

## Review Article

# The Technological Growth in eHealth Services

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The infusion of information communication technology (ICT) into health services is emerging as an active area of research. It has several advantages but perhaps the most important one is providing medical benefits to one and all irrespective of geographic boundaries in a cost effective manner, providing global expertise and holistic services, in a time bound manner. This paper provides a systematic review of technological growth in eHealth services. The present study reviews and analyzes the role of four important technologies, namely, satellite, internet, mobile, and cloud for providing health services.

## 1. Introduction

Technology plays a major role in the development and evolution of all sectors of our civilization. It has always been intertwined with human development for even every small economic or social growth. Information communication technology (ICT) and web services have a major impact on the quality of services and peoples' lifestyle. The implementation of ICT in the health sector, popularly known as eHealth, is emerging as one of the most rapidly growing areas in healthcare today. It has paved way for a new area of research among doctors, scientists, and researchers who try to develop efficient and accurate technologies for dealing with the health problems while the policy makers look at it from the view point of providing affordable healthcare to everyone. At the same time it also helps in imparting knowledge and creating interest among common people. To achieve national and global health appropriate use of ICT should be applied which can bridge the digital and health gap. The technological innovations lead to new applications for disseminating healthcare information to diverse audiences using innovative interoperable design. These applications

are simple, easy to use, engaging, and capable of delivering relevant information for primary healthcare to diverse users.

Although, the term eHealth came into picture in 1960's (Dr. Kenneth Bird, one of the first pioneers of telemedicine provided medical care to patients located at three miles away from the Massachusetts General Hospital in Boston through a two-way audiovisual microwave circuit in 1967 [1]) it became an active area of research and discussion only after 2000.

A prime reason for the growing popularity and awareness of eHealth is the advancement in computer and communication technology which has made the healthcare information and services globally accessible at a very low cost. According to Dr. T. E. Bell (IEEE spectrum 2006) the effective and efficient use of engineering can lower the costs provided it is focused on early detection of the disease. Different factors are participating in driving towards a better implementation and wider use of eHealth services and technologies.

A few advantages of eHealth technologies are listed in the following.

- (i) With the advent of new and modern technologies, voice and data in form of pictures, videos, and text can

be relayed in real time on various types of computing devices, even mobile handsets.

- (ii) Multilocation real time videoconference can be used to conduct training sessions, live demonstrations, collaborations, and so forth.
- (iii) Simple Internet connection can be used by large number of people to study and to gain knowledge about health related issues at their own convenience.
- (iv) eHealth services may play an important role in maintaining the doctor-patient ratio all round the world.
- (v) Electronic health records (EHR) of the patients may be maintained which in turn may be beneficial to the medical practitioners in treatment of diseases.
- (vi) Providing medical facility to elderly is the most challenging task in today's world. The World Health Organization has estimated that the proportion of persons over 60 years of age will double to 22% in 2050 from 11% in 2000. Thus over 2 billion people will require additional medical support, even assisted living, as they will be more prone to health related issues. The aging society can be served by satellite based medical diagnosis and care from their homes.

The literature review concerns the role of prime technologies including satellite, Internet, mobile, and cloud services which are used for providing low cost and timely healthcare. These technologies have a profound effect on the quality, safety, and efficiency of healthcare in the developed as well as developing world. The search in this review is done after going through a large number research papers and related studies collected from IEEE digital library, ScienceDirect and Taylor Francis in the duration from 2003 to 2014. We have tried to cover maximum possible papers for our literature review. However, there is a possibility that some interesting studies might have been skipped. This paper is divided into 8 sections including introduction. In Section 2 we give a brief description of the technologies discussed in the paper; Sections 3, 4, 5, and 6 deal with role of Satellites, Internet, mobile, and cloud, respectively, in the field of eHealth. Section 7, provides an analysis of the review done in the paper. Future scope and suggestions are provided in Section 8. The paper finally concludes with Section 9.

## 2. Short Description of the Technologies Discussed in the Paper

**2.1. Satellite Communication.** Satellite communication uses artificial satellites for providing communication links between various points on Earth. With the help of transponder (an integrated receiver and transmitter of radio signals) a satellite receives and retransmits the signals back.

Satellites are playing an increasing role in the support of health and welfare on Earth. Medical support through satellite is being considered as a cost effective and an accessible solution especially in the developing nations where populations lack even basic levels of healthcare due to

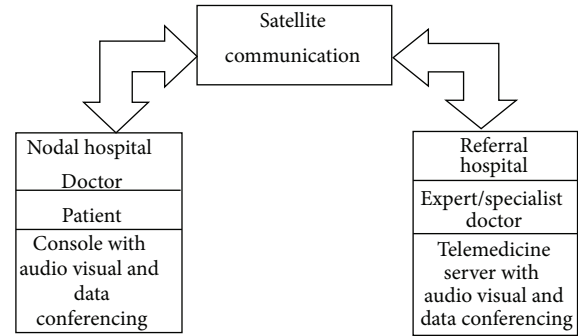


FIGURE 1: Medical services through satellite communication.

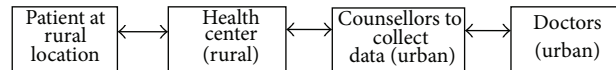


FIGURE 2: Medical services through Internet at WHP India.

remoteness, poverty, and lack of availability of health practitioners. Figure 1 explains the working of telemedicine centers providing medical services through satellite.

