

COMP7440 Web-based and Ubiquitous Health Care

Topic: Implementation of the QardioApp System to monitor the real-time health status for the patient with long-term diseases or elderly

Table of Content

An overview of the healthcare IT Systems for elderly	2
The introduction of elderly healthcare service in Hong Kong	2
The advantage of using QardioApp System	3
The advantage of using remote monitoring service for the patients	5
The weakness and limitations of QardioApp System functions	5
The improvement of QardioApp System functions and architectures	6
Conclusion	9
Bibliography	10

Student number: 15451682

Student name: CHEUNG Saiho

Program: MSc Advanced Information Systems

An overview of the healthcare IT Systems for elderly

For the entering of twenty-one century, the baby born rate is kept to decrease every year. especially in the developed nationals or cities, many couples do not want to have a baby in their life, because there have so many reasons for uncertainty changing of society, such as academic, job opportunity, culture and political etc. In addition, the working hour is too long and high pressure in the workload, the couples have not confident to take care of their children as well when they have a baby born (He &Chou, 2018).

Actually, the medical technology is developing very fast from the starting of past twenty years, many diseases have a different kind of medicines or medical treatments to extend the human life more and more when they are supported by IT Systems. For example, an MRI (Magnetic Resonance Imaging) system can display the high-quality image which is found out the exact location of the malignant tumor to captured in the human body inside and proposed the appropriate medical solution by the doctors. As a result, the patients can increase the survival percent higher than the past century before, or even fully radical cancer. In the latest report of the Hong Kong population statistic, the average of human aging is near ninety years old or above, it will become the elderly age society for the coming twenty years later. So, many medical devices manufacturers have produced so many IT healthcare Systems to embed in the devices and publish the product information on their website.

On the other hand, many elderly people can well understand how to use the smartphone, tablet doing some research the information about healthcare or healthy lifestyle on the internet (Loh, Flicker, &Horner, 2009). Thus, they may try to buy some smart medical devices for the home use, such as heartbeat rate monitor, blood pressure machine etc. As they know to keep their body health very important, instead of full depend on the public medical system or private doctor. In addition, many different kinds of chronic diseases always happen to elderly people who are over 65 years old, such as high blood pressure, diabetes, heart attack etc. it is a very common case and have not very urgent diseases for threatening their life immediately, so they do not need to stay in the hospital anytime. the doctor can assign the drugs and remote monitoring some critical health indexes of the outpatients via wearable healthcare device when it has connected to the internet.

In this case, these critical health indexes have included the value of blood sugar, pressure and heartbeat rate when the patients have wearied the healthcare device. It should collect this information and transfer it to the hospital patient monitoring record system. Certainly, these devices have sent this information via the smartphone Bluetooth network or wifi router, instead of the standalone device is only showing these indexes for the patients. the healthcare IT System is processing this set data to produce the data chart and keep track of abnormal pattern for their heartbeat and blood pressure, the system should automatically report this information to the doctor or caregiver.

The introduction of elderly healthcare service in Hong Kong

In Hong Kong, heart disease and high blood pressure are the most common chronic diseases in the elderly. For patients, monitoring their blood pressure and heart rate at all times is a top priority. With the rapid

development of science and technology, electronic blood pressure machines are gradually replaced traditional mercury blood pressure machine, but their influence in various factors, the measurement results are highly error-prone, making people doubt their measurement accuracy. There are two types of electronic blood pressure machines that are currently the most popular and popular on the market, namely the upper arm type and the wrist type. In fact, it can also measure the blood pressure and heartbeat rate. It is also the most suitable for use at home. Unfortunately, it is more susceptible to various factors, such as measuring blood pressure posture, cuff position etc.

