Adapting RFID Technology for Implementation of a New Birth Record in Jordanian Hospitals

Bassam AL-Mahadeen

Department of Computer and Information Technology,
Tafila Technical University
Tafila, 66110, Jordan

Abstract

This paper introduces a new integrated clinical record in Jordan using the RFID technology, where currently no clinical report links antenatal, birth and postnatal care for women. As a result no continuity of information is provided to clinicians nor are there national statistics on trends, or performance of hospitals around birth. The paper is based on a study conducted in the Jordanian Ministry of Health, the maternity wards and registration departments of three hospitals in Jordan and in the Maternal Child Health Centers located near these hospitals [1]. Lack of active follow-up to ensure the best service for antenatal, birth and postnatal care for women is the main problem. An RFID model for managing the clinical record for maternal child was proposed. The model is valuable to policy makers and program implementers in strengthening implementation of programs and activities to improve maternal child care services. The statistics yielded from the proposed RFID model is of particular importance to help fulfill this need. The proposed maternal child management system is expected to control the health care cost, improve the care quality, and provide a comprehensive strategy for restructuring maternal child care delivery system.

Keywords: *RFID technology, Maternal Child health, RFID reader, RFID tag.*

1. Introduction

Jordan, is a developing country located in the Middle East, has one of the fastest growing populations in the world. Between the two censuses in 1979 and 1994, the population grew from 2.1 to 5.1 million people, an average in-crease of 2.7 percent annually. At this rate, the population of Jordan will double in 25 years. The Government of Jordan (GOJ) has recognized that this will place tremendous strain on Jordan's health services [2]. Jordan faces several issues including less than fully functional public health systems, a significant unmet demand for high quality health care services and information, and a significant increase in the prevalence of chronic diseases. There are three sectors in the provision of health-care services in Jordan: the public, the private and the international sectors. The public sector is composed of the Ministry of Health, the Royal Medical Services, the University of Jordan and the Social Security Organization. Most hospitals provide primary and secondary health services with referrals of some patients to the tertiary hospitals located in the capital city of Jordan, Amman. Primary Health Centers provide healthcare services that include maternal and child health services, school health services, and health education [2][3].

A comprehensive clinical information system for maternal and child health care is of great importance in Jordan now. Jordan hosts millions of refugees from Iraq, Palestine, and Syria. There is no database or electronic medical history for maternal and child health. Building a computerized and databases to record and follow up maternal child health will provide policy makers with online statistics about the current problems that face them and the actual needs of their medications. Comprehensive vision about health problems and their distribution over geographical areas could also be provided.
Radio-Frequency Identification (RFID) technology is an innovative technology with many applications in a number of fields. Academic research into RFID has proliferated significantly over the last few years.

A typical RFID system consists of tags and readers, application software, computing hardware, and middleware. An RFID tag consists of an integrated circuit with memory, which is essentially microprocessor chip. RFID tags can be active (with batteries) or passive (without batteries). The tag has an identity (ID) that can be broadcast to a reader that is operating on the same frequency and under the same tag protocol [4][5][6].

An RFID reader is a device that can read data from and write data to compatible RFID tags. Communication between tag and reader enables the location information of an item to be recorded and transferred to a server through a computer network, thus allowing the movement of the item to be tracked and traced. To ensure the compatibility of the communication, the tag and reader

must work at the same specified working frequency and comply with specific regulations and protocols. Readers come in four types: handheld, vehicle-mounted, post-mounted, and hybrid [5][7].

The communication infrastructure is a collection of wired and wireless network communications that carries out a series of information transfer actions that deliver the data that are stored in a tag to the reader.
The health care sector can obtain great benefits from the deployment of the RFID technology. By using RFID tags and readers, it will be possible to improve the efficiency of the system, to locate and track people and material easily, and the storage of patient data will become easier [3].

2. Identifying Patients

Patients are the most important pieces of the health care. Thus, many efforts of the scientific community and inventors are focused on them. In this paper we are trying to introduce a new integrated clinical record in Jordan using the RFID technology where currently no clinical report links antenatal, birth and postnatal care for women. As a result no continuity of information is provided to clinicians nor are there national statistics on trends, or performance of hospitals around birth. The study will be based on a study conducted in the Jordanian Ministry of Health, the maternity wards and registration departments of three hospitals in Jordan and in the Maternal Child Health Centers located near these hospitals [1].

The study used an exploratory, descriptive design and practice-research engagement to investigate and report on the process of change to improve and implement the new birth record. Engaging practitioners in research achieved system reform as clinicians improved their quality of reporting, managers developed more effective hospital performance and policy makers were provided with the basis to establish a national maternity data monitoring system. Quantitative and qualitative audit data demonstrated improved clinical reporting, organizational development and sustained commitment to the new record from clinicians, managers and policy leaders [2].

