and over dependence or over use of telemedicine can easily get out of control until more uniformed strategies and procedures are put into play.

6) Physician’s reluctance and patient apprehension are also obstacles. Some rural physicians fear the loss of patients to
urban facilities. The public and physicians worry about the impersonality of telemedicine.

I. Applications of Telemedicine

The primary applications of telemedicine are Clinical, Educational, Administrative, and Research. Clinical applications include initial patient evaluations, diagnosis (Telediagnosis), and consultation (Teleconsultation). Physician supervision of non-physicians and monitoring of patient status are possible. Continuing education for professionals is available, as is patient and community education (tele-education). Administrative uses, such as conferences, scheduling, and utilization and quality review may be provided. Research is enhanced by aggregation of data from multiple sources and coordination. Telemedicine allows access to the wealth of information available on the Internet. This allows information to be at the touch of a finger. The availability of e-mail allows an efficient mechanism of communication between consulting and primary physicians. Communication between facilities is enhanced.

J. Telepaediatrics

Telemedicine can be very useful for the delivery of specialist paediatric services, hence the use of the term telepaediatrics. The best known examples of telemedicine services for children are in cardiology, fetal medicine and psychiatry. In terms of general telepaediatrics, i.e. encompassing all paediatric sub-specialties, the work conducted in Queensland represents the largest body of work reported in the literature to date.

Communication technologies used - email, telephone correspondence and videoconferencing. Around 85% of all referrals result in a consultation via videoconference. Consultations 'at a distance' are delivered via dedicated digital telephone lines (ISDN) at a preferred bandwidth of 384 kbit/s using standard videoconferencing equipment. The telepaediatric service enables clinicians, children and their families to 'link up' via videoconference with specialists at the Royal Children's Hospital (RCH) in Brisbane.

In terms of the economics of telepaediatrics, it is likely that substantial savings are made by the health department in the form of reduced expenses associated with reduced patient travel. Significant savings were shown by those who were able to attend a specialist appointment in their regional hospital (via videoconference), compared to families who traveled see the specialist in person. Regional families also saved time, personal expenses and stress associated with having to travel.

A model is used to receive and respond to referrals, the telepediatric coordinator ensures a response by a specialist for each referral, the videoconference facilities which are suitable and accessible in a venue appropriate for clinical work are established, the evaluation and publication of results provide valuable evidence of cost-effectiveness and funding.

K. Home TeleHealth

In the previous example the use of relatively high bandwidth telemedicine systems to deliver health services in rural areas has been described. In this case individuals in a rural hospital consult with individuals in a tertiary hospital. With an ageing population and changing health problems there is a growing trend and necessity to treat patients at home. Home health care has been defined by the World Health Organization (WHO) as the "provision of health services by formal and informal caregivers in the home in order to promote, restore and maintain a person's maximal level of comfort, function and health including toward a dignified death". The possibility for telemedicine to be applied to home health care is an area of increasing interest. This is commonly referred to as home telehealth.

Examples of investigations into home telehealth include asthma, cardiac disease, diabetes, heart failure and smoking cessation. For many of these applications the ordinary home telephone has been used. The telephone is arguably the most
readily available, financially attractive and easy to use device for home telehealth. Even when the telephone itself is not used, the home telephone line provides adequate bandwidth for video telephony, transmission of ECGs and other clinical information such as blood pressure, and blood glucose levels as well as access to the internet for counseling and other services.

L. Critical care telemedicine for newborn babies

The increasing availability of broadband networking is permitting the potential transmission of high-quality, real-time video for a range of clinical applications. While, typically, videoconferencing via digital telephone lines (ISDN) has been carried out at bandwidths from 128 to 384 kbit/s, broadband networking has the potential to deliver multi-megabit connectivity at a comparably low cost.

In Queensland, a pilot study is underway to investigate the feasibility and benefits of a telemedicine service for critically-ill children. Depending on geographical location, newborns and younger children with serious health conditions are cared for at one of three main paediatric tertiary facilities. For parents and families, the emotional stress of transfer and admission of their baby to an intensive care unit is considerable. When an urgent transfer is being arranged, communication between the rural hospital and specialist facility is typically carried out by ordinary telephone. The condition of the child is discussed as well as an appropriate clinical management plan prior to retrieval by the specialists. The main disadvantage of this process is that the specialists have no way of viewing real-time video images of the baby, medical imaging results or test results.