Furthermore, there is no data record and pattern analysis for this type of blood pressure machine. It is not possible to transmit the information to the medical staff immediately. Therefore, there are more than one thousand nurses in the Hospital Authority (HA) in Hong Kong. They have to go the home visitation of different chronic patients for monitoring their health every day. On the other hand, the elderly healthcare service is very shortage, or even ignore. Although many universities have provided nursing and elderly medical service courses, it is definitely not good enough to fulfill the market needs. As a result, the Senior Citizen Home Safety Association has provided an emergency link service through the non-stop 24 hours with 365 days of call and care service center when the elderly people feel unwell and need to do the medical treatments in the hospital (Zhu, 2016). The center will assign the nurses and qualified social workers to provide comprehensive support when the elderly people have pressed the red button in their hand ring device. However, some emergent cases cannot press this button or call the center for using the smartphone by the elderly people when they have a heart attack or blood sugar index drop down suddenly. It is a very dangerous situation.

On the other hand, many elderly houses have not enough for the numbers of caregivers when they serve all patients in the house. especially the private elderly houses. They cannot monitor the patient's blood pressure and heartbeat rate anytime, it is sure that the patients have not received appropriate medical treatment support immediately, there may not have a good for their healthy life. In this case, some healthcare IT Systems can remote monitoring the patient's health index by the real-time. for example, Qardio (Topouchian, Zelveyan, Melkonyan, &Asmar, 2010). this system can collect two critical health information of heartbeat rate and blood pressure from time to time when the patients have worn the smartwatch and connect the smartphone, this information can be shared on the cloud servers. Therefore, the medical staff or other family members can keep track of the patient's health status anytime, it does not need to measure these indexes by the patients regularly. The advantage is reduced the heavy workload of nurses or caregivers when they need to serve a large group of patients in the hospital or elderly houses simultaneously (Appleby, 2012).

The advantage of using QardioApp System

There have five main points to describe for the system functions of Qardio apps, which is shown as below:

1. Easy for configuration, the portable blood pressure machine of QardioArm can exploit the smartphone or tablet using the wifi network when the blood pressure rate has collected to the QardioApp and need to do the data transfer on the cloud server.

2. Integration of two major mobile platforms, the QardioApp has implemented to the Apple Health Kits and full support iWatch, because it has the built-in function of heartbeat rate and blood pressure measurement, the users do not need to buy the extra blood pressure machine for their use. Besides, the QardioArm can also use the S Health on the Android device, the Android device and Apple iWatch are the most popular healthcare devices of mobile platforms around the world, it can be collected the real-time of user's health indexes to show in the mobile apps. Actually, the QardioApp can visualize the ECG signal graph and keep track of tracing the real-time pattern of heartbeat and pulse rate by the users.
3. Data sharing with multiple users, the QardioArm can be paired with up to eight smartphones or tablets via the Bluetooth network. the user can use the QardioApp to share the data with friends and family or email their results to the doctor automatically, there can make it easy to build support networks. By emailing the doctor, the QardioApp can keep informing about the patient's health indexes when the patient can press the button of one click on their smartphone or tablet. Especially the irregular heartbeat rate pattern. If the mobile apps have detected this pattern, it must send an e-mail of high priority to stay alert to the doctor.
4. Improvement of the blood pressure measurement accuracy, because the blood pressure would be not very accurate when the patient feels nervous or stressful. The QardioApp has automatically taken the three times of blood pressure measurements and average to the median value, it can play some person photo slides and microfilms in the tablet or smartphone photo albums, so the patient feels relax emotion during the moment of blood pressure measurement. It can improve the indexes reading more accurately. In addition, this data can be generated to the comprehensive chart and graph by the mobile apps, the patient can keep track of heartbeat rate and measurement history anytime, there can see how their heart and blood pressure changing whether is normally at the different activity time.
5. Sophisticated data analysis system, the QardioArm can detect various types of blood pressure, such as systolic and diastolic blood pressure, or even arrhythmias. It has approved by the FDA and clinically validated to meet America and European standard, so the measurement results are according to the world health organization chart for representing the heartbeat rate trends. The patient can get easy to understand the health status of their heart, this data has analyzed and stored in the ECG signal graph format and sorting by the day and different location or activity tracking. As a result, the QardioApp is summarized the large set of data to estimate overall health status whether would be changed in the future. Besides, the patient can give some comments to highlight a different part of the data for reference.

