Successful Integration of Information Technology in Healthcare: Guides for Managers

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United States healthcare ranked last compared to 10 other industrialized nations based on variables such as quality, access, efficiency, equity, and healthy lives. This paper examines the existing literature in e-health environment, examines five current case examples, then introduces seven key information technology (IT) that should be integrated into healthcare and healthcare system (HAHS) that could improve healthcare and enhances the United States position in the world healthcare system. The seven key IT include (1) the Internet, (2) big data analytics, (3) wearable computing (4) mobile computing, (5) virtual and augmented reality, (6) robotics, and (7) artificial intelligence.

INTRODUCTION AND BACKGROUD

According to a study conducted in 2014, United States healthcare ranked last compared to 10 other industrialized nations as follows: (1) United Kingdom, (2) Switzerland, (3) Sweden, (4) Australia, (5) Germany & Netherlands (tied), (6) New Zealand & Norway (tied), (7) France, (8) Canada, (9) United States. The Key variables used in the study were quality, access, efficiency, equity, healthy lives. They are briefly explained below (Unknown, 2014):

- Quality- This includes effective care, safe care, coordinated care, and patient-centered care.
- Access- Due to high cost and lack of universal healthcare for the nation, healthcare system is not available to everybody compared to their counterpart nations in the study.
- Efficiency- Due to high administrative costs, avoidable emergency room use, and duplicative medical testing, efficiency is relatively low.
- Equity- Due to high cost the healthcare system is mostly available to wealthier people and those that have full-time employment.
- Healthy lives- Measured based on mortality amenable to medical care, infant mortality, and healthy life expectancy.

The United States spends the most on healthcare compared to these other nations. Another study published in 2017 covering 184 countries indicated that U.S. per capita spends far more than other countries with similar life expectancy (Brink, 2017). We believe a proper integration of IT tools and techniques into healthcare and healthcare system can play a major role and offer a positive impact on all of the five key variables mentioned above. We define electronic health (e-health) as: The integration of IT tools and techniques into healthcare and healthcare system in order to reduce overall cost and improve quality, access, efficiency, equity, and healthy lives.

The integration of IT tools and techniques into healthcare and healthcare system in addition to improving healthcare in general, it could also improve reporting, claims processing, data management, and process automation that collectively should reduce the growing cost of HAHS.

LITERATURE SURVEY: THE LANDSCAPE OF ELECTRONIC HEALTH

A recent survey on the status, applications, deployment, challenges, and opportunities presented by e-health reveals interesting facts as follows:

- Medical mistakes in the U.S. hospitals and healthcare institutions are the third leading cause of death and nearly 98,000 people annually lose their lives in this way. E-health could significantly reduce this number (Ehteshami, et al. 2013).
- The experience of Angelina Jolie, the well kwon actress highlights how cloud computing can help address cancer by cutting the cost of genomic sequencing and enabling data sharing (Puranik, 2017).
- The 'doctor's bag of the future could be a 3D printer by allowing doctors to create or make wherever they are, in the space or a remote rural area (Strickland, 2017).
- Apple is working with a start-up called Health Gorilla to turn the iPhone into a personal hub for all of its customers medical information, this could add diagnostic data to the iPhone, including blood work, by integrating with hospitals, lab-testing companies such as Quest and LabCorp and imaging centers (Farr, 2017).
- Senate bill would pay doctors to use Facetime with patients enabling physicians and other healthcare providers to evaluate patients via video chats such as Facetime (Mearian, 2017).
- IBM Watson in conjunction with FDA are exploring blockchain for secure patient data exchange, the initial focus for blockchain will be oncology-related data exchange (a-Mearian, 2017).
- IBM Watson artificial intelligence platform has joined forces with researchers at MIT and Harvard to use genomic data to defeat drug-resistant cancers (Mearian, 2016).
- Aetna gave away 50,000 Apple Watches to its employees and subsidize others for customers. It is working with Apple on iOS-exclusive integrated health apps for iPhone, iPad, and Apple Watch devices (a-Mearian, 2016).
- Artificial intelligence could help diagnose mental disorders using machine learning in order to train software to spot verbal tics associated with schizophrenia, depression, and bipolar disorder (Frankel, 2016).
- A toy-like cardboard contraption that sells for less than $20 online from Google, as a virtual reality tool, has helped save the life of a baby who was so sick that doctors told her parents to take her home to die (Cohen, 2016).
- Because of the availability and readily access to healthcare data, government and industry leaders caution that medical data must come with context in order to provide meaningful insights for patients and researchers (Corbin, 2014).
- As the resistance reduces, IT leaders are helping more and more health care providers move to the cloud from the on premise IT computing (Linthicum, 2014).
- IBM and Pathway Genomics working on a mobile app that uses personal history and genetics to assess risks and plan exercise in order to keep people healthier (Gaudin, 2014).
- A recent Pew Internet study suggests that rising smartphone adoption in the United States seems to be motivating people to use mobile health (Eastwood, 2013).
- Health care workers in the developing world are using mobile phones to address critical health needs ranging from maternal mortality to HIV testing to clean water (Kim, 2012).