Store and forward telemedicine applications

Store and forward techniques may provide a viable alternative to real time consulting when, for example, consulting individuals are not available at the same time.

M. Telemedicine in developing countries

Despite suggestions that telemedicine will offer great hope in developing countries there is only limited published evidence to support this claim. One good example of telemedicine which has proven feasible and useful in developing countries is the service founded and operated by the Swinfen Charitable Trust (SCT). Since 1999, this service has provided free medical advice to doctors and other health professionals working in about 20 countries including Bangladesh, Bolivia, Ethiopia, Iraq, Nepal, and the Solomon Islands. Technological requirements for the service include a standard digital camera and a computer with access to e-mail via the Internet.

N. Retinopathy screening via e-mail

Telemedicine can also be valuable for the screening of chronic health conditions such as diabetes and related complications such as diabetic retinopathy (DR). DR is a leading cause of vision impairment and blindness in all people who have diabetes. This specific microvascular complication is asymptomatic in its early stages. Routine eye screening, accurate diagnosis and intervention can reduce the risk and the progression of DR.

III Teleradiology

Teleradiology is the electronic transfer of radiographic images from one location to another. Teleradiology may be used to provide radiology services to an underserved community, but can also be used to provide specialist medical opinions regarding the treatment and management of
patients in these communities.

A. Teleradiology via e-mail

Teleradiology can be implemented by attaching a digital camera image to an e-mail. The image is obtained by photographing an X-ray film on a light box. In a South African study the accuracy of this form of telemedicine was measured. The results of this study showed that in 94% of cases the reports made via telemedicine were comparable to the reports made on the original film.[51]

B. Dedicated teleradiology systems

Dedicated teleradiology systems can be purchased from numerous vendors. These systems vary in cost, complexity and image quality. A teleradiology system consists of the following components:

1) Image acquisition modalities.
2) Image server-that compresses and transmits images.
3) Telecommunication network-this could be a Local Area Network (LAN) or a broadband internet connection.
4) Receiving station-that receives images transmitted from an images server and displays them on a coupled display station or serves archived images for multiple networked display stations.

C. Web-based Teleradiology

The main advantage is that dedicated image display software does not need to be installed on the reviewer's computer, instead images are displayed inside a standard web browser, e.g., Microsoft's Internet Explorer. Web-based teleradiology is increasingly being used by dedicated teleradiology service providers. These groups are not affiliated to one particular hospital but provide radiological reporting services for multiple institutions, often providing after hours-service to an institution from radiologists located in other times-zones.

D. Logistical factors

There are a number of important logistical factors to be considered when developing a telemedicine service. An overriding imperative is to focus on the clinical problem first with careful consideration given to the significant organisational changes which are associated with the introduction of a new method of service delivery. Expensive mistakes have been made. Even the most advanced equipment will lie idle if it cannot be integrated effectively and efficiently into the routine work flow of clinicians. In addition, for telemedicine to be effective it is important that all sites involved are adequately resourced in terms of staff, equipment, telecommunications, technical support and training.

Telemedicine applications and sites should be selected pragmatically, rather than philosophically

- In developing a telemedicine service, identify telemedicine champions who are keen and prepared to participate in the service.
- Give these clinicians all the support they require and consider gradual development of the service as the enthusiasm grows.
- Clinician drivers and telemedicine users must own the systems
- Acknowledge the importance of the clinical staff driving the telemedicine service and involve them in as much of the planning of the organizational aspects of the service as possible.
- Give clinicians ownership of the telemedicine service.

Telemedicine management and support should follow best-practice business principles

- Do not introduce another layer of management or a special project team to 'manage' the telemedicine service. These teams tend to lack clinical expertise and telemedicine experience and focus on policy before practice.
- Telemedicine services should be treated like all other health services and influenced by the normal management structure.

The technology should be as user-friendly as possible

- Ensure that the telemedicine equipment is easily accessible and clinician-friendly.
- If equipment is difficult to access or to operate, clinicians are less inclined to be involved.

