Institute of Advanced Engineering and Science

International Journal of Information & Network Security (IJINS)
Vol.2, No.5, October 2013, pp. 348~359
ISSN: 2089-3299

Automated Identification Technology and Information Security in Digital Hospitals

Lidong Wang[1], Cheryl Ann Alexander[2, 3]
[1]Department of Engineering Technology, Mississippi Valley State University, USA
[2]Department of Human Services, Capella University, USA
[3]Engineering & Healthcare Solutions, Inc., USA

Article Info

Article history:

Received Aug 10th, 2013
Revised Sep 15th, 2013
Accepted Sep 30th, 2013

Keyword:

Digital hospitals
Automated identification technology (AIT)
Barcodes
Radio frequency identification
Biometrics
Information security
Computer networks

ABSTRACT

"Digital hospital" is a modern hospital mode that strongly relies on information technology and networks. Automated identification technology (AIT) mainly includes bar coding, radio frequency identification (RFID), and biometrics. AIT has been cutting-edge technology for supporting digital hospitals. Bar coding has been widely used in collecting data and identifying patients, personnel, and equipment in hospitals. RFID has been used in identifying and tracking patients, clinicians, equipment, and drugs in hospitals. It can improve quality of patient care by reducing medical errors and improving medication security. Biometrics has much potential in authentication and information security for digital hospitals. The characteristics and functions of digital hospitals, an introduction to the applications of AIT in digital hospitals, and a discussion related to issues in information security are presented in this paper.

Corresponding Author:

Lidong Wang,
Department of Engineering Technology,
Mississippi Valley State University,
14000 Hwy, 82 West, Itta Bena, Mississippi 38941, USA.
Email: lwang22@students.tntech.edu

1. INTRODUCTION

1.1. The Concept of Digital Hospitals

Digital hospital is defined as: an acute facility incorporating the widespread use of information technology to dramatically improve the process and outcome of care [1]. A digital hospital is a well-managed, integrated, physical and digital infrastructure that provides operational optimization and clinical transformation services in a reliable, cost effective, and sustainable manner [2]. It provides IT support for health care delivery processes. Becoming a digital hospital requires defining a sound IT strategy and executing the strategy. No paper is used to record or communicate information about a patient in an all-digital hospital [3].

A digital hospital is also a place where supplies are requisitioned, tracked, and replenished electronically without paper forms. Financial transactions are electronically transmitted to payers. Payments are deposited directly to the bank via electronic funds transfer. Orders, lab results, images, and progress notes are all collected and communicated using electronic tools that capture, store, and transfer the pertinent information. Whenever a clinician needs to know something about a patient, the information is available online through whatever access means have been provided [3]. Everyday operations and record-keeping are carried out and maintained almost exclusively with computers. With an electronic record as a base, software tools that increase the accuracy of treatment can be added to improve patient outcomes and reduce costs. Medical images such as X-rays and magnetic resonance images (MRIs) are stored along with the electronic patient record and can be viewed from any PC in the hospital using a picture archiving and communication system [4].

1.2. Automated Identification Technology

Automated identification technology (AIT) automatically collects data and identifies objects using advanced devices. AIT mainly includes bar coding, radio frequency identification (RFID), and biometrics. Biometrics includes face, fingerprint, signature, voice, iris, retina, hand geometry, palm vein, and DNA recognition.

AIT has been used in criminal identification and Homeland Security, supply chain management, library systems, postal systems, inventory control, warehouse and retail service, production and manufacturing streamlining, and medical and healthcare systems.

Barcodes have been widely used in hospitals. RFID applications in medical and health care services in hospitals can greatly improve patient safety by matching the right patient with the right procedures and medications. Drug safety in the national markets can be improved through advanced identification technology such as biometrics or RFID. The drug industry uses biometrics or RFID to police theft and counterfeiting. AIT fosters digital hospitals through enhancing the functions, services, and management.

The characteristics and advantages of digital hospitals; the applications of barcodes, RFID, and biometrics in digital hospitals; and related issues in information security are presented in this paper.

2. CHARACTERISTICS AND ADVANTAGES OF DIGITAL HOSPITALS

2.1. Characteristics and Key Essentials of Digital Hospitals

Digital hospitals in the 21st century have the following characteristics [5]:

- *Full IP (Internet Protocol) design*: Network- and internet-ready, for business and clinical applications; open and secure communication from/to all places and things.
- *Comprehensive patient- and staff-centric EMR*: Patient-centric, integrated, interoperable technologies that automatically update the central electronic medical record (EMR) system. Allows timely and optimal, point-of-care clinical data collection, clinical decision support, and patient safety; supports state-, regional-, national-, and international- electronic health record (EHR) data exchange.
- *Smart building*: Internal computer systems automate comfort & safety; all alarms, elevators, heating/cooling/circulation, water, medical fluids/gases, and security systems are fully integrated and automated; building management systems (BMS) ease workload, reduce mistakes, and minimize maintenance and system failures.
- *Automated logistics*: Optimal material and human resource flows; use of robotic delivery and automatically moving drugs, supplies, and food where/when needed.
- *Eco-friendly infrastructure*: Optimal environmental impact, minimum waste production, lowest use of electricity & water, lowest operating cost.