The advantage of using remote monitoring service for the patients

The Remote Patient Monitoring (RPM) service can be collected a large set of relevant healthcare data from the wearable IT devices, this data is transferred to the medical staff computer or mobile devices via the HIPAA Cloud Storage Hosting providers. Thus, the staff can get easy to reach with comprehensive patient data, it is suitable for disease management and provides simple medical service for the patients remotely. The realization of this new connected health device is the ultimate goal of remote patient monitoring, it can provide the same level of medical quality in the hospital when the patients have stayed at home (Jurik & Weaver, 2004).

The main benefit is that it allows patients to use mobile medical devices for routine testing and send testing results to doctors in real time without having to visit the hospital. This advantage is important for people with long-term illnesses who must communicate with healthcare professionals more frequently. The Home Care medical service can enable doctors to communicate easily and quickly between patients with no emergent diseases, such as diabetes etc. The doctor can provide advice to the patient online without waiting for the date of the appointment.

Because of people with chronic conditions can spend more time with their families than at home, instead of stay in the hospital only. the monitoring equipment can also inform patients of a serious deterioration in their health status when they need to call the emergency service as soon as possible. certainly, it can significantly improve people's quality of life.

Although many people can't go to the clinic or for some reason, or even they can't afford the doctor's fees, the doctor may not need going to their home directly. This is how healthcare organizations can get more outpatients without overcrowding.

The patients can save a lot of time and money for transportation. There is no need to go to the clinic for a prescription or ask the doctor about the results of the test. In addition, the number of unnecessary hospital visits is reduced, it can become less crowded and receive patients who need urgent help more quickly.

The weakness and limitations of QardioApp System functions

Unfortunately, the author has found out some weakness and limitations of system functions about the QardioApp, there may have a risk of patient data leakage by the strangers, so it is not very safe and delayed medical treatments service support by the patients.

For the data privacy issues, the data of blood pressure and heartbeat rate have collected by the iWatch or QardioArm devices, it has transferred to the mobile apps from time to time. However, there have not any data encryption to protect transmission through wifi network, if this network is a public, everyone can join it without a password or the central server authorization, this data would be captured or replay by the other people very easily. In the system specification, there have not declared how to identify the patient account, such as login procedure, e-health record whether is synchronized some part of IT Systems in the

hospital etc. so, the patients do not know their health information how to store in the cloud server safety and consistency.

For the inappropriate of system functions, the health data can share to other smartphone or tablet via Bluetooth network, this technology is only using in the short distance area within one or two meters when the IT devices have communicated together, instead of using the remote medical monitor. In this case, the caregiver or family members have stayed with the patient nearly, it does not need to use the smart devices monitoring their health status. In addition, the QardioApp can detect the irregular heartbeat rate and send the warning e-mail to the doctor directly, the patients need to write some comments for their abnormal case and send the warning e-mail to the doctor too. however, it is impossible to contact the doctor via e-mail when they feel unwell or fall down.

For the limitation of the data analysis system, it is only focused to keep track of the blood pressure and heartbeat rate when the patients have done any activity for their daily life. The QardioApp is according to this data to generate the ECG signal graph on the screen, so the patient can input some criteria for filtering the information what they want. However, it is belonged to personal behavior, instead of related to the medical record, or even based on the other family members. As a result, the measurement trend is according to the WHO standard, it is not good enough.

The improvement of QardioApp System functions and architectures

According to the problems of QardioApp system functions, there have proposed some solutions and discuss how to improve it as well, because it can enhance the better quality of life when the patients with long-term diseases stay in their home or elderly house.

