Smart Healthcare and Ethical Issues

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Abstract: With the development of Internet of Things (IoT) technologies, the medical field has begun to use this technology to better cover society's needs. The users' data can be accurately collected and analyzed, and people can get quite the same level of quality of medical services without shuttling back and forth between hospitals and their homes. Smart healthcare not only reduces the social burden, but it also lowers the financial burden on end users. However, the collection and upload of massive data still have concerning data security risk, which may lead to various ethical problems and endanger the users' interests. The analysis of ethical issues, can help us to provide users or developers with suggestions and demonstrate the central role played by governments. How to balance the user experiences and ethical security is always a hot topic. The aim of this paper is to review existing literature to present recommendations to balance both the use of IoT technologies or smart healthcare and ethics to deliver accurate smart medical services.

1 INTRODUCTION

Many countries have faced social problems such as population expansion, population aging, chronic diseases or epidemics, and poor living conditions. Although people's basic needs have been met, they have started to seek the improvement of medical services (Marmot, 2005). Nevertheless, people still need to queue up for medical treatment. Those patients with chronic diseases need to go to the hospital for controls and for prescription using the existing medical service system (Darkins et al, 2008). Due to the population growth and urbanization process, the demands of high-quality medical treatment will become more and more urgent (Farahani et al, 2018). With the help of IoT technology, patients can monitor their health using wearable devices, but also some devices part of the smart home concept to ensure security at home (Baudier et al., 2018).

However, the application of this technology may impose a variety of ethical issues directly or indirectly. Ethics is defined as the discipline of "dealing with good and evil", moral responsibility and obligation. Healthcare ethics include some specific ethical issues which are related with disease prevention, lifelong extension or public behaviors of mental and physical health, and those medical ethical issues mainly focus on the relationship between patients and physicians. Healthcare ethics can be defined as the ethical regulations and requirements while handling sensitive and private data such as patients' records (Mittelstadt and Floridi, 2016).

The existence of Insurance and employment discrimination is due to the data leakage particularly in data sharing with institution-based information, unauthorized access and disclosure of health information, which can lead to embarrassment and other physical and mental harms to the users (Denecke et al, 2015). What ethical issues will arise with smart healthcare, or how ethical principles apply to online health research is a challenge for current researchers, health care workers and patients. In this article, we begin to study these issues, the first part will cover the background of IoT and smart medical care, the second part will describe and analyze the ethical issues caused by smart medical care, and finally the last part will put forward the following suggestions and solutions on these problems.

2 THE VISION OF IoT TECHNOLOGY IN SMART HEALTHCARE

Internet of Things (IoT) technology is quickly changing the way people live. The concept of IoT has

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been proposed for only 30 years while its development is amazingly fast, especially in recent years. Relevant products and concepts have been launched, such as sports bracelets, smart watches, smart toys, smart cars, smart homes, smart cities and so on. Medical healthcare has always been a very important part of our life, since people's health can be ensured by using the services of the medical and healthcare industry. However, the defective public healthcare system, high expenditure and low coverage have puzzled the government and residents for a long time, healthcare issues have become one of the social principal contradictions that affect the social harmony. As the concept of precision medicine has constantly been put forward, which points out that the goal of medical development is to meet the specific needs of individuals. As a result, it is necessary to establish a smart medical information network platform system to enable patients to enjoy quality medical services with shorter treatment time and less medical expenses. The application of IoT technology has spawned a new concept of smart medical care, referred to as WIT120. IoT can help hospitals intelligently manage medical resources and help medical staff to effectively process patient's medical record information. Additionally, IoT can provide material management visualization, digitize medical information, and become a solution to the shortage of healthcare resource, which is a fundamental cause of uneven utilization and the physician-patient relationship.

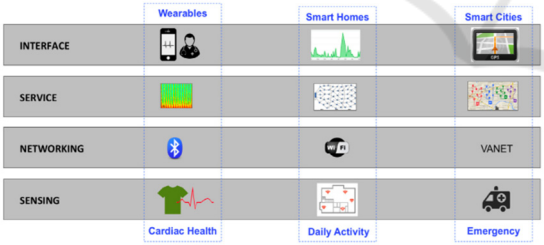

Figure 1: IoT layers.