Telemedicine users must be well trained and supported, both technically and professionally

- Training is very important. Routine training should be provided and adequate technical support should be available at all times to ensure that clinicians are able to deliver services without concerns for technical complications.
- Telemedicine applications should be evaluated and
sustained in a clinically appropriate and user-friendly manner. Evaluation is very important for all telemedicine services to ensure that the effectiveness of the programme is being measured.

- Aspects should include feasibility, clinical effectiveness (diagnostic accuracy), user satisfaction, and cost-effectiveness.

Information about the development of telemedicine should be shared

- Despite the growing amount of literature on telemedicine, there remains a substantial amount of anecdotal evidence which lacks quantitative data.

- Regardless of whether results are positive or negative, they should be published for others to learn from these experiences.

IV. CURRENT EFFORTS

A. India

Many programs worldwide using variety of telemedicine technologies
  In India telemedicine programs actively supported by:
  • Dept. of Information Technology
  • Indian Space Research Organization
  • NEC Telemedicine program for North-Eastern states
  • Apollo Hospitals
  • Asia Heart Foundation
  • State governments

B. CISCO

Cisco HealthPresence Pilot Results From Scotland and California Show That More Than 95% of Patients Are Satisfied With Remote Care

CONCLUSION

Telemedicine offers great opportunity as an alternative method of health service delivery to rural areas. Telemedicine applications will play an increasingly important role in health care and provide tools that are indispensable for home health care, remote patient monitoring, and disease management, that encompasses not only rural health and battlefield care, but nursing home, assisted living facilities, and maritime and aviation applications. But, it has enormous potential to be a tremendous asset to the world and all its civilizations. There is no arguing that the contributions it can make have endless possibilities however more time and effort will be needed to organize telemedicine for it to be confidently accepted.

Telemedicine is not yet all worked out where it can be utilized constantly or flexibly. Although there are many examples of successful telemedicine applications in a wide range of clinical practice settings, more research is required to prove clinical and cost effectiveness. But, it has enormous potential to be a tremendous asset to the world and all its civilizations. There is no arguing that the contributions it can make have endless possibilities however more time and effort will be needed to organize telemedicine for it to be confidently accepted.

V. NEUROPROSTHETICS

A. Introduction:

Definition: Neuroprosthetics or neural prosthetics is a discipline related to neuroscience and biomedical engineering concerned with developing neural prostheses that is artificial devices used to replace or improve the function of an impaired nervous system. Neural prostheses are a series of devices that can substitute a motor, sensory or cognitive modality that might have been damaged as a result of an injury or a disease.

Until recently, the concept of helping the deaf to hear, the blind to see, and the paralyzed to walk was more the province of science fiction or theology than of clinical medicine. Today, however, individuals with profound deafness who have been fitted with cochlear prostheses are able to hear, and to enjoy relatively normal conversations with family, friends and fellow workers. This approach to hearing restoration is rapidly becoming a widely accepted therapy. The neural code is the software, set of rules, syntax, that transforms electrical pulses in the brain into perceptions, memories, decisions. A solution to the neural code could – in principle – give us almost unlimited power over our psyches, because we could monitor and manipulate brain cells with exquisite precision by speaking to them in their own private language.
It requires a high bandwidth for real-time data transmission; this is a great challenge considering that this data link has to operate through the skin. The minimal size of the implant means no battery can be embedded in the implant, the implant works on wireless power transmission through the skin which is equally challenging as the data transmission. The tissue surrounding the implant An example of such devices is Cochlear implants. This device substitutes the functions performed by the ear drum, Stapes, frequency analysis in the cochlea and stimulates the auditory nerves directly. A microphone on an external unit gathers the sound and processes it, the processed signal is then transferred to an implanted unit that stimulates the auditory nerves through a microelectrode array.

B. Types Of Prosthesis
There are three main types of neuroprosthetics - sensory prosthetics, motor prosthetics, and cognitive prosthetics. 

1) Sensory prosthetics
Sensory prosthetics get information into sensory areas like hearing and sight. Although the term "neuro" makes us think of the brain, all neuroprosthetics in use today replace nervous system aspects external to the brain.