Following are the links and the name of some telemedicine centers in India providing medical facilities through satellite:

- (i) Apollo Hospital [<http://www.apollotelehealth.com:9013/ATNF/aboutATNF.jsp>];
- (ii) Sri Ramchandra Medical Center <http://www.sriramachandra.edu.in/medical/telemedicine.htm>;
- (iii) AIIMS Hospital [<http://www.aiims.edu/aiims/telemedicine/telepage.htm>].

**2.2. Internet Communication.** Interconnected networks of computers which make use of Internet protocol suite (TCP/IP) to link the devices located worldwide. The network can be private, public, academic, business and government and can be linked by a broad array of electronic, wireless, and optical networking technologies. The Internet users not only can seek health information, but also can get connected to the specialist doctor for the proper consultation. For example, in India an NGO named World Health Partners is providing health services in the rural areas through Internet [<http://worldhealthpartners.org/>]. Figure 2 shows the working of WHP.

**2.3. Mobile Communication.** Mobile communication is a wireless form of communication in which voice and data can be transmitted and received through microwaves. The exchange of data can be done while moving from place to place, for example, cellular, cordless, pagers, and so forth.

In the recent years mobile devices can be effectively used in providing medical support to the patients locating at a distant places. Services through mobile phones may include collection of community and clinical healthcare data, delivery of healthcare information to practitioners, and real-time monitoring of patient vital signs. Figure 3 provides

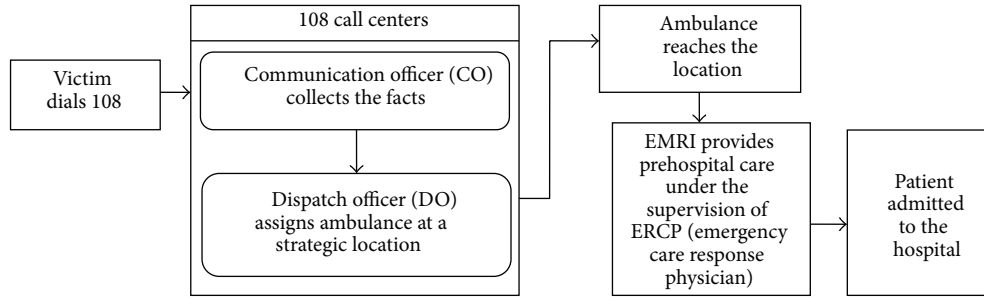


FIGURE 3: Emergency medical services through 108 services in India.

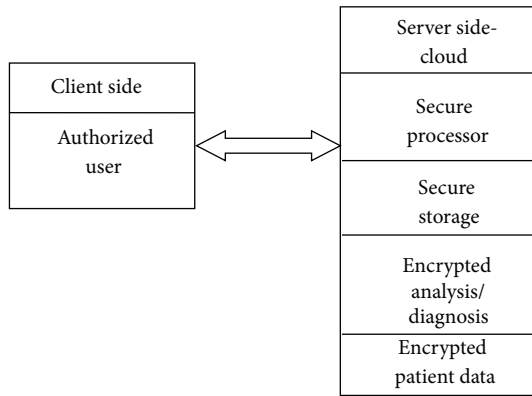


FIGURE 4: Medical services through cloud.

the working of 108 emergency medical services in India [<http://www.emri.in/>].

**2.4. Cloud Communication.** Cloud computing relies on sharing computing resources to handle the applications. It is a type of Internet-based computing, where different services like servers, storage, and applications are shared which results in the effective and optimized use of software and hardware resources (Figure 4). For example, in India eHealth centers (eHC) are providing cloud enabled healthcare centers [<http://www8.hp.com/hpnext/posts/cloud-enabled-e-health-centers-bringing-quality-healthcare-rural-areas>].

### 3. Role of Satellites

Satellites play a major role in the support and welfare of mankind by monitoring the climatic changes, calamities, and so forth. In context of eHealth, satellite communications (SatCom) combined with information technology play a vital and significant role. Satellite communication is particularly beneficial for providing medical benefits to remote and inaccessible areas. In order to ensure healthy life, especially in rural and tribal regions, the basic issue of providing timely advice and diagnostic facilities has to be solved. The satellite based communication provides a feasible solution and is being looked at for medical support. In the remote locations or places without access to traditional Internet infrastructure, the satellite communication can provide educational services.

The medical personnel can use this to improve their skills and patients to educate themselves. As the latest information will become accessible, this can potentially become a powerful educational tool.

A system with satellite communication can support all or a number of the following services.

- (i) Patients at home and medical personnel (doctors, nurses) at remote hospital or medical center can interact through videoconferencing.
- (ii) Telemonitoring of patients at home.
- (iii) Collection and transmission of medical data, such as glucose measurements, heart pulse measurements, and weight measurements, to a hospital or medical center for further process.
- (iv) Satellite communications can also be used for monitoring endemics/epidemics at any area.