As shown in Fig. 1, the IoT platform has a multi-tiered architecture with four different layers. The sensing layer is the first layer designed to connect the world and collect data through different types of devices. The second layer is the network layer that supports data conversion. The third layer is the service layer, which is mainly used to meet user needs by creating and processing various services. The fourth layer is the interface layer that provides interactive approaches for operators and other applications, as in this stage all information would be parsed, rendered and delivered smoothly. However, for each IoT system, potential risks can be identified such as the data privacy securities of end-users. If the IoT security is compromised, end users' data can be extracted by the untrusted authentication (Mittelstadt and Floridi, 2016). In addition, this can also lead to personal safety risks. Protecting the IoT e-health environment should be considered as a complex and severe problem (Farahani et al., 2018).

First-generation of tele-healthcare devices is relatively simple, such as smart pillboxes or communication devices, which can call the medical centers or remind users to take medicine on time, but these settings often require the users to trigger. Second-generation devices have more sensors and no longer need users intervention, such as some wireless automatic alarms. The third-generations of equipment can process, collect and analyze data, and can continuously detect the user's life (Technology meets healthcare). For example, the remote life detector, the user can use the device to test his blood pressure, pulse oxygen, heart rate, body temperature, blood sugar, etc., these data are uploaded to the server through the network. If abnormal data is observed, an alarm will be triggered, and the doctor or housekeeper will contact the user. Early intervention may reduce the occurrence of emergencies and reduce the risk of hospitalization (Mittelstadt and Floridi, 2015).

Figure 2: IoT in smart healthcare.

As shown in Fig. 2, smart healthcare can use IoT technologies to create a healthcare information platform and databases. This can interlace patients, healthcare providers, devices and medical databases together to achieve efficient interactions and communications between people, equipment and information (Farahani et al., 2018). Through the wireless network and handheld PDA to connect various medical instruments, so that medical staff can grasp the medical record information of each patient at any time, and quickly formulate the diagnosis and treatment plan. Patients and doctors can easily access medical imaging materials and medical orders

remotely. The patient's referral information and personal medical records can be accessed through any medical network in any hospitals (Ballantyne and Mulhall, 1999). Internet of Things technology makes healthcare services more convenient and cheaper as follows. First, the use of wireless medical devices can greatly reduce the financial burden of public healthcare. Second, Telehealth or self-service medical treatment is realized through digitalization, which relieves the imbalance of medical resources (Mayo Clinic, 2017). Third, medical information shared can help healthcare platforms to be developed equally across the world. Last but not the least, it is suitable with the modernization of healthcare services and the improvement of healthcare standards. This can be further improved using AI and big data services. Diagnosis can be provided to users with better quality and accuracy (Chang, 2018).

Smart healthcare is a huge and complex interconnection system consisting of three parts: the smart hospital system, the regional health system, and the family health system. The Smart Hospital System includes two major parts, one is the part of the Hospital Information System, the Laboratory Information Management System (LIS), the Picture Archiving and Communication Systems (PACS), the transmission system and the doctor workstation, which mainly focuses on the data collection, storage, processing, extraction and exchange of patient personal medical records and administrative information. Another part of smart hospital includes the application of remote image transmission, massive data calculation in the construction process of digital hospitals, and the improvement of medical service level, such as remote visit, remote visit, automatic alarm, clinical decision system and smart prescription. The regional health system is a combination of a regional healthcare platform and a public healthcare system, which is mainly responsible for collecting, processing, and transmitting all information recorded by communities, hospitals, medical research institutions, and health regulatory agencies, and formulate Electronic Health Record (EHR) to prevent and control the diseases from spreading. The family health system is the health insurance closest to the residents, who can become the source of a large amount of medical data and the terminal of all services. The existing smart medication system can already include automatic reminder time, taking contraindications, remaining doses, etc. The collection and processing of data in smart healthcare can help doctors reduce diagnosis time and improve accuracy. The users' physical condition is regularly recorded, and the doctor can judge the cause through a long-term course of disease, not just the current symptoms. At the same time, big data can also be used for diagnosis, and doctors are responsible for more complicated consultations and prescription drugs. These medical devices help to improve the users' self-management capabilities (Stowe and Harding, 2010).