- By filtering through 2 billion public tweets, John Hopkins University scientists discovered health patterns, including misuse of medications (Samson, 2011).
- IoT medical devices will play a major role in healthcare system, according to recent surveys, healthcare providers, manufacturers, and regulators believe cybersecurity risks of IoT medical devices and connected legacy systems are a top security concern (Kawamoto, 2017).
- Many hospitals transmit health records unencrypted due to lack of budget and personnel to address security concerns (b-Mearian, 2016).
- Hackers want your healthcare data which is much more valuable than credit card information (Rashid, 2015).
- California DOJ report on data breaches shows most losses in healthcare revolve around stolen devices, due to weak use of encryption that, poses greatest risk to healthcare data (Yegulalp, 2014).

The following five case examples set the stage for our presentation.

Case #1

Based in St. Louis, Missouri, Express Scripts provides pharmacy benefits management. It processes nearly 1.5 billion prescriptions for approximately 100 million consumers per year. The company constantly analyzes its massive amount of data on prescriptions and insurance claims in order to speed up delivery, reduce errors, and increase profitability. Big data analytics has enabled Express Scripts to quickly find out if customers are filling their prescriptions through mail order, which is cheaper, or going to a retail pharmacy. For customers not using mail order, the company can intervene and provide them with cost options. By using analytics, the company is also able to be proactive and present customers who are taking drugs on a long-term basis with cost alternatives. Express Scripts has recently expanded into predictive analytics with a system called Screen Rx. The goal of the system is to screen and identify those patients with chronic diseases (such as high blood pressure, diabetes, or cholesterol) who are not sticking with their prescriptions. This system uses 400 factors (such as family history, past diseases, gender, and where the customer lives) to identify these patients and then offer proactive recommendations. Nonadherence is the most expensive healthcare-related problem in the United States, with an annual cost of over $317 billion. The Screen Rx system is able to bring this cost down by intervening proactively (King, 2013).

Case #2

According to an article in InfoWorld, only 9 percent of U.S. hospitals were using even a basic form of electronic health records (EHR) in 2009, but that has changed. For example, Kaiser Permanente, a managed care consortium with over nine million members, implemented an EHR system that became fully operational in 2010. It took Kaiser 10 years to implement its system, with a total cost of $4 billion ($444 per member). The Kaiser system, which covers every department and every patient, is called HealthConnect, and it uses data mining and analytics to improve patient service and reduce their bills. For example, the system reminds a patient about a particular test or a need to refill a prescription. According to Kaiser, duplicate testing is approximately 15 to 17 percent of total healthcare costs, and Health Connect eliminates this cost by integrating all the patient's medical records, including X-rays and ER visits. The system also allows patients to access their medical records (including lab results) from iOS and Android devices, and they can e-mail their doctors directly through the system. Kaiser has already launched the next phase of its EHR system, Health360, which embraces the latest in mobile technology (Snyder, 2013).