2) Visual prosthetics
A visual prosthesis can create a sense of image by electrically stimulating neuro cells in the visual system. A camera would wirelessly transmit to an implant, the implant would map the image across an array of electrodes. The array of electrodes has to effectively stimulate 600-1000 locations, stimulating these optic neurons in the retina thus will create an image. The stimulation can also be done anywhere along the optic signal's path way. The optical nerve can be stimulated in order to create an image, or the visual cortex can be stimulated, although clinical tests have proven most successful for retinal implants.

A visual prosthesis system consists of an external (or implantable) imaging system which acquires and processes the video. Power and data will be transmitted to the implant wirelessly by the external unit. The implant uses the received power/data to convert the digital data to an analog output which will be delivered to the nerve via microelectrodes. Photoreceptors are the specialized neurons that convert photons into electrical signals. They are part of the retina, a multilayer neural structure about 200 um thick that lines the back of the eye. The processed signal is sent to the brain through the optical nerve. If any part of this path way is damaged blindness can occur.

3) Auditory prosthetics
Cochlear implants (CIs), auditory brainstem implants (ABIs), and auditory midbrain implants (AMIs) are the three main categories for auditory prostheses. CI electrode arrays are implanted in the cochlea, ABI electrode arrays stimulate the cochlear nucleus complex in the lower brain stem, and AMIs stimulates auditory neurons in the inferior colliculus.

Cochlear implants have been very successful among these three categories. Today Advanced Bionics and Medtronic are the major commercial providers of cochlea implants. In contrast to traditional hearing aids that amplify sound and send it through the external ear, cochlear implants acquire and process the sound and convert it into electrical energy for subsequent delivery to the auditory nerve. The microphone of the CI system receives sound from the external environment and sends it to processor.

The processor digitizes the sound and filters it into separate frequency bands that are sent to the appropriate tonotonic region in the cochlea that approximately corresponds to those frequencies.

Prosthetics for pain relief
The SCS (Spinal Cord Stimulator) device has two main components: an electrode and a generator. The technical goal of SCS for neuropathic pain is to mask the area of a patient's pain with a stimulation induced tingling, known as "paresthesia", because this overlap is necessary (but not sufficient) to achieve pain relief. Paresthesia coverage depends upon which afferent nerves are stimulated. The most easily recruited by a dorsal midline electrode, close to the pial surface of spinal cord, are the large dorsal column afferents, which produce broad paresthesia covering segments caudally.

4) Motor prosthetics
Motor prosthetics help regulate or stimulate malfunctioning motor functions.

Devices which support the function of autonomous nervous system include the implant for bladder control. In the somatic nervous system attempts to aid conscious control of movement include Functional electrical stimulation and the lumbar anterior root stimulator.
A key element in this restoration of function has been the development of a new generation of penetrating microelectrode arrays that provide unprecedented selective access to the neurons of the CNS and PNS. The active tips of these microelectrode arrays penetrate the nervous tissues and abut against small populations of neurons or nerve fibers, thereby providing selective access to these cells. These electrode arrays are not only beginning to provide researchers with the ability to better study the spatiotemporal information processing performed by the nervous system, they can also form the basis for new therapies for disorders of the nervous system.

6) Sensory/motor prosthetics

In 2002 an array of 100 electrodes was implanted directly into the median nerve fibers of the scientist Kevin Warwick. The recorded signals were used to control a robot arm developed by Warwick’s colleague, Peter Kyberd and was able to mimic the actions of Warwick’s own arm. Additionally, a form of sensory feedback was provided via the implant by passing small electrical currents into the nerve. This caused a contraction of the first lumbrical muscle of the hand and it was this movement that was perceived.

7) Cognitive prostheses

Cognitive prostheses are a largely still-on-the-drawing board field of future prosthetics for replacing or improving problem areas in the brain itself. Cognitive prostheses seek to restore cognitive function to individuals with brain tissue loss due to injury, disease, or stroke by performing the function of the damaged tissue with integrated circuits. The theory of localization states that brain functions are localized to a specific portion of the brain. However, recent studies on brain plasticity suggest that the brain is capable of rewiring itself so that an area of the brain traditionally associated with a particular function (i.e. auditory cortex) can perform functions associated with another portion of the brain. (i.e. auditory cortex processing visual information). Implants could take advantage of brain plasticity to restore cognitive function even if the native tissue has been destroyed.