For the parts of hardware design and data security, the QardioArm is typically belonged to the internet of thing device, because it can send and receive the data through the internet by itself (Rahmani et al., 2015). Most these kinds of devices should automatically join the wifi network during data transaction, it has a need to input login account activating the system functions by the patient. However, most patients do not have to change the default password and ignore join in which type of wifi network is more security. Thus, the devices should force to change the password when the patient has used it in the first time, the patient must input the self-defined password by themselves, so the hacker cannot guess the password and illegal to access this device very easily (U.Farooq, Waseem, Khairi, & Mazhar, 2015). The wifi network list should exclude all public and weak security protection of the network segments, such as free access wifi and WEP network. As the hackers have sniffed the data packets in these kinds of network segment very easily, the devices should have only allowed joining some wifi network segment for the patient when it has configured the strong data encryption technologies by the wifi router, such as WPA, RADIUS, or even GPRS 3G mobile network (Banitsas, Istepanian, & Tachakra, 2002).

Actually, most patients do not like to remember so many login passwords and input this information to their smartphone every time, the Qardio company should implement a new patient authentication system to replace the traditional user login system. Because of this system is a mobile application and using in the

smartphone or tablet device, it has only need to know three fields of information that can be identified the patient, phone number, mobile phone serial number and sim card number (ICCID) (Yeh, Chen, &Lo, 2013). The patient is only needed to type their login account at the first time when they are activated their user account for the remote medical monitoring system, this authentication system is automatically retrieved these three kinds of their mobile device information to the central database server. After that, the application is binding to the patient's smartphone, there have no needed to input the login account by the patient every time. the advantage is to prevent the patient's data leakage when the hackers have stolen their login account. In addition, all mobile applications send or receive the data in the remote server when they have encrypted through the data transaction channel and implemented the secure socket layer (SSL) or transport layer secure (TLS) in the web server. Although the hacker may capture a few data packets in the wifi network or web server, the packet header is encrypted by the server security token or private key, so they cannot decrypt the packets and read or modify in this content. As a result, it is ensured that the data packets are confidential and integrity during a network transaction (Elgazzar, Aboelfotoh, Martin, &Hassanein, 2012).

For the part of inappropriate system function, the QardioApp can only share the real-time health data to the family members or caregiver via Bluetooth network when the patient has turned on it in their smartphone or tablet device. Certainly, this function is not necessary and useless for monitoring patient's health, the Qardio company should design a remote monitoring healthcare system, it seems like an administration panel and can keep track of more than one patient's health status simultaneously. The advantage is to reduce the human resources in the elderly houses or daytime healthcare service centers when the patients with long-term diseases need to monitor their blood pressure and heartbeat rate regularly, such as nurses and healthcare assistants (Ahmed, 2015). So, the new system design should have implemented the web portal of the healthcare system when it can capture all data in the iWatch or QardioArm device and provide the unique system interface of central administration.

In this case, some elderly houses or daytime healthcare service centers have fully subsidized by Hong Kong Government, they can apply the technology coupons for upgrading the existing of IT infrastructure which is including software and hardware. So, these elderly healthcare sectors or HA have a price discount to purchase for these kinds of the healthcare system or even full cover by the subsidized scheme. Due to these sectors have installed the internal wifi network, the healthcare devices can use this network during data transmission when the patients have worn it on their hand. for example, there have five or eight patients in a room or ward, it can only have a tablet with Bluetooth router to connect at most the twenty devices when they send amount data at same time. the nurse is only needed to see a group of patient's health status on the monitor and does not needed to bring the blood pressure monitor device measurement one by one (Tolentino, Kim, Park, &Park, 2011).

In addition, the QardioApp should have add a new system function for emergence calling when the healthcare device has detected the irregular changing rate of heartbeat and blood pressure, instead of pressing the help alarm or send an e-mail to the medical staff by the patients, because it is too late and impossible way. This function should have provided a contact list to link up the phonebook by the patient's smartphone, because some patients have lived in their home with couple or other family members. They

can input some people contact number in the list who can take care for them, such as their son, daughter or social worker etc. while the mobile applications have detected the heartbeat or blood pressure indexes irregularly within 3-4 minutes, it should have automatically issued a warning sound and send out a warning message to the contact list of phone number, such as SMS, voice message and instant message software. This message should have contained some critical information when these persons can easy to found and give support for them appropriately, such as GPS location, medicine list currently and real-time health status etc. As a result, they can make a good decision to base on this information immediately, for example calling ambulance, police or someone who can help them at once (Suryadevara, Mukhopadhyay, Wang, &Rayudu, 2013). This function may help to save the patient's life when they live in alone, it is becoming the selling point for this mobile application.