Case #3

3D printing technology is increasingly being used in the medical field to improve patient care and reduce medical cost. They are also being used for presentations, media events, and other medical PR activities. 3D printing lowers risk and cost of complex surgeries. Boston Children's Hospital has used the technology to assist surgeons, doctors, and medical students; it helped a neurosurgeon save the life of a 4-month-old. Cincinnati Children's and New York-Presbyterian Morgan Stanley Children's hospitals have used this technology to print organs, such as hearts made from their patients' CT or MRI scans for practicing complex surgical procedures ahead of time. A 3D-printed model of a 5-year-old child at Miami's Nicklaus Children's hospital helped surgeons know exactly how to operate before the first incision (Lee, 2018). The technology also helped save the life of a 56-year-old mother of three with a brain aneurysm at Kaleida Health's Gates Vascular Institute in Buffalo, New York. 3D printing could help the medical field in the following areas, (Meskó, 2018) such as creating tissue with blood vessels; low–cost prosthetic parts; prescription drugs; tailor-made medical sensors; medical models, such as cancerous tumors; bone that promotes the growth of bone in any shape; heart valves; ear cartilage; medical equipment; cranium replacement; synthetic skin; and organs such as the liver, heart, and kidney.

Case #4

At 5 feet, 4 inches, and 140 pounds, the RP-VITA (Remote Presence Virtual 1 Independent Telemedicine Assistant) by iRobot Corporation is the first robot to receive FDA clearance for use in hospitals (Unknown, 2013). To make the robot resemble humans as closely as possible, it has a video screen for a head, a microphone and speaker for a mouth, and two high-definition cameras for eyes. One of its functions is to assist doctors in making hospital rounds remotely. Controllable by a tablet computer using a wired or wireless network, it is able to move around and is intelligent enough to avoid obstacles. RP-VITA does not offer medical advice, nor does it treat patients. Instead, it is used by doctors and nurses to communicate with their patients. It can also be used with InTouch Health's cloud service to provide doctors and nurses with real-time electronic medical record information. The robot is also able to connect with diagnostic devices such as otoscopes for examining the inside of the ears; it can also perform an ultrasound (Mearian, 2012).

Case #5

Medical devices that are controlled by computer software—from heart monitors and pacemakers to mammogram and X-ray machines—are new targets for computer viruses and malware (Talbot, 2012). This could put patients at risk, although no injuries or deaths have been reported so far. The Food and Drug Administration (FDA) is warning the manufacturers of medical devices about the problem and is requesting them to review the parts of their security plans that are related to these devices when they seek approval from the government agency. In October 2016, Johnson & Johnson warned patients that use its insulin pumps to exercise cushion as it has learned of a security vulnerability that a hacker could exploit to overdose diabetic patients with insulin, although the risk is low (Finkle, 2016). A Department of Veterans Affairs report has shown that 327 devices at VA hospitals have been infected by malware since 2009. In January 2010, a VA catheterization laboratory was temporarily closed due to infected computer equipment that is used to open blocked arteries. And in a case at a private Boston Hospital, computer viruses exposed sensitive patient data by sending it to out-side servers. The increased applications of electronic record systems as a part of the 2009 stimulus package is adding to this risk. In addition to privacy issues, hackers can change patients' medical records and treatment plans. If the system does not have a strong login access, some patients can access a system and alter their own medications, such as those taking narcotic substances. Hackers could use Shodan, a search engine for locating Internet-connected devices, using terms such as "radiology" and "X-ray" (Niccolai, 2015). Manufacturers must improve the security features of these devices, making them more difficult for hackers to break into. And there needs to be close coordination between the manufacturers and healthcare providers to further enhance security. Also, hospitals and medical facilities must make sure that all the software running these devices is up to date and any updates have been installed. Finally, these devices must be blocked from Internet access (Weaver, 2013).