Two key essentials of digital hospital are [5]:

- All building, business and medical equipment, computers, and software must be carefully specified in advance. Compatible interoperability specifications can greatly reduce installation and life cycle maintenance costs, reliability, safety, and satisfaction.
- Advanced internal and external networks and telecommunications. All conduit, wiring, antennas, optical fibers, connection rooms, and emergency cooling and power must be designed into the structure just like steel, electricity and plumbing.

Future digital hospital & integrated healthcare vision can be [6]:

- *Digital information*: minimize and eventually eliminate paper, film etc.
- *Digital communications*: leverage technology to facilitate better communications between patients, staff, clinicians and third party organizations.
- *Automated systems:* replace manual systems; automated processes contribute to improved clinical care and safety.
- *Interoperable systems:* single view of the patient across disparate systems, enabling new processes and optimized workflows.

- *Data at the point of care:* additional integration between IT, medical, communication and building technologies to create a real-time hospital information environment.

2.2. Advantages of Digital Hospitals

Digital hospitals increase operational efficiencies, orchestrate care inside the walls of a hospital, and extend care coordination with the physician office, to the home and to mobile consumers [6].

Advantages of digital hospitals are summarized as follows [2]:

- Are more cost effective by reducing energy and operating costs.
- Use active and designed-in techniques to achieve efficiency and environmental responsibility.
- Have the ability to respond to the occupants inside them as well as the environment around them.
- Maintain a safer and more secure workplace.
- Communicate in real-time due to supporting infrastructure (i.e. smart grid, broadband, etc.).
- Leverage real-time communication to improve clinical outcomes.

2.3. Some Technology Progress and Information Security in Digital Hospitals

Digital hospitals aim to document better outcomes. The type of data analysis required to significantly improve patient care can only happen in a digital platform. On an analytical basis, digital technology allows clinicians to conduct post-treatment reviews in a way that was almost impossible in a paper-based system. A digital hospital transformation often includes making patient data immediately accessible to any pertinent clinician within the facility or in a remote location. Many new hospitals are building in all-digital platforms, and older hospitals are increasingly switching over [7].

Digital Ward is one of the three pillars of the digital hospital foundation. The other two pillars are Digital Clinic; and TeleCare, TeleMedicine and Homecare. The patients' vital signs are captured automatically via customized monitoring devices (using WiFi and Active RFID technologies). Clinicians can view the vital signs charts online. WiFi and Active RFID technologies can be used to automatically and wirelessly recording and tracking people with whom they have come into contact within the ward, which helps to ring-fence the spread of contagious diseases outbreaks such as SARS and Bird Flu [8].

Hospital Digital Networking Technologies (HDNT), such as telemedicine, can be developed to utilize internet, mobile and satellite communication systems to connect primitive rural healthcare centers to well advanced modern urban setups and thereby provide better consultation and diagnostic care to the needy people [9].

Healthcare IT departments within digital hospitals are busy designing infrastructures that deliver the required bandwidth, storage, redundancy and security for clinical applications. Increasingly, digital hospitals are choosing an "on-demand" approach by designing data centers based on modular, scalable standard components and systems with built-in redundancy because of numerous challenges associated with legacy data centers that prevent them from achieving the desired capabilities. Digital hospitals design data centers to support electronic medical records (EMRs), the picture archiving and communications system (PACS), and *computerized physician order entry* **(***CPOE***).** Traditional data centers are prone to the single largest cause of downtime—human error because of a lack of standardized and modular components. A better choice for digital hospitals would be to follow the lead of modern IT, which has evolved into standardized, modular, redundant and hot-swappable systems [10].

The information security and privacy of the patients in digital hospitals is an important issue. When the health record of each patient is an EHR/EMR and is widely available, it can be misused [11]. A patient's medical history can be read by others due to a failure to follow confidentiality procedures or other reasons. A more basic privacy-related challenge stems from the complexity of health care delivery. It is important to determine how and which providers can access patient data. In general, only individuals with a direct medical need should be able to access files. Yet in an emergency room setting, dozens of people may need to examine a single patient's record, from physicians to nurses to interns—and speed is often necessary [12].

2.4. Case Studies about Digital Hospitals

Oklahoma Heart Hospital is an all-digital hospital in the United States. The hospital, designed from the ground up to be all digital and completely paperless when it opened its doors in August 2002, runs on Cerner Corp.'s Millennium Health Information System. Caregivers can pull up any clinical information on patients in digital form, including medical images, medication and allergy reaction records, past procedures, and consultations with other doctors [13].