Cognitive prosthetics are a largely still-on-the-drawing board field of future prosthetics for replacing or improving problem areas in the brain itself. The related procedure of sacral nerve stimulation is for the control of incontinence in able-bodied patients.
Power consumption drives battery size. Optimization of the implanted circuits reduces power needs. Implanted devices currently need on-board power sources. Once the battery runs out, surgery is needed to replace the unit. Longer battery life correlates to fewer surgeries needed to replace batteries. One option that could be used in the medical field to recharge implant batteries without surgery or wires is inductive coupling to recharge batteries. Another strategy is to convert electromagnetic energy into electrical energy, as in radio frequency identification tags.

H. Bio Compatibility

Cognitive prostheses are implanted directly in the brain, so biocompatibility is very important obstacle to overcome. Materials used in the housing of the device, the electrode material, and electrode insulation must be chosen for long term implantation. Subject to Standards: ISO 14708-3 2008-11-15, Implants for Surgery - Active implantable medical devices Part 3: Implantable neurostimulators. Crossing the Blood Brain Barrier can introduce pathogens or other materials that may cause an immune response. The brain has its own immune system that acts differently than the immune system of the rest of the body.
Questions to answer: How does this affect material choice? Does the brain have unique phages that act differently and may affect materials thought to be bio compatible in other areas of the body?

I. Data Transmission

Wireless Transmission is being developed to allow continuous recording of neuronal signals of individuals in their daily life. This allows physicians and clinicians to capture more data, ensuring that short term events like epileptic seizures can be recorded, allowing better treatment and characterization of neural disease.
A small, light weight device has been developed that allows constant recording of primate brain neurons at Stanford University. This technology also enables neuroscientists to study the brain outside of the controlled environment of a lab. Methods of data transmission must be robust and secure. Neurosecurity is a new issue. Makers of cognitive implants must prevent unwanted downloading of information or thoughts from and uploading of detrimental data to the device that may interrupt function.

J. Correct Implantation

Implantation of the device presents many problems. First, the correct presynaptic inputs must be wired to the correct postsynaptic inputs on the device. Secondly, the outputs from the device must be targeted correctly on the desired tissue. Thirdly, the brain must learn how to use the implant. Various studies in brain plasticity (int link) suggest that this may be possible through exercises designed with proper motivation.

VI APPLICATION

The neuroprosthetic seeing the most widespread use is the cochlear implant, which is in approximately 100,000 people worldwide as of 2006. An early difficulty in the development of neuroprosthetics was reliably locating the electrodes in the brain, originally done by inserting the electrodes with needles and breaking off the needles at the desired depth. Recent systems utilize more advanced probes, such as those used in deep brain stimulation to alleviate the symptoms of Parkinson's Disease. Researchers in the US have also implanted electrodes into the motor regions of the brain in paralyzed patients, and have been able to use recorded neural activity to infer the desires of these patients, enabling them to control the cursor on a computer screen simply through volitional thought. These attempts to restore lost sensory and motor function are the result of new neuroprosthesis-based therapy, a field that is still in its infancy. The most famous and widely-used neuroprosthetic is the cochlear implant, which bypasses the eardrum and directly stimulates the human auditory nerve, giving the power of hearing to those who lack it. The first cochlear implant was built in 1957, and today, these implants are used by over 100,000 people.