For the problem of data analysis system, the QardioApp has only kept track of the heartbeat rate and blood pressure by the patients which is only according to their daily activities and base on the individual life style to estimate the trend of health status for the coming few days or a week. It seems like to use for the leisure purpose, instead of measurement the patient's health status for medical use. Thus, the data analysis system should have extended some medical criteria for estimating their health status in near future, such as the patient has what type of the long-term diseases, taking drugs list and treatments currently, another family member's medical record etc. It is a very critical information to estimate the trend of health status for each patient, because all patients have a different kind of medical treatment needs and impossible to use one evaluating standard for fulfilling all cases.

In Hong Kong, the HA has deployed an electronic healthcare record sharing system (EHRSS) for using in the eight hospital clusters, it is provided an extremely huge database of medical record system which is stored the patient's data of medical history, pharmacy, laboratory and radiology for all citizen (Cheung et al., 2001). Actually, the EHRSS is a healthcare information service provider and can share some parts of patient's electronic medical record to the other private clinics or healthcare industries when it has approved by them. So, the QardioApp can retrieved the information of medical record and history by the EHRSS, it is no needed to input or collect this information once again by the doctor or patient, the advantage is to avoid making a mistake and reduce the time for their input. Therefore, the threshold of irregular detection in the patient's heartbeat and blood pressure rates should have fine-tune by the different standard which is according to the medical history record.

Moreover, the EHRSS has developed the business intelligence tool by the HA's IT team, it is provided a graphic user interface (GUI) to select some criteria topics for enquiring the huge amount of data, instead of requiring input the complex SQL statements. So, the medical staff is only needed to press the pull-down menu and button on this GUI when the system has linkup related the specific of dataset, show the object relationship and generate the data analytics reports (Zhou &Dongmei Liu, 2002). In this case, the QardioApp can identify which the patient may have or had some serious diseases in this result of data analysis, it should need to keep track of their health status more frequently and linkup the HA instant message software directly. The doctors can monitor this kind of patients from time to time and purpose the best of medical treatment decision for them immediately.

Conclusion

In fact, many people with special need care are lived in the different communities in Hong Kong, including long-term diseases, disability and elderly, because the government is impossible to build the amount of elderly or disability houses for fulfilling their needs. On the other hand, the hospital is only provided a different kinds of medical treatment services when they have a serious illnesses or urgent need, it is not stayed in the hospital for a long-term. The remote monitoring system is the best way to release the extremely high pressure of public hospital service when the medical staff can keep track of their health status out of the hospital, so the healthcare system is playing a very important role in this situation.

As the development of internet infrastructure is becoming more matured, the wireless high-speed network connection and IoT healthcare devices can install in all ambulances, the healthcare system has shared the real-time of patient's body health data more efficiency and easy to summarize it for representing the graphic report. The doctor can monitor this kind of information on their mobile devices via the mobile applications, they do not need to bring many medical measurement devices for checking up all patients one by one. The advantage is allocated which the cases need to put the most priority for follow-up in the long queue, the patients can be recused the life by the doctor at once, especially in the emergency department.

However, the risk of data leakage is higher when the network infrastructure or cloud servers have not good enough the security equipments or software to protect this data in the network transmission of confidential and integrity. It is an absolutely huge disaster for the public healthcare service industry, so the IT service providers should need to consider this kind of security issues for all hospitals and healthcare service sectors, instead of providing the IT hardware service support only.