PricewaterhouseCoopers has worked closely with the Indiana Heart Hospital, which opened in 2002 as an all-digital heart hospital in the United States. The goal is not simply to build a digital hospital. Ultimately, it is to create the Digital Health Community, one in which all processes and stakeholders; payers, providers, labs, pharmacies and others have significant connectivity and integration [14].

Dublin Methodist Hospital, part of OhioHealth, is opening as one of the nation's few all-digital, full-service community hospitals in the US. It was being constructed to implement a full EHR system. A computerized physician order entry system supports physicians as they make decisions and place patient orders. Caregivers can chart patient care at the bedside and check to see what was done on the previous shift. Using bar-code scanning technology, nurses will scan patients' arm bracelet IDs so bar-coded medications can be scanned and compared, ensuring they get the right dose of the right medication, at the right time, following the right route, with right documentation [15].

The Royal Hobart Hospital (RHH), Tasmania's largest public hospital and State's only tertiary referral hospital in Australia, implemented a digital medical record (DMR) in July 2006. The DMR has definitely made life easier for the triage clerks in the emergency department through reduction in retrieval of as many medical records, less storage space taken up with files; and clinical staff can now access patient information easily and quickly. The DMR has improved outpatient services. Firstly, nursing staff do not spend all day checking hard copy medical records prior to actual clinic day, reducing their workload. Secondly, in most outpatient sites, the nursing and clerical staff is not transporting heavy trolleys full of medical records to designated clinics. The DMR is accessible at any time, so if a patient has multiple appointments in one day, the clinicians are not compromising patient care as they now have simultaneous access to the patient's record [16].

Reggio Emilia hospital installed Picture Archiving and Communications Systems (PACS) as the final step towards a completely digital clinical environment completing the HIS/EMR and web/terminals for patient information access [17].

3. BARCODES-SUPPORTED DIGITAL HOSPITALS

Prevention of medication errors has, for some time, become a high priority worldwide. Bedside bar-coded medication administration (BCMA) is one of key components of strategies to prevent medication errors. BCMA is safety technology that has been shown to reduce medication administration errors. BCMA systems require that the nurse who administers the medication at the bedside should scan the patient's identification bracelet and the unit dose of the medication being administered. The system alerts the nurse to any mismatch of patient identity or of the name, dose, or route of administration of the medication. BCMA reduces medication errors and increases patient safety by ensuring the six 'rights' of medication administration: the right patient, drug, dose, route, time, and documentation [18]. BCMA systems provide a safe mechanism for delivering medications throughout the entire process, from medication ordering to patient consumption [19]. The use of barcodes to identify medications should start in the inventory and procurement stage. The use of barcodes for dispensing and administration can ensure patient safety. Electronic inventory control using barcodes can assist with product receiving and tracking assets in hospitals [20].

The Winscribe digital dictation system was used in a hospital. Each dictaphone unit had an integrated barcode reader at the top of the handset, which one uses to scan the barcode on the patient demographics label in the clinical notes. All the dictations are then automatically transferred to the secretary electronically for transcription. One can achieve high quality, efficient and accurate digital dictations [21].

Several commercial systems used the barcode technology for improved sample labeling. Barcode technology has also been applied to the pre-transfusion check [22]. A barcoded patient-blood unit identification system is ideally suited to bedside check requirements and has recently been demonstrated significant improvements in transfusion practice. To ensure that the blood unit is intended for the patient, the verification procedures were carried out separately at the transfusion service (issuing verification) and the bedside (bedside verification). In the issuing verification procedure, staff members sequentially scan barcodes of their own identification badge, blood units and compatibility labels using a handheld device. In the bedside verification procedure, transfusionists sequentially scan barcodes of their own identification badge, patient wristbands and blood units using a handheld device. If the barcodes of the wristband and the blood unit are identical, the screen of the handheld device displays "OK". Non-matching data result in a warning "NG" with an alert sound [23].

As toxic medications, chemotherapies should be treated as high risk medications at all phases of the medication-use process with safeguards along the way to reduce the potential for error. Barcode verification of the chemotherapy product is used to ensure that the correct drug is selected based on the order, as entered by the pharmacist and verified by a second pharmacist. The technician was able to scan the bar code on the medication vial at the point of preparation in an attempt to match this to the list of national drug codes (NDCs) in the database. A mismatch would produce an error message, notifying the user that he or she had selected the incorrect medication or medication concentration. The adoption of barcode technology has had an enormous effect on the safety of medication dispensing and administration. The telepharmacy system has enabled our pharmacy to transfer the benefits of bar coding into the chemotherapy preparation area. Telepharmacy and bar coding provide a means to improve the accuracy of chemotherapy preparation by decreasing the likelihood of dispensing the incorrect product or quantity of drug [24].