For this study, we studied a total of 50 articles based on the use of satellite in eHealth services. Out of these 50 articles 28 were published during the period of 2004–2008 and the remaining 22 were published in the period of 2009–2014. We have categorized these papers into 8 areas, given in Table 1, out of which the first seven include the application of SatCom in various areas and the eighth one consists of papers devoted to the work done for improving the SatCom for eHealth purposes:

- (i) disaster management;
- (ii) diagnosis of disease particularly in rural area;
- (iii) medical education and training of health professionals;
- (iv) treatment of chronic disease like cancer, HIV/AIDS, and so forth;
- (v) ultrasound;
- (vi) high speed video audio conferencing;
- (vii) services of elderly people;
- (viii) improvements proposed over the existing satellite based system.

The number of publications on eHealth services through satellite communication is presented in Table 1.

References [2, 3] are case studies which give the vision of ambulance telemedicine for providing health services

TABLE 1: Role of satellite.

S. number	Areas	Satellite communication in eHealth	
		2004–2008 Ref. number	2009–2014 Ref. number
1	Disaster management	[2–11]	[12–14]
2	Diagnosis of disease particularly in rural	[15–20]	[21–24]
3	Medical education and training of health professionals	[25, 26]	[27]
4	Treatment of chronic diseases like cancer, HIV/AIDS, and so forth	[28–30]	
5	Ultrasound	[31, 32]	[33]
6	High speed video-audio conferencing	[34–36]	[37–39]
7	Services for elderly people	[40, 41]	
8	Improvements proposed over the existing satellite based system		[42–51]

during disaster in Japan using Quasi Jenith satellite system. The authors analyzed that this will shorten the ambulance transport time. Also, the authors suggested that during emergencies miniaturized sensing equipment can be used to send data to a medical centre through satellites. In [5], the authors describe the development of small and light telemedicine package using mobile satellite and a wireless LAN communication and in [11] focus is on the development of low cost movable telemedicine system that can be used easily in disaster stricken areas.

A description of four telemedicine projects DELTASS, MEDAShip, Emisphere, and Galenos which provide medical services in the disaster has been presented in [6]. Similarly [12] demonstrates the launch of first telecommunication satellite in Venezuela for providing medical services in emergency, thus improving disaster management.

References [4, 13, 14] focus on the technical issues for improving the quality of data and images being provided through satellite communication in emergency situations. Reference [4] describes the development of high definition images; [13] emphasizes the use of optical links for increasing the bandwidth whereas [14] demonstrates the requirement of the number of channels in satellite communication for supporting the telemedicine at an early stage after major disaster.

The benefits of satellite communication for providing emergency health services have been discussed in [7–10].

There have been some publications indicating the use of satellite communication for providing health services to rural areas of the developing countries like India [15, 18, 22], Mexico [16, 18], Peru [17], Brazil [17], Rural America [23], Crete [19], South Aegean [19], sub-Saharan Africa [24], and Pakistan [20]. In [21] the authors discuss about diagnosing the disease by the transmission of cardiac sounds of a patient located at a distant or rural.

In references [25, 26], the authors explain the use of satellite communication to utilize the knowledge of specialized experts in certain specialized field whereas [27] explains the innovative ways through satellite communication for providing medical education and training of health professional on surgical techniques.

The application of SatCom is also beneficial for diagnosis and treatment of chronic diseases. In reference [28],

the authors define the application of satellite communication in the treatment of chronic diseases like HIV/AIDS. In [29], the authors present a new mobile flow-cytometry device for diagnostic applications in the oncology field whereas, in [30], the authors demonstrate the real-time echocardiography using satellite transmission focusing on its feasibility and accuracy.

Study shows that satellites have also been able to provide support ultrasound facility.

A teleultrasound approach is proposed in [31–33]. This is done by maintaining a connection between a technician at a remote place to a radiologist, through customized software, and a satellite Internet connection.

6 papers were reviewed which discuss the technical issues related to high speed video-audio conferencing through satellite communication. Reference [34] provides a framework using VSAT (very small aperture terminal) and wireless LAN (local area network) to enable bidirectional, high speed, real-time video and audio on IP (Internet protocol). This platform can be used for face to face consultations between experts and patients in remote locations.

References [35, 37, 39] present the platform for collection, remote monitoring, and transfer of medical data.

In [36], the authors analyze that connection through leased line based on terrestrial IP (Internet protocol) performs better than Sky IP. The study shows that for telemedical video conference integrated services digital network (ISDN) media has been technically less acceptable.

Reference [38] discusses the problems and limitations of satellite communication. It further provides a solution by using high bandwidth links to accommodate high end medical applications like real time medical imaging and robotic surgery.

In [40, 41] the constant monitoring of older people has been described. An alarm is raised if some abnormal condition is observed and is sent to physician office via satellite.

Out of the total papers studied in the category of use of SatCom for healthcare, 10 papers lie in the “Improvement” section which recommends various improvements that can be made for improving the system. Table 2 presents a summary of the suggestions made to improve the existing system.

TABLE 2: Improvement over existing system.