A. Alzheimer's Disease

Alzheimer's Disease is projected to affect more than 107 million people worldwide by the year 2050. Due to increased life spans, more and more people are being affected by Alzheimer's disease. In the United States this fact has important repercussions. With many baby boomers reaching retirement age the strain on the medicare and medicaid systems may become too great. Alzheimer's disease renders individuals incapable of supporting themselves. Unfortunately many of the more severe cases of Alzheimer's patients end up in nursing homes. Even a small measure of success by cognitive implants would help keep Alzheimer's patients out of nursing homes longer and lessen the load on medicare and medicaid.
B. Hippocampal Deficits
Dr. Theodore Berger at the University of Southern California is developing a prosthetic for treatments of hippocampal detriments including Alzheimer's. Degenerative hippocampal neurons are the root cause of the memory disorders that accompany Alzheimer's disease. Also, hippocampal pyramidal cells are extremely sensitive to even brief periods of anoxia, like those that occur during stroke. Loss of hippocampal neurons in the dentate gyrus, an area associated with new memory formation has been attributed to blunt head trauma. Hippocampal dysfunction has also been linked to epileptic activity. This demonstrates the wide scope of neural damage and neurodegenerative disease conditions for which a hippocampal prosthesis would be clinically relevant.

C. Traumatic Brain Injury
More than 1.4 million people in the United States suffer traumatic brain injury. Orthosis for TBI patients to control limb movement via devices that read neurons in brain, calculate limb trajectory, and stimulate needed motor pools to make movement. (Anderson Paper, Cole at NIH - specifically "Computer software as an orthosis for Brain Injury", Anderson Lab)

D. Parkinson's Disease
Nearly 1 million people in the United States are affected by Parkinson's Disease. Deep Brain Stimulation relieves symptoms of Parkinson's Disease for numerous patients. Parkinson's Disease patients could benefit from a cortical device that mimics the natural signals needed to promote dopamine production. Another possible avenue for mitigation of PD is a device that supplements dopamine when given specific neuronal inputs which would let the body regulate dopamine levels with its intrinsic sensors.

E. Speech Deficits
Approximately 7.5 million people in the United States have trouble speaking. Many of these can be attributed to aphasias. The success of cochlear implants suggest that cortical implants to the speech areas of the brain can be developed to improve speech in such patients.

F. Paralysis
According to the Christopher and Dana Reeve Foundation's Paralysis Resource Center, approximately 6 million people are living with paralysis in the United States. Paralysis results from many sources, stroke, traumatic brain injury, neurodegenerative diseases like multiple sclerosis and Lou Gehrig's Disease, and congenital sources. Many patients would benefit from a prosthetic device that controls limb movement via devices that read neurons in brain, calculate limb trajectory, and stimulate the needed motor pools to make movement. This technology is being developed at the Andersen Lab, located at the California Institute of Technology. The goal is to develop a device to enable locked in patients, those without the ability to move or speak, to communicate with other persons.

VII. SOCIETAL IMPACT/MARKET INFORMATION
Nearly 1 million people in the United States are affected by Parkinson's Disease. Alzheimer's Disease is projected to affect more than 107 million people worldwide by the year 2050. Just these two diseases indicate that there is already a large market for cognitive neural prosthetics, with more potential market space revealed in traumatic brain injury and speech problems (particularly damage to Broca's or Wernicke's areas).

More than 1.4 million people in the United States suffer traumatic brain injury. Approximately 7.5 million people in the United States have trouble speaking. Many of these can be attributed to aphasias. More than 6.5 million people in the United States have suffered stroke.

VIII. CURRENT DEVELOPMENTS
A. Andersen Lab
The Andersen Lab builds on research done previously by Musallam and show that high-level cognitive signals in the post parietal cortex, or PPC, can be used to decode the target position of reaching motions. Signals like these could be used to directly control a prosthetic device. Functionally speaking, the PPC is situated between sensory and motor areas in the brain. It is involved in converting sensory inputs into plans for action, a phenomenon known as sensory – motor integration.

Within the PPC is an area known as the post parietal reach region, or PRR for short. This area has been shown to be most active when an individual is planning and executing a movement. The PRR receives direct visual information, indicating that vision may be the primary sensory input. The PRR encodes the targets for reaching in visual coordinates relative to the current direction of gaze AKA retinal coordinates. Because it is coding the goal of the movement and not all the different variables required for the limb to contact the target, the planning signals of the PRR are considered cognitive in nature. Decoding these signals is important to help paralyzed patients, especially those with damage to areas of the brain that calculate limb movement variables, or relay this information to motor neurons. Perhaps the most astonishing possibility is utilizing these signals to provide 'locked in' individuals, those without the ability to move or speak, an avenue of communication.