Sometimes, barcode scanning can fail in medical applications and health care. Primary reasons can be: the lack of a barcode on the package; poor barcode readability; and the lack of a corresponding National Drug Code (NDC) in the access database [25]. From our experience and experiments, dirty or destroyed barcodes can lead to poor readability.

4. RFID-SUPPORTED DIGITAL HOSPITALS

4.1. Advantages of RFID in Hospitals

Barcode technology has some shortcomings. Barcodes are located on the outside of items; it is easy to be damaged. Sometimes, it is not easy to prevent an unauthorized scan. This is a problem in information security. When barcode technology is applied to the bedside clerical check of blood products or intravenous medications, it requires “line-of-site”. Line of sight is also not available in most operating room (OR) cases. Bedside medical care requires that healthcare workers move and that their hands are free for patient care tasks. RFID technology allows for “hands free” use by the healthcare worker. It also allows for recording of much more information than barcodes [22].

Implementing RFID in hospital operations has the following advantages [26]:

Improved patient safety: Patients tagged with unique RFID codes would reduce or eliminate medical errors such as the administration of the wrong medication or surgical procedure.

Improved medical services: RFID does not require line of sight for reading and its ability to read many items simultaneously. RFID technology has a great potential to speed up medical treatment and helps in saving lives. RFID can also be used to track medical staff and medical equipment in an instant.

Cost reduction: In cases where it can prevent adverse events and accuracy is very critical, moving to RFID becomes a matter of patient safety, and it can eliminate malpractice costs. RFID could also positively impact costs and patient safety by ensuring that fewer unnecessary procedures are performed. There are also labor cost savings as RFID technology help automate the processes.

Improved inventory management: RFID technology can provide an accurate account of both official and unofficial inventory levels.

Barcode technology and RFID can coexist and complement each other and improve medication-use safety at a patient’s point of care. Some hospitals decided to have the “best of both worlds” by using RFID tags on its caregiver badges, patient identification wristbands, and intravenous (IV) products prepared by the pharmacy; and continue to use the less-expensive barcodes on all other medications [27].

4.2. RFID in General Healthcare Management

RFID application in hospitals have been proposed including medicine control, patients contact history, patient identification, equipment tracking, injection management, physician order monitoring, medical malpractice prevention, blood bag quality control, and operation room workflow; all of which concern primarily the safety of the patients [28].

The important data (e.g., patient ID, name, age, location, drug allergies, blood group, drugs that the patient is on today) can be stored in the patient’s back-end databases for processing. Healthcare providers (e.g., hospitals) have a chance to track patients, improve patient’s safety by capturing basic data, preventing the use of counterfeit medicine, reducing medical errors, and increasing efficiency [29]. Employee and patients’ RFID tags could indicate when a restricted area is entered. When such an event occurs, an alarm would be triggered to alert security personnel [30].

Active RFID chips permit location tracking of an object or a person, which is being used for “asset management” in hospitals, specifically identifying the location of expensive equipment. Passive RFID tags operate over a short distance. This is a distinct advantage in the bedside-safety check where proximity to the patient is essential [22].

An RFID-enabled healthcare management system was proposed. Figure 1 depicts the generic architecture of the system. It consists of three subsystems: asset monitoring system (AMS), patient registration system (PRS) and medication management system (MMS). AMS is responsible for keep tracking and locating the equipment by displaying the result in a user-friendly interface; while PRS provides a platform to patients for membership registration and for making an appointment to see a doctor in an automatic and self-service manner; and MMS ensures the medical safety and pharmaceutical safety by alerting both the doctors and nurses during the drug prescription process if any errors are detected [31].