S. number	Recommendation	Ref. number
1	MEDNET's EC FP7 project telemedicine network solution	[44]
2	Performance evaluation, through emulation and using real medical equipment	[45]
3	Emphasis on the technical characteristics and trend	[43, 46, 48]
4	802.11n/satellite 2-in-1 OFDM-based transmission architecture	[42]
5	To support remote medical observations use of HEO on Ku-band with satellite communication system	[47]
6	Integration of different technologies like GSM/GPRS, GPS, sensors (wearable device), and P2P for providing instant medication and shifting of patient to nearby hospital	[49]
7	A project based primarily on satellite facilities to construct the model of a powerful telemedicine centre	[50]
8	Solution for the management of functions of mobile equipment for critical telemedicine through satellite	[51]

#### 4. Role of Internet

In this section we discuss the role of Internet in eHealth sector. The Internet has been capable enough to become a low cost and effective source of health promotion. It can empower people living in urban or rural areas [60] to make better informed choices about their health. The first recorded instance of providing medical treatment through Internet occurred in April 1995 when an SOS email was sent to help a Chinese university student, who was suffering from an unknown disease [1].

The papers reviewed under this section have been categorized into six areas (Table 3), where S. numbers 1–5 provide reference for a specifically defined area, S. number 6 defines the general importance of Internet in eHealth:

- (i) diagnosis of diseases in rural or remote areas,
- (ii) medical education and training of health professionals,
- (iii) treatment of chronic diseases like cancer, AIDS/HIV, and so forth,
- (iv) general diseases,
- (v) services for elderly people,
- (vi) general significance of Internet in eHealth.

Study reveals that the Internet is being used heavily for distance learning and continuing education. The Internet

provides patients, families, and care givers a platform to learn, inform, and communicate with one another. In [58, 59], the authors focus on obtaining expert advice from the specialist located anywhere in the world. The practitioners who are serving in a remote or underserved region can easily get connected to the specialists through the Internet. Similarly [52] focuses on providing medical consultation at remote places in Nigeria.

References [53–55, 57] discuss the general issues like impact of Internet-based programs, usage of online health information, and development of healthcare portal and medical education on Internet.

Besides providing education it is also important to provide web-based patient education during his hospitalization or even for patients suffering from serious mental health disorders so that more options of nursing can be explored. In this context [56] describes the sessions specially designed for psychiatric department for providing web-based patient education.

In the recent years Internet has also been involved in providing an ideal platform for spreading awareness about the chronic diseases like cancer, HIV/AIDS. This category has the highest number of publications and maximum of them are based on cancer related issues.

Articles [60–64, 66, 68, 69, 77, 78] focus on the health websites related to cancer. Table 4 summarizes the purpose of publications dealing the issue of cancer.

Besides dealing with the cancer related issues there have been publications which deal with other chronic diseases like mental issues [65], Internet delivered PCIT [67] (parent child interaction therapy) treatment, smoking cessation [70, 72], Internet-delivered ACT (acceptance and commitment therapy) intervention for chronic pain [71, 80], diabetes [73], gastrointestinal disorders [74], psychosis [75], cardio (ECG monitoring) issues [76, 79], vaccination [81], eating disorders [82], and reduction of MetS risk factors in working women [83].

There are four papers concerning the problems associated with older adults. References [84–86] emphasize on the issues related to elderly people and [87] proposes the idea of smart homes for elderly so that they can communicate with the outside world in an intelligent and goal oriented manner.

13 papers that were reviewed describe the general significance of internet in ehealth. In [92, 93, 95, 96] authors describes the design, usage, architectural and technical issues for the development of health websites and the article [98] is regarding the process of evaluation of best health websites. The impact of Internet based telemedicine on the health behaviors in terms of affordability and reducing medical errors has been discussed in [97], patient-doctor interaction has been discussed in [89, 94, 99] whereas [88, 90, 91] throws light on accessibility of health information through internet.

In [100] author analyzes the impact of “IoT (Internet of Things)” on the design of new eHealth solutions. The authors aim to illustrate that IoT concept has a great potential in the implementation of Internet-based healthcare systems.

Apart from these areas there are more than 100 papers which focus on the use of social media for different purposes

TABLE 3: Role of Internet.

S. number	Area	Internet communication in eHealth	
		2004–2008 Ref. number	2009–2014 Ref. number
1	Diagnosis of disease in rural and remote areas	[52]	
2	Medical education and training of health professionals	[53]	[54–59]
3	Treatment of chronic diseases like cancer, HIV/AIDS, and so forth	[60–64]	[65–80]
4	General diseases	[81]	[82, 83]
5	Services for elderly people		[84–87]
6	General significance of Internet in eHealth	[88–95]	[96–100]

TABLE 4: Cancer related websites.

S. number	Purpose	Ref. number
1	Evaluation of cancer information on the internet	[60]
2	Impact of internet on cancer patients	[62, 66]
3	To access the quality of breast cancer related information in Swedish language available on the Internet	[61]
4	Evaluation of preexisting doctor-patient relationship within an interactive cancer communication system (ICCS) for underserved women with breast cancer	[63]
5	To review the impact of computer-based patient education on prostate cancer patients	[68]
6	To explore the role of face to face support group of the breast cancer survivors who are facilitators of these online communities	[69, 77]
7	How women with breast cancer learn from interactive cancer communication system	[64]
8	The designing of supportive eHealth interventions for patients diagnosed with cancer	[78]

like patient education, doctor-patient, advertising new services, and so forth.

The next section is dedicated to the literature review based on the role of mobiles in the wide deployment of eHealth services.