With this background information, now we concentrate on the seven key IT, assess the security and privacy risks, and then offer a plan for implementation.

INTEGRATION STEP #1- THE INTERNET

With patient records stored on the Internet, healthcare workers can order lab tests and prescriptions, admit patients to hospitals, and refer patients to other physicians more easily; also, test and consultation results can be directed to the right patient records automatically. All patient information can be accessible from one central location; finding critical health information is faster and more efficient, especially if a patient falls ill while away from home. Electronic medical record systems offer some unique advantages including the following:

- Improve patient care
- Increase patient participation
- Improve care coordination
- Improve diagnostics & patient outcomes
- Offer practice efficiencies and cost savings
- Solve what medication are you taking dilemma
- Enhance sustainability and promote "going green" phenomena

However, these systems have potential problems involving information privacy, accuracy, and currency. Health-related Web sites could play a major role in patient awareness and self-diagnosing for patients in particular those in remote and hard to reach areas. Popular health-related Web sites include:

- Yahoo! Health (http://health.yahoo.net)
- National Institutes of Health (NIH) (www.nih.gov)
- WebMD (www.webmd.com)
- MedicineNet (www.medicinenet.com/script/main/ hp.asp)

There are other uses for health care Web sites. Telemedicine, for example, enables medical professionals to conduct remote consultation, diagnosis, and conferencing, which can save on office overhead and travel costs. In addition, personal health information systems (PHISs) can make interactive medical tools available to the public. These systems use public kiosks (often in shopping malls) equipped with Internet-connected computers and a diagnostic procedure that prompts patients with a series of questions. These systems can be useful in detecting early onset of diseases (Ruiz, 2009). In addition, virtual medicine on the Internet enables specialists at major hospitals to operate on patients remotely. Telepresence surgery, as it is called, allows surgeons to operate all over the world without physically traveling anywhere. A robot performs the surgery based on the digitized information sent by the surgeon via the Internet. These robots have stereoscopic cameras to create three-dimensional images for the surgeon's virtual reality goggles and tactical sensors that provide position information to the surgeon. The Internet also facilitates communication among patients, doctors, and health providers. It enables remote monitoring and provides tools for "Doctors on Demand" where doctors and psychologists are able to provide virtual visits for less than $40. Clinical groupware is another application of the Internet where health providers are able to integrate and coordinate the data provided by every member of the healthcare team, from the doctor to the patient (Kibbe, 2009).

INTEGRATION STEP #2- BIG DATA ANALYTICS

A study published in 2017 outlined the following five key trends and applications that big data analytics will bring in HAHS (McDonald, 2017):

- Value-based and patient-centric care
- The Healthcare Internet of Things (IoT)
- Reducing fraud, waste, and abuse

- Predictive analytics to improve outcomes
- Real-time monitoring of patients

The foundation is the existence of an electronic medical record (EMR) system that enables the capturing and storing of all relevant patients information. Big data analytics helps to implement a proactive versus reactive HAHS. Other applications of big data analytics in HAHS include (Marr, 2018):

- Prevention
- Better diagnostic
- Picking up warning signs of serious illnesses
- Help to fight diseases such as cancer
- Offering personalized healthcare
- Better and faster identification of patients at risk