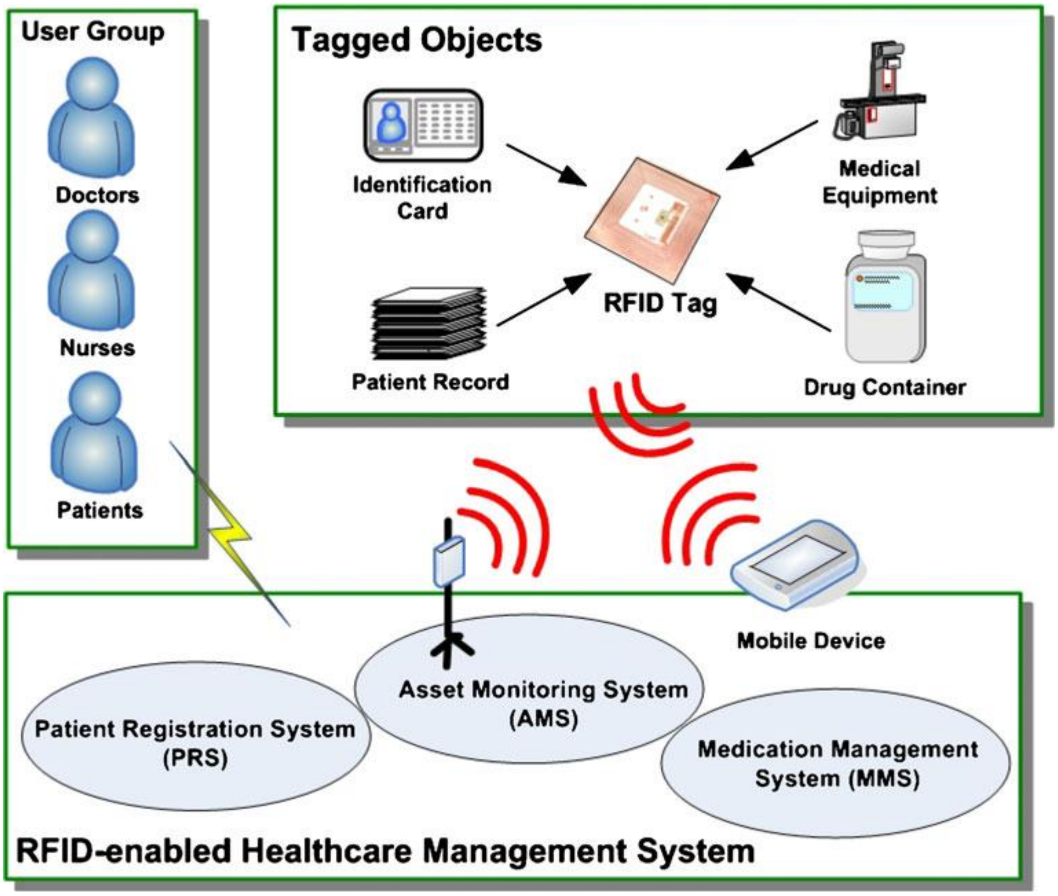

Figure 1. System architecture of RFID-enabled healthcare management [31]

4.3. RFID in Blood Transfusion or Intravenous Medication

Because intravenous (IV) bags are curved and wrinkled and the liquid inside is reflective, scanners often have difficulty reading the label's bar code. The height of IV poles creates a difficult angle for barcode scanning. Using RFID tags on IV bags "completely eliminates all the drawbacks of scanning the bag [27].

When RFID tags are used on caregiver badges, nurses and other caregivers can more quickly and conveniently authenticate their identification with the medication administration system. By adding RFID to patient wristbands, the need for the caregiver to rotate the patient's wristband into the scanner's view is eliminated because scanners can read RFID tags through most materials. If the patient is wearing a gown or has their arm underneath the covers or something, RFID can pass right through the materials and still pick up the information. Because there is no contact involved, the spread of infection is also reduced [27].

When the healthcare worker wishes to administer a blood transfusion or intravenous medication, he or she has only to wave the RFID-tagged blood or medication container in front of the bedside computer with a RFID reader. The reader reads the RFID encoded data of the intended recipient and compares this to the RFID encoded from the wristband. In less than 200 milliseconds, the system responds with a "match" or a "no match" reply [22].

The RFID tag "can be tailored to specific clinical requirements, such as monitoring the temperature, vibration, humidity, radiation, light or shock to which the package might be exposed". Temperature-sensitive tags can provide accurate tracking—in real time—to ensure that blood stored at less than optimal temperatures would not be distributed to a patient. Other benefits include the ability to track tainted blood. All these factors will aid in protecting a hospital's blood supply [30].

4.4. RFID Applications in the Emergency Room

Medical treatment safety can be improved through RFID applications in medical treatment process for the patients in the emergency room, including alert of excessively prolonged queue, patient location tracking, and alert of excessively prolonged stay, congested queue for emergency treatment and sickbed space, understaffed medical personnel, and patient's leave against medical advice (AMA) [28].

The semi-active RFID tag of UHF frequency on the patients at emergency room was used for safe emergency room service. Upon the arrival of a patient at a triage where the patient is redirected to the waiting area for an emergency room or directly goes to an emergency room, an RFID wristband is printed and mounted to the wrist of the patient. All following procedures must be reconfirmed with a reader, including diagnosis by physician, medication distribution by nurse, injection, examination, urgent operation, and etc. If a physician fails to diagnose the patient in due time stipulated by the hospital, a short message is immediately sent to the management center where high management may initiate an emergency protocol. If the patient is made to wait for excessively long time without further attention from the medical personnel, the RFID will not be read for a predetermined amount of time. The information of the patient will be automatically sent to the management center where the management of the hospital may respond accordingly, such as instructing the medical personnel to give further attention provide more medical service, or request the examination reports to be completed within a certain amount of time [28].