## 5. Role of Mobiles

The use of mobile phone is exploding across the developing world. According to the International Telecommunication Union (May 2014) there are nearly 7 billion mobile subscriptions worldwide and this is equivalent to 95.5 percent of the world population. Accessing health services using mobile phones are mostly appropriate for data collection,

analysis, and registration and monitoring patients. The first successful implementation of a mobile wireless application for the healthcare industry in the United States of America (USA) was announced on 13 October, 2008, by InfoLogic [155].

In providing health services through mobile phone, 54 articles were reviewed. Table 5 categorizes the publications in six areas:

- (i) benefits, challenges, and opportunities of mobiles,
- (ii) treatment of chronic diseases,
- (iii) mobile and Internet,
- (iv) improvements proposed over the existing mobile communication based system,
- (v) case study,
- (vi) security.

There were 19 papers which discuss the importance of mobile phone in the implementation of eHealth services and 14 papers concentrated on the treatment of various chronic diseases like hypertension, diabetes, and so forth with the help of mobiles. A summarized list of the chronic diseases monitored through the mobile communication technology is given in Table 6.

Some research articles [101, 103–107, 111, 113–115, 118] revolve around the different features of mobile communication and its benefits which results in the wide deployment of eHealth services across the globe. Research articles [102, 116, 117, 119] discuss the challenges in establishment of eHealth services through mobiles whereas [108–110, 112] focus on the impact and strategies that may be followed for deploying mobiles for eHealth services.

Publications are also devoted to suggestions that may be incorporated for improving the current system through mobile technology. These may be found in [108, 118, 134–146] which focus on various aspects that may be adopted for improving the technical issues leading to better accessibility of health services through mobile.

There are also some articles and case studies which revolve around the eHealth services being provided in the developing nations like Sri Lanka [147], Finland and Cameroon [148], Macedonia [149], Brazil [150], and Sweden [151].

Articles [11, 75, 133] focus on the integration of mobile and Internet technologies for better delivery of health services.

TABLE 5: Role of mobile communication in eHealth.

S. number	Area	Mobile communication in eHealth	
		2004–2008 Ref. number	2009–2014 Ref. number
1	Benefits, challenges, and opportunities of mobiles	[101–103]	[104–119]
2	Treatment of chronic diseases	[120, 121]	[75, 122–132]
3	Mobile and Internet	[11, 133]	[75]
4	Improvements proposed over the existing mobile communication based system	[134–137]	[108, 118, 138–146]
5	Case study		[147–151]
6	Security	[152]	[153, 154]

TABLE 6: Chronic diseases for which mobile communication is used.

S. number	Diseases	Ref. numbers
1	Psychosis	[75]
2	Hypertension	[120]
3	Diabetes	[122]
4	Mental disorders	[123, 124, 127]
5	Tobacco cessation	[125]
6	Self-care	[126]
7	Weight management	[128]
8	Rheumatoid arthritis	[129]
9	Diabetes, HIV, cardiovascular	[130]
10	Influenza	[131]
11	Brain activity monitoring	[132]
12	Psoriasis	[121]

Papers [152–154] discuss the security related issues like authentication and authorization. The study also proposes models/solutions for dealing with the problem of security.

## 6. Role of Cloud

This section is devoted to the application of cloud computing, one of the latest advancement in the field of eHealth. The biggest advantage of using cloud computing systems is the availability of infinite computing resources when needed. It can offer many opportunities to improve healthcare services from the viewpoint of management and technology. Electronic health records may be created and placed in a cloud. In this way the valuable data extracted from the different databases of treatment, patients, diseases, and so on can be accessed by doctors to perform analytical studies. We studied 24 publications which provide information on eHealth services using the cloud computing platform. The research areas mainly include implementation of cloud computing, its use for diagnostic purposes and for treatment of chronic diseases, security issues, and suggestions for improvement. These are summarized in Table 7.

Out of the 24 research articles studied, maximum of 10 articles [156–165] are devoted to the secure and reliable platforms for cloud computing. References [166–168] present different models which suggest various improvements over the existing cloud solutions. In [166] the concept of reverse

TABLE 7: Role of cloud.

S. number	Area	Cloud communication in eHealth
		2009–2014 Ref. number
1	Implementation	[176]
2	Diagnosis of disease particularly in rural, remote, and tribal regions	[177]
3	Treatment of chronic diseases	[178, 179]
4	Improvements proposed over the existing cloud based system	[166–168]
5	Security	[156–165]
6	Benefits, challenges, and opportunities of cloud	[169–173]
7	Mobile cloud	[163, 174, 175]

cloud is presented while [167] integrates the concept of SOA and in [168] use of scalable video coding is discussed for fast application.

References [169–173] discusses the different issues for the successful implementation of eHealth cloud. These articles discuss benefits of cloud computing, challenges like sustainability and privacy, opportunities like cloud for telemedicine, and so forth. Articles are also devoted to the integration of two technologies. Research articles [163, 174, 175] are based on mobile cloud. Here, it is shown how the integration of mobile along with cloud computing can help in providing the maximum benefits.

Implementation and use of cloud computing for diagnosis purpose in rural areas and for treatment of chronic diseases have also been a point of discussion [176–179].

The next section presents the analysis of detailed literature review done in the above section.