The Pittsburgh Health Data Alliance – which aims to take data from various sources (such as medical and insurance records, wearable sensors, genetic data, and even social media use), with the help of big data analytics offers a comprehensive picture of the patient as an individual, in order to offer a tailored healthcare package (Leventhal, 2017). Apple and IBM are collaborating on a big data health platform that will allow iPhone and Apple Watch users to share data to IBM's Watson Health cloud healthcare analytics service. The aim is to discover new medical insights from crunching real-time activity and biometric data from millions of potential users (Marr, 2018). Big data analytics is also helping the fight against the spread of epidemics. In Africa, mobile phone location data is proving highly valuable in efforts to track population movements, which helps to predict the spread of the Ebola virus. This gives insight into the best areas to provide treatment centers and allows movement restrictions to put in place when necessary (Fabian, 2016). A Big data analytics solution has even been proposed for a cure for cancer. Flatiron Health has developed a service called the OncologyCloud, based on the idea that 96% of potentially available data on patients with cancer is not yet analyzed. It aims to take this data gathered during diagnosis and treatment, and make it available to clinicians to further their study (Marr, 2018). Personalized care or patient-centric care is one of the objectives of big data analytics by tailoring medicines to a person's unique genetic makeup – and is developed by integrating a person's genetic blueprint and data on their lifestyle and environment, then comparing it alongside thousands of others to predict illness and determine the best treatment.

INTEGRATION STEP #3- WEARABLE COMPUTING

Wearable computers are small computers embedded into many devices used daily such as cellphones, cameras, watches, and so forth. Because people usually carry these devices around, the term "wearable" has been coined to describe them. Wearable computers are increasingly being used in medical monitoring systems for providing real time health information. Wearable medical sensors used widely in hospitals and health facilities are spreading into the mainstream as tech companies increasingly incorporate them into popular handheld devices such as Apple watches and Fitbit fitness bands. Princeton University scientists are working to take these sensor technologies one step further by developing software that could one day use multiple health signs from wearable sensors to diagnose countless diseases in real-time. When fully developed, the system would warn a patient who is at risk for diabetes, as an example (Shekhtman, 2018). There are many platforms and several players in this market. The following are five popular examples:

- Apple Watch- Provides easy access to critical health information
- Google Glass—Displays information in a hands-free format; can communicate with the user and the Web in a natural language
- Nike+ FuelBand—Uses a sensor that runners can slip into their shoes to track performance
- Jawbone Up— Tracks one's movements around the clock

- Fitbit- measures data such as the number of steps walked, heart rate, steps climbed, and other personal metrics

A new type of wearable computing using ingestible sensors and implantable chips may soon become common. These devices can be used to collect information about what is going on inside a patient's body. They can be used for treating chronic illnesses and could assist the medical community in coming up with more suitable drugs faster. At the same time, these devices may create some legal issues. For instance, they could reveal that someone has a particular illness, which could result in a higher insurance fee (Thompson, 2013). The popularity of wearable devices continues to grow; in 2015 Target Corporation announced that it would be giving its 335,000 employees in the United States Fitbit Trackers as the company focuses more on wellness (Unknown, 2015). In 2016, health insurer Aetna announced that it will provide Apple Watches at no cost to its nearly 50,000 employees who participate in the company's wellness reimbursement program (Unknown, 2016).

INTEGRATION STEP #4- MOBILE COMPUTING

Mobile computing has become a familiar term because of the popularity of mobile apps. An app is designed to perform a specific task and can run on mobile devices, such as smartphones, tablets, and other handheld devices. Today, there is an app available for just about any task or application that has a general audience, including such areas as games, social media, retail, banking, finance, and medicine. Many of the apps are free; some must be purchased. As of 2017 there were over 325,000 mobile health apps available on the market for both iOS and Android devices where Android is in the lead (e-Unknown, 2018). Medical mobile apps perform a variety of tasks in HAHS. Below are a few examples (Savitz, 2012).

- Provide mobile bedside assistance and monitoring
- Improve access to care through virtual visit
- Improve patient engagement with care providers (medication reminder app, text message,…)
- Improve patient safety- an app can remind a patient to take pills, monitor side effects and transfer the information to a doctor
- Reduce Medicare fraud ($60 billion annually from Medicare) by tracking the information among all the key players

TABLE 1 lists several popular medial apps and the specific functions that they perform (Reisenwitz, 2018).