In the case that a patient is not yet authorized to leave, or that a patient is notified that leave is authorized before the cashier process, and the patient departs AMA, the RFID reader at the exit of the hospital will automatically send an instant message to remind the medical personnel that the patient has departed [28].

4.5. RFID in Specimen Management

Specimen management refers to all stages including sampling, specimen collection, transportation, and storage. Specimen management is a complex procedure. The starting procedure of specimen management is specimen collection and labeling. Specimen means a variety of samples such as blood, sputum, urine, or cerebrospinal fluid collected from patients for disease diagnosis [32].

The barcode has the possibility of experiencing a fatal error when it is exposed to humidity and when under volatile temperatures like those found in refrigerators or cultivation instruments. Specimen containers are put in moist environments or chemical-like substances such as alcohol during specimen collection and preservation [32].

A new specimen management system and architecture with RFID technology for clinical laboratory was designed. The system with RFID technology has advantages in comparison to the traditional specimen management system with barcode in the aspect of mass specimen processing, robust durability of temperature, humidity changes, and effective specimen tracking [32].

4.6. RFID in Infection Control

Nosocomial (i.e., hospital-acquired) infections (NI) is a major cause of morbidity and mortality in hospitals. NI rate is higher in intensive care units (ICU) than in the general ward due to patients with severe symptoms, poor immunity, and accepted many invasive therapies. Contact behaviors between healthcare providers and patients are one of the infection factors. It is difficult to obtain complete contact records by traditional method of retrospective analysis of medical records [33].

A contact history inferential model (CHIM) was established to extend the use of proximity sensing of radio frequency identification (RFID) technology to transferring all proximity events between health caregivers and patients into clinical events. Active RFID timely records the all contact events with proximity sensing. This method would help infection control in hospitals [33].

4.7. RFID Integration with Mobile Smart Phone, Wireless Sensor Network and Bluetooth

A mobile physiological patient monitoring system was proposed, which integrates current mobile smart phone, wireless sensor network, Bluetooth, and RFID patient identification systems for patient monitoring. This system enables continuous monitoring and patient identification during intra-hospital or inter-hospital patient transport. The architecture of telemedicine system with a personal physiological sensor network for patient transport monitoring was proposed. The overall system architecture of proposed telemedicine system is shown in Figure 2 [34].

The patient's physiological sensor network comprises several medical sensor nodes and a control node responsible for management of sensor network communication and communication with a remote database and physicians. A mobile smart phone or a PDA can be used as the control node. It will communicate with medical sensor nodes and using Bluetooth. Medical sensor nodes have one or more sensors (ECG: electrocardiography; EEG: electroencephalogram; and RFID tag, etc.) and capable of processing and storing data. Observed data will be forwarded to remote users using wide area networks GPRS or UMTS [34].

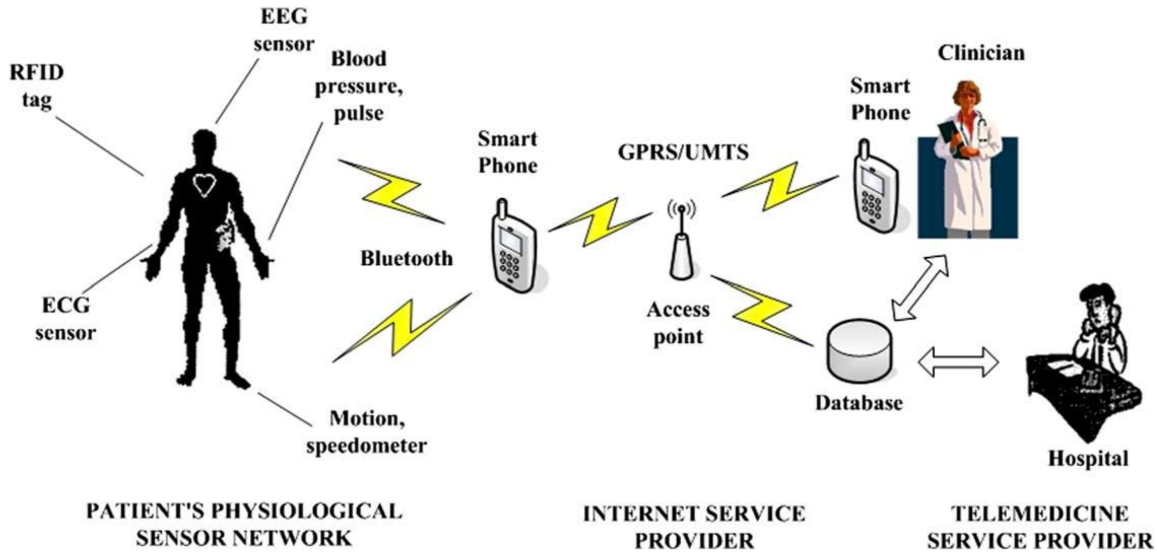

Figure 2. System schematic of a mobile telemedicine system

4.8. RFID Middleware, Data Management, and Information Security

There is an exponential increase in data volume in an RFID-based system while RFID readers pick up data on RFID-tags attached to items. A lot of noise and 'dirty data' are generated from the RFID system. The key to data management is using RFID middleware to process the data. RFID middleware standardizes ways of processing the flood of information that the tags produce, filters out redundant and unneeded information, and lowers the volume of information [35]. As a result, data is transmitted selectively in the network, making the use of such data efficient and useful [36]. Only important information is sent to applications.