## 7. Analysis

In this section we briefly describe the advantages and disadvantages of the techniques mentioned in this paper. The literature review described above revolves around the usage of

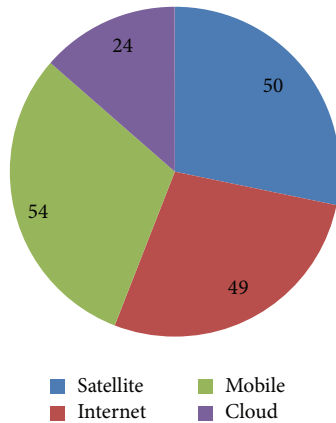


FIGURE 5: Pie chart showing the work done in different areas.

four different technologies namely satellite, Internet, mobile, and cloud in the deployment of eHealth services. In the recent years integration of various media into a single system around computers has revolutionized health services. Through Tables 1, 3, 5 and 7 we can analyze that out of 177 papers reviewed 50 papers focus on the satellite communication and 49 papers focus on Internet, 54 discuss the mobile communication, and 24 papers discuss the application of cloud in health (Figure 5). Out of the total papers studied, the maximum number of articles concentrated on use of mobile communications for the deployment of eHealth. One of the reasons for the popularity of mobile communications could be their availability and affordability among the common man. The second popular choice among researchers seems to be Internet and satellite communications. Cloud computing is an emerging area of research in the area of eHealth and has relatively lesser material in comparison to other mediums studied in this paper.

Figures 6–9 give a pictorial representation of the work done through different mediums of communication. Most of the research is based on the advantages and disadvantages/shortcomings of different mediums. In the next subsections, we describe in brief the benefits and shortcomings of different mediums.

### 7.1. Advantages and Disadvantages/Shortcomings of Different Mediums

**7.1.1. Satellite Communication.** Satellite communication is one of the earliest medium for providing eHealth services. The work done in this area is shown in Figure 6, which indicates that maximum work is done in the area of disaster management and then in the diagnosis of disease in rural and remote regions. The reason may be contributed to few facts as follows.

- (i) Satellite communication is flexible enough to provide communication. They do not need the installation of n/w fixed assets and are able to reach all areas of the globe.

- (ii) The location of ground stations needs not to be fixed at a particular place.
- (iii) The deployment of a satellite communications system can be very speedy since no ground infrastructure may be required.

Therefore for many remote areas and disaster stricken areas, satellite communications systems provide an ideal solution where other technologies may not be viable. However, there are certain shortcomings as well; for example,

- (i) the main problem with building of satellite communications is the high operational cost; building, placing in orbit, and then its maintenance all require heavy cost;
- (ii) round trip time can be an issue since the distances are greater than those involved with terrestrial systems;
- (iii) satellite communication may fail or may provide poor quality services (reception problem) in case of extreme weather conditions like heavy rainfall, snowfall, sandstorms, and so forth.

**7.1.2. Internet Communication.** In Figure 7, we describe graphically the work done in eHealth sector while using Internet communication. Here we see that the maximum work has been done for the treatment of chronic diseases like cancer, TB, HIV/AIDS, mental disorders, cardio vascular, and so forth. The reasons for this can be summarized as follows.

- (i) Low cost: the user does not have to pay while accessing the information, only Internet connection is required.
- (ii) Fast: it enables a large number of people to quickly access medical and other information. New information can be disseminated quickly to the public and medical community.
- (iii) Better interaction: it delegates the user to take an active role in managing their health. Computer-based programs prioritize one to one interaction between the client and the provider, with the goals of health approach and can target large population segments.
- (iv) The Internet also provides a medium for interaction and collaboration among institutions, health professionals, health providers, and the public.
- (v) Providing health education and training through Internet is also one of the important aspects of eHealth services.
- (vi) Internet may also be considered as an efficient tool for elderly and physically disabled who can get useful information through it while sitting at home.

However, there are certain drawbacks of using Internet for the purpose of eHealth services. These are listed as follows.

- (i) The most crucial drawback of the Internet is the wrong or incorrect usage of the information provided in it. The information available on the Internet with respect to medicine for particular disease or



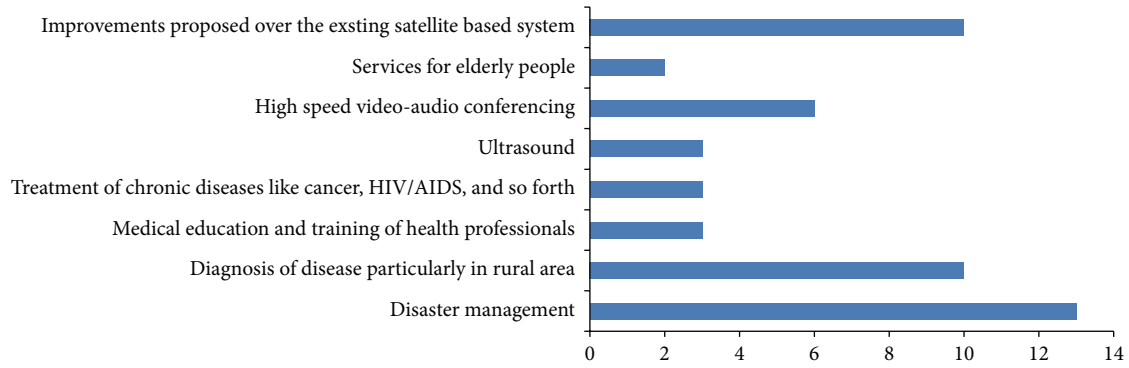


FIGURE 6: Satellite communication.