TABLE 1
SELECTED MEDICAL APPS

Name	Platform	Function
Epocrates	iOS and Android	Looks up drug information and interactions, find other providers for consultations and referrals, and quickly calculates patient's measurements such as BMI
PEPID	iOS and Android	Helps doctors to diagnose faster by suggesting possible ailments based on patient's symptoms, physical exam findings, and lab results
UpToDate	iOS and Android	Provides medical knowledge that answers clinical questions in real time
Medscape	iOS and Android	Looks up drug information based on the latest medical news
Figure 1	iOS and Android	Allows the medical personnel to view and share medical images with other physicians

INTEGRATION STEP #5- VIRTUAL AND AUGMENTED REALITY

Virtual reality (VR) and augmented reality (AR) could play a major role in HAHS. They can reduce the overall cost and improve patient engagement. AR has the potential to change healthcare and everyday medicine completely for physicians and patients alike. It can save lives through showing defibrillators nearby (a-Unknown, 2018). Google Cardboard is a VR platform developed by Google for use with an HMD and a smartphone app. The user places the smartphone inside the cardboard and views the objects through the HMD. The platform is intended as a low-cost system to encourage interest and development in VR applications. This $20 device saved the life of a baby who was missing a lung and half a heart by providing images in three-dimensional virtual reality that cannot be seen in a 3D environment. In 2016, doctors at Nicklaus Children's Hospital in Miami used the device to map out an operation that they couldn't have envisioned otherwise. Using the device made it possible to move around and see the heart from different angles – similar to being inside the heart and checking out its structure (Cohen, 2016). Other areas that AR/VR could pay a major role in HAHS are listed below:

- Used for treatment of PTSD
- Used for pain management
- Used for AR-assisted surgery
- Used by patients to describe their symptoms better through AR
- Used by pharma companies to provide more innovative drug information through AR
- Used by nurses to find veins easier with AR

INTEGRATION STEP #6- ROBOTICS

Medical robots are transforming the face of healthcare. They have been used to train medical personnel (doctors, dentists, and nurses) for several decades. They have assisted elderly patients during rehabilitation and have allowed surgeons to make smaller incisions for certain types of surgery. They have been used during the training process as dummies to mimic a live patient's feelings of pain. Microbots are being used that can scrape plaque from arteries and personal assistant robots that help care for patients. Socially assistive robots are assisting individuals suffering from dementia. As an example, since 2000, da Vinci Surgical Systems have been used in more than 3 million minimally invasive procedures (b-Unknown, 2018). In suitable cases, robotic surgery offers several advantages to patients compared to open surgery including: shorter hospitalization, reduced pain and discomfort, faster recovery time and return to normal activities, smaller incisions, resulting in reduced risk of infection, and reduced blood loss and transfusions (c-Unknown, 2018). Robotically performed surgery is costly compared with open approaches. However as the volume increases and further improvement in technology the cost is expected to go down (Unknown, 2012). Below are the top six robotic applications in medicine (Crawford, 2016):

- Telepresence
- Surgical assistants
- Rehabilitation robots
- Medical transportation robots
- Sanitation and disinfection robots
- Robotic prescription dispensing systems

INTEGRATION STEP #7- ARTIFICIAL INTELLIGENCE

There are a number of areas within the AI field that could play a major role in HAHS including expert systems, case-based reasoning, machine leaning, IBM Watson, and natural language processing (NLP). According to a recent study, diabetes is a growing global epidemic with 642 million people expected to suffer from this metabolic disease by 2040 and AI-based solutions could play a major role in treating this disease and reducing its explosive growth (d-Unknown, 2018). According to IBM Watson Health general manager Deborah DiSanzo, in four areas AI/Watson are making a big difference in HAHS (Speights, 2018):

- Managing care
- Accelerating drug discovery
- Identifying appropriate cancer treatments
- Matching patients with clinical trials

IBM and Pathway Genomics are developing an app that uses personal history and genetics to evaluate risks and recommend exercises and diet. It enables delivery of real-time, highly personalized insights to empower people to change unhealthy behaviors, allowing them to live healthier lives in ways that have not been possible before (Baum, 2016). IBM Watson also provides tools that enable doctors to battle against certain types of cancer with advanced genomics (Mastroianni, 2015). Johnson & Johnson and Sanofi are using IBM Watson with big data to identify new applications for drugs that have already been developed (Baum, 2014).