A wide variety of methods have been used to identify patients when they are in hospitals or in Maternal Child Health Centers. One of the most popular methods is based on using a wristband. Patient wristbands can be checked during the practitioner's visit or before undergoing a sampling or an operation. The tag may store data ranging from a single pointer to a record in the hospital information system database, to a complete dataset about the patient [3].
A second feature of RFID technology is the implementation of active tags in a WiFi environment: this enables a more effective patient location and real time monitoring of patient flows and of their progress in the care process, thus also acquiring important data for process and layout optimization. RFID tools are important means enabling new advanced applications and tools for coordinating wards, optimizing operational costs and reducing patient waiting time [3].

The aim of such data collections is to improve the health of mothers and babies by monitoring maternal and child health namely, antenatal, postnatal and delivery care, childhood vaccination and common childhood illnesses and their treatment, as well as providing ongoing information to service providers, program implementers, and policy makers about trends and patterns in the health status of mothers and babies to improve their health services.

3. RFID Technology

RFID stands for Radio Frequency Identification and it is a term that describes a system of identification. RFID is based on storing and remotely retrieving information or data [8]. A typical RFID system consists of tags, readers, application software, computer hardware, and middle-ware [5][6], as depicted in Fig. 1.

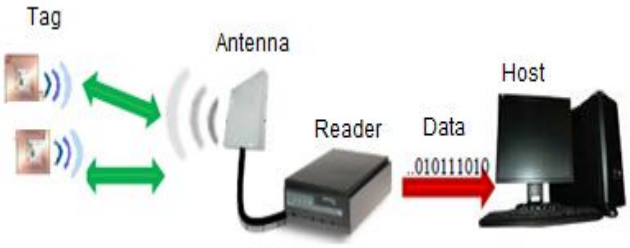

Fig. 1. Main Components of an RFID System

RFID tags store unique identification information of objects and communicate the tags so as to allow remote retrieval of their ID. RFID technology depends on the communication between the RFID tags and RFID readers. The range of the reader is dependent upon its operational frequency [6] [7]. Usually the readers have their own software running on their ROM, and they also can communicate with other application software to manipulate these unique identified tags. Basically, the

application which manipulates tag deduction information for the end user communicates with the RFID reader to get the tag information through antennas [7]. RFID middle-ware that interprets tag information to communicate it to the application software, and application software are integrated in a manner to form an RFID solution [8].The main components of an RFID system are:

3.1 Tags and antennae

RFID tag consists of an integrated circuit with memory, which is essentially a microprocessor chip capable of holding stored information [6]. RFID tags can be active (with batteries) or passive (without batteries). The tag has an identity (ID) that can be broadcast to a reader that is operating on the same frequency and under the same tag protocol. RFID antennae collect data and are used as a medium for tag reading between the tag and the reader [9]. As well, RFID antennae have a reading range both sideways and in front of the antenna. The antennae draw energy from the reader's signal to energise the tag and send the data that are received from the readers.

3.2 Reader

RFID reader works as a central place for the RFID system [8][9]. RFID reader can read data from and write data to compatible RFID tags. Upon receipt of the RFID reader's radio signal, a tag sends information stored in its memory back to the reader. The reader then converts the data into digital information and forwards it to the appropriate application. Communication between tag and reader enables the location information of an item to be recorded and transferred to a server through a computer network, thus allowing the movement of the item to be tracked or traced [4].

3.3 Communication infrastructure

Communication infrastructure is a collection of wired and wireless network communication that carries out a series of information transfer actions that deliver the data that are stored in a tag to the reader. Adapting RFID in healthcare may have a great potential to reduce operating costs, and improve medical services and patient safety. RFID allows the wireless storage and automatic retrieval of data. Although tagging objects, such as medical equipment, drugs, etc., is a potential area for RFID in hospitals, the tagging of patients involves both more value and more challenges, data collected from tagged patients may help improve medical processes, decision making, and re-source management. Equipment tagging may be easier in that experience from manufacturing and retail is already available. Tagging people is more challenging because it involves patients, physicians, medical know-how and practices, and organizational issues [9].

4. RFID Technology in Healthcare

RFID technology can provide new capabilities and efficient methods for several applications in healthcare. This technology is being used extensively for access to medical literature, patient tracking, drug information, e-prescribing and medical research [10][11]. In addition, using these devices, clinical data can also be collected and stored at the point of care, which guarantees accurate data entry. The collected data can also be easily networked to a centralized portal or database system or transferred to a different medical site, which insure accurate and quick clinical delivery [9]. As a result, there is recently an international trend to incorporate PDA and Smart phone as well as other wireless technology in modern clinical practice, to increase the efficiency, cost effectiveness and quality of healthcare [10].