RFID-based systems can fail due to several reasons (e.g. RFID tags can be destroyed accidentally or, communications can be broken due to interferences). There is a need for real-time fault tolerant RFID systems to deal with situations in which patients lives could be in danger. RFID components interact wirelessly; thus, attackers have plenty of opportunities to eavesdrop communications and obtain private data of the patients [29]. Therefore, information security and privacy are important issues in RFID systems. General RFID security and privacy threats are: eavesdropping, tracking attacks, fraudulent tags and readers, and denial of service (DoS) attacks. Tags are vulnerable to eavesdropping, spoofing, or denial of service. Unauthorized readers may access tags. The chip can be duplicated and read by anyone with a RF sniffer operating at the correct frequency. The character of RFID wireless communication can catch transmitted data through intercepted wireless signals. Data can be broadly shared, and data that is communicated can be intercepted. For this reason, RFID must encrypt information to prevent eavesdropping, modification or replacement, and misuse. The primary concern of RFID use in telemedicine is illegal use of patient information or breaches of patient confidentiality. To combat these issues, several possibilities exist for support. A randomized hash lock for security can be proposed for secure data transmission. The tag can be locked and opened with a key. Re-encrypting data using a security key can also be used to prevent data hijacking [35], [37]. Information on the person's health status can be gained by intruding on the communication channels. This can be avoided by encrypted communication protocols at the different levels of communication and encrypted storage [38].

There are three main types of RFID malware: RFID exploits, RFID worms, and RFID viruses. RFID exploits target-specific system components (such as database and web interfaces) using a host of hacking tools. An RFID worm is a program that self-propagates across a network, exploiting security flaws in widely used services. RFID tags could also be vulnerable to computer viruses. While an RFID worm relies upon the presence of a network connection, a truly self-replicating RFID virus is fully self-sufficient. Countermeasures have been presented to stop RFID malware. They include: bounds checking, sanitizing the input, disabling back-end scripting languages, limiting database permissions and segregating users, using parameter binding, isolating the RFID middleware server, and reviewing source code [39].

RFID can be integrated with other data management systems. A system was presented which integrated RFID with a patient data management system for managing patients and ensuring better control and safety procedures. The RFID-integrated system tracked treatment, drug dosage, and diet using RFID together with the classical entities in a health information system or patient data management [49].

5. BIOMETRICS-BASED AUTHENTICATIONS AND INFORMATION SECURITY FOR DIGITAL HOSPITALS

The biggest concern in the health care industry today is how to provide easy access to patient data and medical information while keeping it all secure. Any access control or security system implemented would need to accommodate heavy use by staff accessing and logging out of the data [40]. Data breaches at hospitals may cost the US health care industry as much as $7 billion a year, according to the Ponemon Institute, a Michigan-based organization that studies privacy, data protection, and information security. And that does not count the unknown cost of fraudulent use of information from lost or stolen insurance cards and drivers' licenses. Biometrics can be used to combat medical identity fraud [41].

A multitude of biometrics applications were envisioned including pharmacy medication dispensing, patient identification, registration and admissions, patient-medical record matching, infant-and parent matching, and on-site commercial transactions [43]. An information technology framework was designed to strengthen tele-healthcare delivery. The framework integrated diverse biometric sensors, adopted medical informatics standards, integrated data from existing information systems, and provided different data transmission networks to support a patient's house network despite the facilities [50].

HCA, the largest for-profit U.S. hospital chain, chose scanners using iris technology developed by Maryland-based Eye Controls for its private facilities in London over patient ID cards with magnetic strips. At HCA's British hospitals, scanners are used when patients check in, as well as in radiology and at the cashier [41]. Some hospitals are using iris recognition systems for physical access control. The systems are located at the building's front entrance and at the door leading to the main computer room in a medical center [43].

Fingerprint biometrics has been used to capture the patient's fingerprint to prove identity. Hospitals have used fingerprint scanners to reduce insurance-card fraud. Some hospitals put the Ultra-Scan fingerprint scanner in the admissions process to establish patients' identity and prevent patients from passing health-insurance cards to each other. When patients place a finger on a biometrics scanner during the front-desk registration process, the fingerprint image is captured electronically and made part of the patient's permanent record in a database [44]. As a result of our experiments, and based on our experience, fingers with sweat, moisture, water, or oil can affect the finger image quality and lead to failure in fingerprint recognition.