The smart healthcare is convenient to both patients and medical staff, but these advantages combined with ethical issues. Recently, remote health monitoring is one of the main application example in the Internet of Healthcare Things (IoHT). Under these circumstances, the process of healthcare is shifted from hospitals back into the resident homes. Such technologies and devices include several parts such as websites of health information, on-line network, automated telephone counseling, interactive health promotion programs, and e-mail exchanges, which means the personal data is also shifted from paper into digital world. As in the world of institutional EHR, access to the personal health records (PHR) data can be exposed to inappropriate third-party, which is a threat to individuals' privacy and arise ethical problems (Sholla, Naaz and Chishti, 2017).

3 THE ETHICAL PROBLEMS

The healthcare service itself contains many ethical issues (Summers, 2012). In general, there are four principles to help people to deal with these ethical issues, justice, autonomy, non-maleficence, and beneficence (Breslin et al, 2005). In fact, in daily medical services the situation is complicated. For example, if someone wants to give up treatment to maintain the quality of life, doctors will respect patient's choices based on the principle of autonomy, but when patients are unconscious or unable to make the right choices, this is an ethical issue that is difficult to solve. There are also many controversial points about the rights to be harmless. Generally speaking, being harmful and harmless is often determined by doctors based on the diagnosis results. This judgment has subjective components that are difficult for non-professionals to understand. Whether it is harmful or not, it depends on different people's mindsets and understanding. This contradiction is one of the important reasons for the relationship between doctors and patients. According to the principle of fairness, everyone should have equal access to the same medical services. However, only 1% of Americans occupy 23.7% of medical resources, and the remaining 50% of Americans have only 3.4% of resources (Cushman et al, 2010), this is

obviously unfair. This phenomenon is mainly due to the long-term lack of medical resources and uneven distribution. The medical level and resources of big cities or developed countries are much higher than those of rural and developing countries. In other words, if a person is born in a big modern city, he or she can enjoy the high-quality services much easier while the other person in rural areas may need to spend more time and money to seek the same level of services. Children and the elderly are often groups that can enjoy extra benefits. However, in medical services, children are often more favored because considered as more important for the future, and many resources are tilted towards children for an ethical discrimination for the elderly (Organisation mondiale de la santé, & World Health Organization, 2007).

For smart medical care sector, the similar ethical issues of traditional medical care services still exist, which is combined with other new high-risk ethical issues, mainly caused using remote medical equipment, social networks and unclear laws.

3.1 Risk from Device Information Leakage

Since every operator is independent, many links can reveal user information. The low-level authorization has a big risk of information leakage, while the high-level authorization is likely to cause loss or error in the information transfer process, which will directly affect the final service quality. In any cases, the range of capabilities of mobile devices depends on manufacturer. Devices installed at home, or worn, can collect body data in real time. Many manufacturers claim that the more comprehensive the information is acquired, the higher the quality of service will be, but this boundary is not explained clearly. If hackers invade the system to obtain data information, it is difficult for users to be protected against this risk (Cushman et al, 2010).

3.2 Risk from Social Network

Strong social networks make privacy more challenging as personal data may be exposed without the owners' consent. Especially for young people, social networking is their first choice for seeking solutions (Denecke et al, 2015). It is difficult to accuse some healthcare operators if users themselves reveal their personal information in social networks. In addition, some operators provide their own social networks for users to exchange information, so that users can consult through these social groups, encourage each other, etc. Despite they can make friends on social network, privacy and personal life may have different outcomes, if disagreement has raised to higher levels that expose sensitive information or personal data leakage.