B. Hippocampal Prosthetic
Dr. Theodore Berger's research lab at the University of Southern California seeks to develop models of mammalian neural systems, currently the hippocampus, essential for learning and memory. The goal is to make an implantable device that replicates the way living hippocampal neurons behave and exchange electrical signals. If successful, it
would be a large step towards a biomedical solution for Alzheimer's symptoms. Complications from brain injury to motor areas of the brain like reduced coordination could be improved. Speech and language problems caused by stroke could be reversed. To accomplish this, the device will listen for neuronal signals going to the hippocampus with implanted electrode arrays, calculate what the outgoing response of normal hippocampus neurons would be, and then to stimulate neurons in other parts of the brain, hopefully just like the tissue did before damage or degeneration.

IX TECHNOLOGIES INVOLVED

1) Local Field Potentials
Local field potentials (LFPs) are electrophysiological signals that are related to the sum of all dendritic synaptic activity within a volume of tissue. Recent studies suggest goals and expected value are high-level cognitive functions that can be used for neural cognitive prostheses. explain how they are used how they are better than other methods

2) Automated Movable Electrical Probes
One hurdle to overcome is the long term implantation of electrodes. If the electrodes are moved by physical shock or the brain moves in relation to electrode position, the electrodes could be recording different nerves. Adjustment to electrodes is necessary to maintain an optimal signal. Individually adjusting multi electrode arrays is a very tedious and time consuming process. Development of automatically adjusting electrodes would mitigate this problem. Anderson's group is currently collaborating with Yu-Chong Tai's lab and the Burdick lab (all at Cal Tech) to make such a system that uses electrolysis-based actuators to independently adjust electrodes in a chronically implanted array of electrodes.

3) MRI
Used for imaging to determine correct positioning

4) Imaged Guided Surgical Techniques
Image-Guided Surgery is used to precisely position brain implants.

FUTURE DIRECTIONS
Self-charging implants that use bioenergy to recharge would eliminate the need for costly and risky surgeries to change implant batteries. Memory/Brain off-loading and subsequent uploading to learn new information quickly. Researchers at the Georgia Institute of Technology are researching mammalian memory cells to determine exactly how we learn. The techniques used in the Potter Lab can be used to study and enhance the activities of neural prosthetics devices. Controlling complex machinery with thoughts instead of converting motor movements into commands for machines would allow greater accuracy and enable users to distance themselves from hazardous environments. Other future directions include devices to maintain focus, to stabilize/induce mood, to help patients with damaged cortices feel and express emotions, and to enable true telepathic communication, not simply picking up visual/auditory cues and guessing emotional state or subject of thought from context.

Research in visual neuroprosthetics has given rise to extremely fine electrodes, thinner than a human hair. This has helped progress tangential areas of neurophysiology, but unfortunately true visual prostheses - devices which would allow the blind to see - are still in development

RESULT-ANLYSIS
The capability of the individuals can be improved through Neuroprosthetics. The quality of work can be considerably increased. We must create awareness among the people who are suffering from disabilities, so that we can increase their living standards.
CONCLUSION
Healthcare is, and remains, one of the most pressing challenges facing our nation (and the world) in the 21st century. Almost any discussion related to improving healthcare, whether it implicates reducing costs or improving patient safety and satisfaction, usually has technology as a core component. Technology, in and of itself, will not solve the problem, but used appropriately will contribute to the transformation of healthcare, as it has in many other industries.

While considering a new application, it is important to consider a range of logistical factors. A common and expensive mistake for service developers is to focus entirely on the technology. It is essential that one considers the significant organisational changes that are required to be integrated as a mainstream health service. There should always be a clear reason using these technologies, such as a proven clinical problem where online communication technologies may be helpful for the delivery of a health service. The service should be subject to robust evaluation to determine the benefits over conventional services for the health service provider, the consumer and for society as a whole. It is recommended that new services be piloted on a small scale and gradually developed if proven beneficial. To conduct them successfully, it is important that all sites involved are well-resourced with the appropriate personnel, equipment, telecommunications, technical support and training.

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