Barcode scanning can be used on each patient wristband and in every medication that enters the hospital, ensuring that the correct medications are administered at the right time. However, the medications themselves are only accessible after a nurse has been authenticated using finger biometrics, greatly reducing medication errors and better ensuring patient safety [40].

Non-family infant abductions have been increasing in non-healthcare locations (private homes and public facilities). Now organizations are calling for a more biometric approach to identification and protection of infant identity. A three second infant "saliva swipe" and mother fingerprint is all it takes to provide a tool to help identify and track an infant that links the mother-child parentage.

The Infant Identi' fier™, an infant identifier was used to capture the infant's saliva for DNA testing and scent recognition on one end; and provide the mother's thumbprint/fingerprint on the dual end of a thermoplastic wafer (identifier swab). This imprinted 3-D fingerprint provides for reliable maternal identification. This will link the mother and infant in one, unique biometric tool. The parents were given the Infant Identi' fier™ in a double sealed security bag and instructed to keep the bag in a safe place with hopes that it will never need to be used [45].

Hand geometry recognition, which identifies users by the size and shape of their hands, was used for accessing high-security areas. Hand geometry recognition provided both high security and ease of access for physicians [46].

Palm-vein scanners can be installed at all ingress and egress points, and implemented a patient registration and security system. Near-infrared light was used to illuminate the veins in a patient's palm and record an image of the "print," This identification method is considered highly accurate, since each person's vein pattern is unique. The palm-scanning system could be used to authenticate physicians as they move from floor to floor, and patient to patient. With palm-scanning, physicians would simply scan their palms upon entering or exiting a floor or a hospital wing [47].

PalmSccurc, a biometric palm vein authentication system, has used to control access to HER/EMR [48]. The patient then rests his or her palm on the scanner, which illuminates their unique vein pattern with a harmless, near-infrared light. Using a biometric template, the scanner runs the vein pattern through an algorithm and stores the patient's identifying information in an SQL database. When the patient returns for subsequent care, registration staff asks for the date of birth and the patient scans his/her palm. The vein-scanning system matches the patient's identification to the pattern and scripts the information back to the HER/EMR to begin registration. A correct match between the patient's palm and the medical record reduces the chances of identity theft or misidentification. Palm scanners enhance patient safety [49].

6. CONCLUSION

Digital hospitals increase operational efficiencies, making patient data immediately accessible to any pertinent clinician within the facility or in a remote location, and finally improve patient safety. barcoding, RFID, and biometrics strongly facilitate digital hospitals. Barcoding has been widely used in hospitals. It requires line of sight and the reading range is short. RFID does not require line of sight. Based on our experiments and experience, RFID can perform remote readings and multiple tag readings at the same time; it has advantages over barcoding in efficiency, reading range, and storing memory. RFID has been used to track patients, doctors and expensive equipment in hospitals in real time. RFID tags can be attached to the ID bracelets of all patients, so their location can be tracked continuously from admission to discharge. It can also be used to improve the security of a hospital or treatment center by controlling facility access. Biometrics is a powerful tool in authentication and information security for digital hospitals. Fingerprint, iris scanning, hand geometry, palm vein, and DNA, etc. have been used in hospitals. Information security and privacy is an important issue due to the number of fraudulent cases. The solution to this problem depends on advance technology as well as government policy and education.

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BIOGRAPHIES OF AUTHORS

Dr. Lidong Wang is the Director of the Automated Identification Technology (AIT) Program and an Associate Professor in the Department of EngineeringTechnology at Mississippi Valley State University, USA. His current research interests include: biometrics and radio frequency identification (RFID) in medical applications and health care. He has published over 45 papers in various journals. Dr. Wang has been invited to review papers by over 10 professional journals. He has also been invited by four professional journals to act as their guest editor. He has been the Editor-in-Chief of the International Journal of Automated Identification Technology (IJAIT) for five years.

Ms. Cheryl Ann Alexander is a graduate of the University of Phoenix where she earned a dual Master's degree in Healthcare Administration and Nursing, and she is currently a doctoral candidate at Capella University where she will graduate soon with a degree in Public Service Leadership. She is Chairman of the Board of Engineering & Healthcare Solutions, Inc., a nonprofit research and consultant firm located in Greenwood, MS, US, which promotes engineering solutions as methods to reduce costs and errors in healthcare management and improve quality care. She has been awarded several honors for her work in critical care in 2012, including the American Critical Care Association Continuing Education Scholarship 2012. She has extensive clinical knowledge in a wide variety of clinical backgrounds, and a firm grasp of engineering and technology concepts through continuing education and workshops. She is a member of both engineering and healthcare organizations, and is working as guest editor for a leading journal in engineering.