HAHS could significantly benefit from various NLP applications. NLP systems could reduce administrative healthcare costs and improve the accuracy of data. An NLP-based clinical decision support can be used to set up colonoscopy follow-up for patients. The system can extract relevant text from various files and then set a follow-up for the patient. An automated dictation system allows a doctor to read his/her diagnostic of a patient or an X-ray, and the NLP system generates a Word document to be sent to the patient or other doctors. An NLP-based system can extract clinical information from multiple reports and generate a single document for a doctor's review. It could accommodate such requests as scheduling an office visit or paying any outstanding medical bills. Also an NLP-based system can provide real-time translation with a high degree of accuracy for patients and clinicians, similar to those services offered by companies such as Google and Microsoft (Bresnick, 2018).

INTEGRATION STEP #8- RISK ASSESSMENT

As we mentioned earlier, privacy and security risks are the major concern associated with e-health systems. These systems are vulnerable to security risks outlined in TABLE 2 as well as intentional computer and network threats outlined in TABLE 3 (Bidgoli, 2016). These systems must be protected against all of these security risks and threats by comprehensive security measures outline in TABLE 4.

TABLE 2
SECURITY RISKS

Spyware and adware
Phishing and pharming
Keystroke loggers
Sniffing and spoofing
Computer crime and fraud (ID theft, industrial espionage, and sabotage)

TABLE 3
INTENTIONAL COMPUTER AND NETWORK THREATS

Viruses
Worms
Trojan programs
Logic bombs
Backdoors
Blended threats (e.g., a worm launched by Trojan)
Rootkits
Denial-of-service attacks
Social engineering
Ransomware

TABLE 4
SECURITY MEASURES AND ENFORCEMENT

Biometric security measures
Nonbiometric security measures (callback modems, firewalls, and intrusion detection systems)
Physical security measures (cable shielding, corner bolts, electronic trackers, ID badges)
Access controls (terminal resource security and passwords)
Virtual private networks
Data encryption

In recent years, ransomware has been created, which is a type of malware designed to block access to a computer system until a sum of money is paid. Hackers and computer criminals have been using ransomware to receive money from both individuals and corporations. According to Kaspersky Lab, the number of ransomware attacks targeting companies increased threefold from January 2016 through September 2016, affecting one in every five businesses worldwide. The report indicates that there was one ransomware attack every 40 seconds against companies in September 2016 (Correspondent, 2016). Recently more than half of U.S. hospitals have been hit by ransomware. Kentucky Methodist Hospital, Chino Valley Medical Center, Desert Valley Hospital, and Alvarado Hospital Medical Center are a few examples. Some hospitals may not even know that they have been a victim. Hospitals are particularly a target because they have so much critical information related to their patients (Sullivan, 2016). According to one study, 88 percent of ransomware attacks hit hospitals (Green, 2016). In March 2016, Methodist Hospital in western Kentucky was hit by ransomware that encrypted part of the hospital computer files. Hackers refused to give the hospital a key to unlock documents until they were paid a ransom. The ransomware entered the hospital network through an e-mail with an attachment. An employee opened the e-mail, and the ransomware spread through the network. The attackers demanded money to be paid in Bitcoin, an electronic money that's difficult to trace. Attackers usually keep the ransom low, around $300, to increase the chances that people will pay to get their files back. Methodist Hospital refused to pay. It shut down the infected part of the network, and they were able to bring the network back up in five days (Pagliery, 2016).