3.3 Ambiguities in the Laws

Although there are already some laws to protect information security, many laws and regulations on ethical issues are ambiguous. There is no clear indication on the subject of responsibility and the boundaries of information. For example, wrong treatment and diagnosis may cause additional pain and burden to the patient (Breslin et al, 2005). Therefore, once information leakage occurs, it is still difficult for patients to defend their rights through legal channels. For example, when a device analyzes the users' data and draws a conclusion "do exercise", but the user's physical condition is not good, then how to define responsibility if an accident occurs?

4 ETHICAL PROBLEM ANALYSIS

4.1 Ethical Issues in Different Population

The information protection of the elderly and children and some special groups (disabled, fragile or weak individuals) is also a problem. The information authorizers are regarded as guardians. However, legally speaking, their authorization has no legal effect (Slovenko, 1998). For example, how much information is given to the operator? The way analysis results are returned to the operators is unknown. Most of elderly people rather prefer to stay at home, but around 35% of the elderly live in nursing homes, which could represent potential users (Rubenstein, 2006). They may not care if they are monitored, but they are worried about whether the use of these devices will be communicated to others. They could be concerned about their reputation and the fact that neighbors could think that they cannot take care of themselves affecting his normal social interaction (Chung, et al, 2016). In order to achieve the purpose of medical uses, these devices are likely to embarrass users periodically, such as constantly warning them not to do something because of certain defects on users. Monitoring systems may force users to have more permission to process data. For example, if a user plans to get a fall alarm service, he

or she must turn on the surveillance camera and keep a 24-hour video. The system may create false data to prove that the user is better than ever to pursue a follow-up subscription services. These telemedicine monitoring may result in fewer visits by family members and psychological harm to some users. For people with chronic conditions, their physical data may be in an unhealthy state for a long time, which may lead to anxiety and depression (Stowe and Harding, 2010).

Different groups of people, countries and regions have different expectations for medical services, and their level of acceptance is different. The ethical issues of one technology is solved in one region but may still be problems in other regions (Kaplan and Litewka, 2008). In addition, the application of smart medical care will involve social issues. Many authors (Finkelstein, Speedie and Potthoff, 2006) agree that smart medical care can solve the problem of uneven distribution of medical resources. Nevertheless, the service and resource sharing of smart medical care is based on a certain technology platform, which means that users can receive these services cheaper and more conveniently for the related medical equipment. In this case, the unfairness may be more serious than the original. For example, for a citizen without a smartphone or computer, he or she has no way to use all online service platforms, so it is not us who choose to buy a mobile phone, but the environment forces us to do so. Smart healthcare may reduce hospitalization and reduce the financial burden, but so far there is not enough data to support it (Stowe and Harding, 2010). For example, there are studies that show that in some cases the cost of telemedicine is higher (Henderson et al, 2013). The benefits of this new technology may only be enjoyed by the rich, while the poor may face a scarce resource. Enterprise competition will gradually transfer funds and resources to more commercially valuable areas. The high burden of traditional industries and the loss of customers will inevitably lead to the retreat of service providers, people who stick with traditional medical services, their service quality may be reduced, which artificially distinguishes the boundaries between the poor and the rich.

4.2 Ethical Issues in Public Health

Thanks to the use of Internet technology and EHR, patient data is almost always aggregated like a data center. Is the analysis of these data a human test or a contribution to public health? We need more tools to help us to define the differences. Not using data can be unethical, because data is more valuable in the hands of medical staff, who are not only responsible for a few patients, but in charge of a patient group or even the entire public health. When he gets some conclusions from patients' previous data, whether he should use these data to benefit the society (Goodman, 2010).

There are many studies that have analyzed telemedicine to save money (Finkelstein, Speedie and Potthoff, 2006) or improve quality of life (Noel et al, 2004). These studies all try to avoid ethical risks, they only study the people with full self-care ability, and require patient who have the ability to install these facilities. Moreover, they do not use any equipment with recording or video recording or declare that the video functions they use in the study have not been approved by the government (Finkelstein, Speedie and Potthoff, 2006). In fact, video functions are essential in most telemedicine. For example, rehabilitation training can effectively help users complete the standard movements by education through video. Therefore, these studies data do not represent real usage and the data may be too optimistic (Chang et al, 2011).