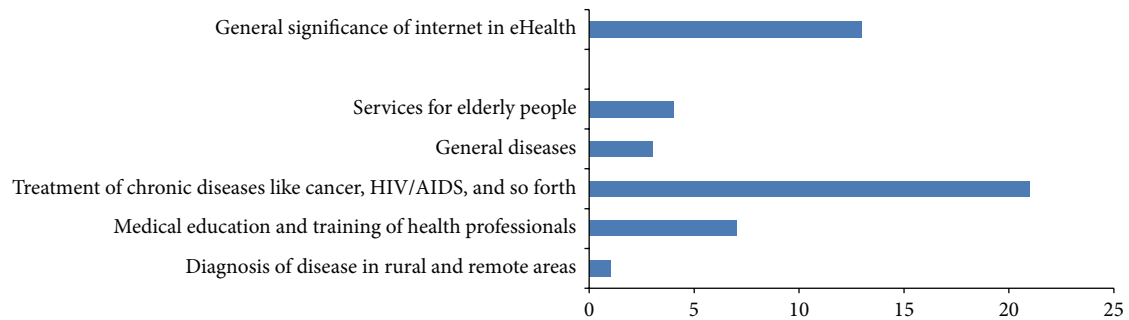


FIGURE 7: Internet communication.

symptoms may not be accurate for individual cases. Since individual symptoms or past history is also important according to which the doctor may or may not prescribe the same medicine, the medicine suggested for a particular disease may or may not be appropriate for individual person. For example, an issue of the journal *Annals of Internal Medicine* reported the case of a person with maxillary sinus cancer who developed fatal hepatorenal failure after taking hydrazine sulfate that was marketed on the Internet as a remedy for cancer [180, 181].

- (ii) Authenticity of a website is yet another problem while using Internet. According to a survey of 400 health sites it was found that half of them had not been scientifically reviewed and 6% provided incorrect information [182].
- (iii) Security and privacy have always been a serious issue in the world of Internet.
- (iv) Bandwidth or connectivity problem may affect the audio/video quality during a video call.

**7.1.3. Mobile Communication.** Figure 8 gives a pictorial illustration of the work done in the field of eHealth using mobile communication. Today the most accessible technology for general public is mobile phones. As mentioned in Table 5 we can see that maximum papers have been published in the category of “benefits, challenges, and opportunities of

mobiles” and then in “improvements proposed over the existing mobile communication based system.” The integration of mobile phones makes the services more efficient in terms of time and cost.

Smartphone are major extensions on normal cell phones. They are the catalyst in the transition of health services to mobile devices.

Few points which are responsible for the wide acceptance of mobile services are listed in the following.

- (i) Mobiles are the lowest cost communication medium that can be used for eHealth purposes.
- (ii) Mobiles are very easy to use by a common man, which is another reason for its popularity.
- (iii) Use of mobile technology does not require any urgent infrastructure.
- (iv) It can be used at any time and any place implying a high medical care (24 × 7 availability).

Some shortcomings associated with mobile communication technology are as follows.

- (i) Mobile phones have limited memory and computational power.
- (ii) Reception of images or picture quality can be an issue.
- (iii) Although the advent of smartphones has minimized these shortcomings, availability of high end smartphone to general public is not always possible.

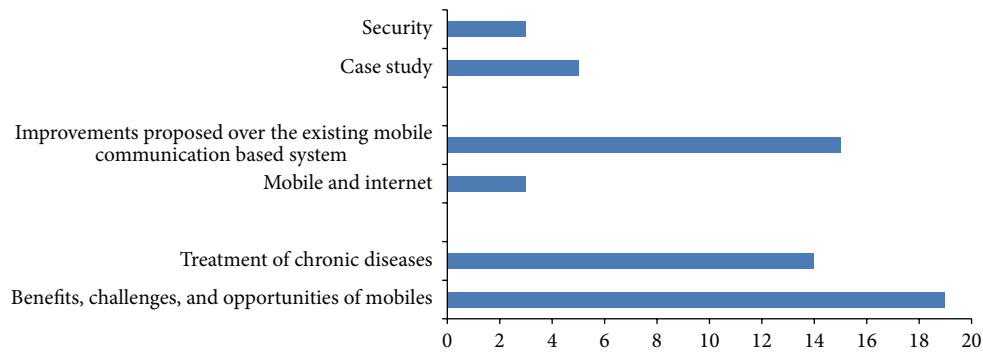


FIGURE 8: Mobile communication.