INTEGRATION STEP #9- PREPARING FOR AN E-HEALTH PLAN FOR IMPLEMENTATION

An organization's employees are an essential part of the success of any e-health initiatives, so training and education on strengths and weaknesses of this platform and security awareness and security measures are important. End users lack of knowledge and awareness of e-health policies and procedures is a key issue and it must be addressed (Bidgoli, 2018). Some organizations use a classroom setting for training, and others conduct it over the organization's intranet. Tests and certificates should be given to participants at the end of training sessions. In addition, making sure management supports the training program is important to help promote the adoption of this new technology throughout the organization. The following steps should be considered when developing an e-health implementation plan (Siwicki, 2016, Myers, 2013 & Bidgoli, 2016):

1. Set up an e-health committee with representatives from all departments as well as upper management. The committee's responsibilities include the following:
    - Developing a clear, detailed e-health acquisition and use plan.
    - Providing e-health awareness for key decision makers and users.
    - Conducting a basic cost/benefit analysis and calculating an ROI for the e-health acquisition.
    - Overseeing enforcement of the e-health policy.
2. Force software updates and work with the e-health technology providers in order to have the latest updates.
3. Define the organization's needs. A clear definition of needs will assist the organization to decide on the following:
    - Prioritizing the seven IT tools (discussed in the paper) for the integration.
    - Defining the full benefit of the seven IT tools as they relate to the organization's strategic goal.
    - Defining new areas within the seven IT tools for future adoption.
4. Post the security policy in a visible place, or post copies next to all workstations.
5. Raise employees' awareness of security problems in an e-health environment.
6. Revoke terminated employees' passwords and ID badges immediately to prevent attempts at retaliation.
7. Exit programs and systems promptly and never leave logged-on workstations unattended.
8. Limit computer access to authorized personnel only.
9. Examine security risks outlined in TABLE 2, and intentional computer and network threats outlined in TABLE 3 and offer a countermeasure outlined in TABLE 4.
10. Encrypt sensitive health data before storing them on servers.
11. Backup data files on regular bases.
12. Tell the users and employees to be skeptical: Don't click on any suspicious e-mail with an attachment.
13. Install the latest patches for all software.
14. Block popups.
15. Install cable locks on laptops, and use biometric security measures.
16. Make sure confidential data is stored on laptops only when absolutely necessary.
17. Use logon passwords, screensaver passwords, and passwords for confidential files.
18. Encrypt data stored on the laptop.
19. Install security chips that disable a laptop if unauthorized users try to access it. Some chips send out an audio distress signal and a GPS alert showing the laptop's location.
20. Have a continuity plan in place in order to get back to normal operation in case of a disaster.

CONCLUSION

This paper examined the existing literature in e-health environment, reviewed five current case examples, and then introduced seven key information technology (IT) that should be integrated into healthcare and healthcare system (HAHS). This integration should improve healthcare and enhances the U.S. position in the world healthcare system. The seven key IT include (1) the Internet, (2) big data analytics, (3) wearable computing (4) mobile computing, (5) virtual and augmented reality, (6) robotics, and (7) artificial intelligence. The paper also assessed major risks associated with e-health systems including security and privacy of medical records, and risks associated with medical IoT devices and then recommended an e-health plan for implementation. TABLE 5 shows the seven IT tools that could improve key variables (quality, access, efficiency, equity, and healthy lives) in the healthcare and healthcare system.

TABLE 5
INTEGRATION SUCCESS FACTORS

	Quality	Access	Efficiency	Equity	Healthy lives
The Internet	X	X	X	X	X
Big data analytics	X		X		X
Wearable computing	X		X		X
Mobile computing	X	X	X	X	X
Virtual and augmented reality	X	X	X		X
Robotics	X	X	X	X	X
Artificial intelligence	X	X	X		X

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