Bibliography

- Ahmed, B. (2015). *Mobile Health*, 5(October). <https://doi.org/10.1007/978-3-319-12817-7>
- Appleby, W. (2012). (12) Patent Application Publication (10) Pub . No . : US 2006 / 0222585 A1 Figure 1, 1(19). <https://doi.org/10.1037/t24245-000>
- Banitsas, K., Istepanian, R. S. H., &Tachakra, S. (2002). Applications of medical Wireless LAN systems (MedLAN). *Journal of Medical Marketing*, 2(2), 136–142. <https://doi.org/10.1057/palgrave.jmm.5040067>
- Cheung, N. T., Fung, K. W., Wong, K. C., Cheung, A., Cheung, J., Ho, W., ...Fung, H. (2001). Medical informatics - The state of the art in the Hospital Authority. *International Journal of Medical Informatics*, 62(2–3), 113–119. [https://doi.org/10.1016/S1386-5056\(01\)00155-1](https://doi.org/10.1016/S1386-5056(01)00155-1)
- Elgazzar, K., Aboelfotoh, M., Martin, P., &Hassanein, H. S. (2012). Ubiquitous health monitoring using mobile web services. *Procedia Computer Science*, 10, 332–339. <https://doi.org/10.1016/j.procs.2012.06.044>
- He, A. J., &Chou, K. L. (2018). What Affects the Demand for Long-Term Care Insurance? A Study of Middle-Aged and Older Adults in Hong Kong. *Journal of Applied Gerontology*, (March 2018). <https://doi.org/10.1177/0733464818766598>
- Jurik, A. D., &Weaver, A. C. (2004). Remote medical monitoring system. Retrieved from <https://patents.google.com/patent/US20060122469A1/en>
- Loh, P. K., Flicker, L., &Horner, B. (2009). Attitudes Toward Information and Communication Technology (ICT) in Residential Aged Care in Western Australia. *Journal of the American Medical Directors Association*, 10(6), 408–413. <https://doi.org/10.1016/j.jamda.2009.02.012>
- Rahmani, A. M., Thanigaivelan, N. K., Gia, T. N., Granados, J., Negash, B., Liljeberg, P., &Tenhunen, H. (2015). Smart e-Health Gateway: Bringing intelligence to Internet-of-Things based ubiquitous healthcare systems. *2015 12th Annual IEEE Consumer Communications and Networking Conference, CCNC 2015*, (June), 826–834. <https://doi.org/10.1109/CCNC.2015.7158084>
- Suryadevara, N. K., Mukhopadhyay, S. C., Wang, R., &Rayudu, R. K. (2013). Forecasting the behavior of an elderly using wireless sensors data in a smart home. *Engineering Applications of Artificial Intelligence*, 26(10), 2641–2652. <https://doi.org/10.1016/j.engappai.2013.08.004>
- Tolentino, R. S., Kim, Y.-T., Park, B., &Park, G.-C. (2011). A Design and Analysis Ubiquitous Healthcare Monitoring System over Wireless Sensor Network. *International Journal of Multimedia and Ubiquitous Engineering*, 6(2), 55–69. Retrieved from

http://www.sersc.org/journals/IJMUE/vol6%7B_%7Dno2%7B_%7D2011/6.pdf

Topouchian, J., Zelveyan, P., Melkonyan, A., &Asmar, R. (2010). Validation of the QARDIO QARDIOARM upper arm blood pressure monitor , in oscillometry mode , for self measurement in persons fulfilling the population as described in this paper , according to the European Society of Hypertension International Protocol re, 2–5.

U.Farooq, M., Waseem, M., Khairi, A., &Mazhar, S. (2015). A Critical Analysis on the Security Concerns of Internet of Things (IoT). *International Journal of Computer Applications*, 111(7), 1–6.
<https://doi.org/10.5120/19547-1280>

Yeh, C. K., Chen, H. M., &Lo, J. W. (2013). An authentication protocol for ubiquitous health monitoring systems. *Journal of Medical and Biological Engineering*, 33(4), 415–419.
<https://doi.org/10.5405/jmbe.1478>

Zhou, S. Q. J., &Dongmei Liu. (2002). Information and Communications Security. *15th International Conference, ICICS 2013 Beijing, China, November 20-22, 2013 Proceedings*, 2513(November), 399–410.
<https://doi.org/10.1007/3-540-36159-6>

Zhu, H. (2016). HKBU Institutional Repository, 34, 147–153.