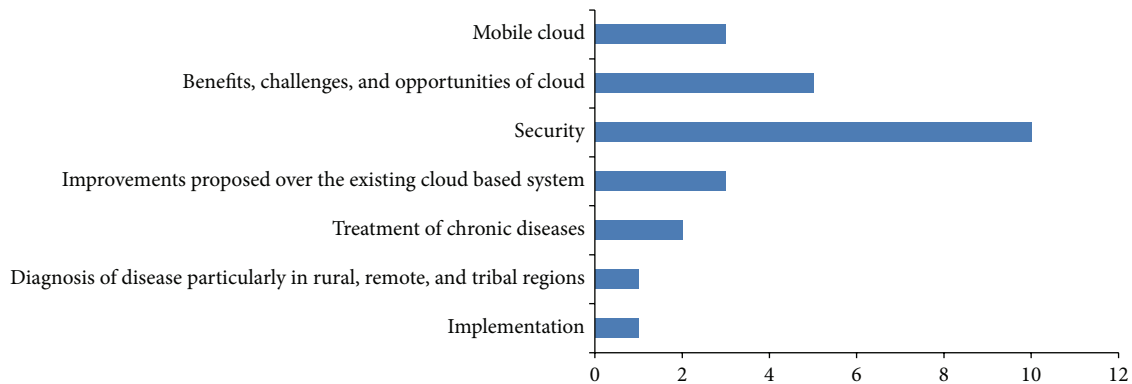


FIGURE 9: Cloud computing.

**7.1.4. Cloud Computing.** The use of cloud computing in health services has a significant potential to optimize the software and hardware infrastructures. It offers a large pool of resources and is available to the user according to their requirement. Although the journey of cloud took speed after 2000, the use of cloud paradigm in eHealth came into existence after 2009. All the 24 papers reviewed under this area are in the period of 2009–2014. Maximum papers are based on the security category, which gives an indication that security is a major challenge in providing health services through cloud. A graphical representation of the use of cloud computing for eHealth is given in Figure 9.

## 8. Future Scope and Suggestions

There are several challenges ranging from technical to social to financial to political issues in the path of eHealth services for which solutions have been suggested to overcome the obstacles and to provide the benefits of eHealth services to the masses. eHealth services have major impact on health professionals as well as on general public. The review done in this paper shows that eHealth has significant potential in making the services available at emergency situations as well as at remote and rural areas. Besides this, in imparting health education also eHealth has done a remarkable contribution. Although, eHealth services have reached to most of the segments but there are still some sections where more

emphasis should be given specially in the developing nations, for example,

- (i) elderly and disabled;
- (ii) career women;
- (iii) maternity and child care;
- (iv) adolescents;
- (v) chronic conditions;
- (vi) disaster.

The health services can be brought closer to them through eHealth.

### 8.1. Suggestions

(1) *Exposure to Computer/Internet Technology.* Internet technology can provide a diverse array of online resources for elder, disabled, and pregnant ladies. Internet awareness can help them to manage their health problems and maintain social connections.

(2) *User Friendly Mobile Applications.* Customized packages focusing on the ailments specifically related to older generation/disabled/pregnant women/adolescents.

(3) *Customized Smart Homes.* It is especially designed for elder generation and disabled people keeping their diseases

TABLE 8: Usage of technology in different scenarios.

Technology	Optimization of resources	Low cost	Ease of use	Global accessibility	Education and training	24*7 availability	Audio-video transfer
Satellite	×	×	×	√	×	√	√
Internet	×	×	×	×	√	√	√
Mobile	×	√	√	×	×	√	×
Cloud	√	×	×	×	×	√	√

or health issues and way of communication in mind. It may include the different facilities like email/chat/video, appointment scheduling, personal health records, vital sign monitoring (RPM), and different equipment for measuring their Bp or glucose level.

(4) *Audio Video Interactive Programs at School Level for Solving the Adolescence Problems.* According to WHO Internet and mobile communications have significant potential in providing health services to the school at an affordable cost. They can, for example, provide confidential and anonymous interactions and easy access 24 hours a day and in some cases should also provide personalized interaction [http://apps.who.int/adolescent/second-decade/section6/page4/dchool-health-E-health.html].

## 9. Conclusions

In this paper we have provided a systematic literature review of the role of different technologies in the establishment of eHealth services in the period from 2004 to 2008 and in the duration from 2009 to 2014. Some conclusions that can be drawn from this research are as follows.

- (i) The focus of research mainly concentrates on
  - (a) security and reliability issues (13 papers),
  - (b) technological development (28 papers),
  - (c) treatment of chronic diseases like hypertension, diabetes, influenza, and so forth (39 papers),
  - (d) articles being devoted to benefits and challenges of different mediums for providing eHealth services (37 papers),
  - (e) the point that since eHealth is still an emerging area of research, many studies are devoted to the case studies (5 papers).
- (ii) Table 8 summarizes the appropriate usage of satellite, Internet, mobile, and cloud considering their characteristics.
- (iii) In the recent years with the advent of social media people have got new platform to express or share the health information dealing with the different chronic diseases like HIV/AIDS, cancer, and so forth.
- (iv) The best way to get the maximum benefit of eHealth services is to integrate different technologies like mobile Internet, cloud Internet, satellite Internet or mobile cloud, and so forth, so that the common is benefitted the most.

- (v) Later on we have focused on the issue of providing eHealth services to elderly, disabled, maternity and child care, adolescents, and the victims of disaster management and chronic diseases. Few suggestions like exposure to Internet, user friendly mobile applications, or customized packages concerning the type of ailment have also been given to make the health services easily available.

We have tried to cover most of the aspects of four different technologies which are being used for providing eHealth services. However, there is a possibility that we might have overlooked a few important research articles related to this work.

## Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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