5 SECURITY AND PRIVACY PROTECT SOLUTIONS

In order to protect consumer rights, we should insure the privacy from multiple ways and sources. The policy can provide a holistic protection and the setting of technical authority can prevent each operator from leaking information. Suggestions from several aspects can be presented as follows.

First, related devices causing information leakage should be identified and protected. These include unauthorized connection to sensors, medical devices, gateways, fog nodes, and mobile devices that capture, aggregate, process, and transmit medical data to the cloud. Common attacks include tag cloning, spoofing, RF interference, cloud polling, and direct connections. To respond to threats, IoT devices must always check and censor that the authentication is truly part of the Smart Healthcare cloud, and that strong authentication algorithms and key management systems are used to ignore and block unauthenticated requests. Second, IoT technologies such as RFID and wireless sensor networks can provide identity verification and tracking capabilities, and network authorization and network firewalls can be used to improve network security. All authorization methods require two-factor authentication, along with the device number and the

password set by the user on the software. Third, at the network level, common cyber-attacks include eavesdropping, Sybil attacks, Sinkhole attacks, Sleep Deprivation attacks, and Man-in-the-Middle attacks should be identified and understood (Farahani et al., 2018). To prevent such attacks, the system should use a trusted routing mechanism, along with both message integrity verification techniques and peer-to-peer encryption based on encryption algorithms. Last but not the least, training for users is also very important, for example, end users should learn how to avoid network's attacks, choose strong passwords, and not buy used equipment or equipment of unknown source.

The most important thing is that all service providers should strictly comply with the principle of autonomy priority and provide multiple choices to users. Users have the right not to use these functions or freeze sensor usage and database at any time. These monitoring devices should be less cameras when possible or replace the cameras with other technologies such as infrared sensing (Stowe and Harding, 2010). Traditional medical services cannot be eliminated, people should have the right to choose between smart medical services and traditional medical services.

6 DISCUSSION

Smart healthcare not only improves the quality of medical care, but also prevents rising medical expenses. It also enables service providers to search, analyze, and use a wealth of scientific evidence to support their diagnosis, while also benefit each group of physicians, medical researchers, drug suppliers, insurance companies, and more across the entire healthcare ecosystem. A medical information integration platform will be established to integrate business processes between hospitals and medical information. Resources can be shared and exchanged, and cross-medical institutions can also make online appointments and two-way referrals, which makes the ideal residents' medical treatment model become a reality. However, ethical issues brought by smart medical care cannot be ignored. After all, the development of smart medical care is unstoppable. Developers and governments should anticipate these ethical risks and minimize the harms caused by ethical problems. If people lose their jobs or are under discrimination due to information disclosure and depression, it is difficult to compensate the loss of the victims no matter how many advantages smart medical care have achieved. At the same time, traditional medical services should be abandoned, and the quality of services should not be reduced. Smart medical care is a part of the overall upgrade of medical services, but not a complete replacement of the medical system. The government needs to consider the needs of different groups in different regions and gradually improve the legal system. The law is the strongest guarantee for developers and users. The lack of legal enforcements will eventually hurt every participant in the healthcare system. Ideally, the smart healthcare system is managed by local governments. All personal information collected should be kept by government-administered databases because public trusts the government more than companies. The established trust relationship can also promote medical services and help develop a healthy ecosystem.

7 CONCLUSION

This article introduced the content, function and application of IoT in smart healthcare. Importance of healthcare ethics for different groups and usage scenarios were discussed in detail. The social relationship of smart medical care could be complicated, since one person's information might be obtained by many people and manufacturers without their approval, which would cause many ethical problems. Personal medical information would provide a valuable and important personal asset. The disclosure of this information could impact the user that could be discriminated within the society. The inappropriate use of information could also violate the ethical bottom line. This paper proposed some feasible solutions, mainly based on the technical aspects of IoT. However, the government's participation and intervention, and the education and training of the public could be the core solution of ethical risks. Every individual, government and policy-maker should try to implement ethics and ethical approval program together with IoT smart medical services.

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