The RFID system should enable the integration and optimization of resources while improving accuracy and minimization of patients' transition time (the time needed for a patient to get service), and this leads to improvements inpatients' services. The application of RFID in healthcare could save important resources that can further contribute to better patient care [12]. Moreover, RFID applications could reduce the number of errors by tagging medical objects in healthcare setting such as patients' files and medical equipment tracking in a timely manner. Improving the situation for patients care by integrating medical objects involved throughout the patients' care is also an advantage of RFID.

Adapting RFID technologies in maternal child health is expected to promote safe, reliable, and appropriate care as well as positive patient-provider-administrator's interactions [12]. Medication errors and adverse drug events could be prevented by building a safer healthcare system. Such technology could be used to reengineer the inpatient medication process to improve the efficiency of hospital management and increase higher quality of patient care [13][14][15]. The RFID technology can facilitate the building of the u-healthcare (ubiquitous healthcare) environment, provide strategic services to patient-centered recording, use medical data for cooperative care, process integrated decision support through current medical knowledge and comprehensively use patient data for research and healthcare reporting [8].

The use of RFID technology together with a wireless networking system allows medical assets within the hospital to be managed and controlled from a fix location. Medical assets can be tracked and monitored to control the misplacement of resources and reduce their loss, achieving an optimal use of resource management. It provides direct and continuous identification, position and tracking of patients, drugs and assets at the right time all the time. A standardized RFID software network architecture is used to convert the data gathered by RFID into information. This information is then processed by the backend system into useful knowledge that could be used in the organization's decision-making process.

5. The Proposed System

There are no electronic patient records in the public hospitals, or computer system to manage the process of Maternal Child Health. The result of this research is to build a health care model to implement a new birth record in Jordanian healthcare sector. The basic idea of the system is to equip each clinic with RFID reader. Doctors could also be equipped with an RFID reader integrated in mobile phones.

In the proposed model, as shown in Fig. 2, each woman during the first antennal visit is given an RFID tag with a unique patient ID. All medications for antennal, birth and postnatal are documented on the dedicated database of maternal and child health, with their patient information.

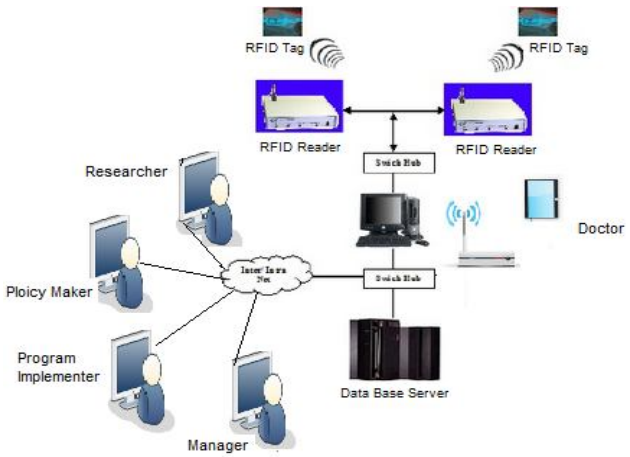

Fig. 2. RFID Infrastructure of Maternal Child Management System

When a woman comes to doctor for her next follow-up visit, the system's database is accessed for validation using the patient's tag, and the patient's information and profile are retrieved automatically to the computer or mobile device as shown in Fig. 3.

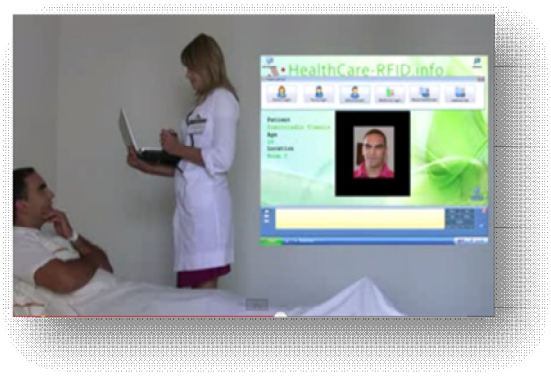

Fig. 3. Loading Patient's Profile

In addition, when doctors visit their patients they obtain their medical history in the mobile device just approaching to them. Crucial errors can be avoided, thanks to better monitoring of all operations inside the hospital, e.g. avoiding an error in prescribing the wrong medicine. Since women can obtain care from several resources, multiple (profiles) answers were allowed. The proposed system will help doctors to come up with a common patient profile.

Antenatal care can be more effective in preventing adverse pregnancy outcomes when it is sought early in pregnancy and continues through to delivery. The system can use short messaging service (SMS) through mobile phones, as shown in Fig. 4, to communicate women to remind them for the next visit, in addition to provide counseling services that impact the survival of both mother and infant. The system can be used to identify women whose babies are at risk due to non-use of maternal health services, especially those population lives in rural areas and where physical barriers pose a challenge to healthcare delivery.

The proposed RFID system will supersede the current paper-based management of maternal and Childs medications, and will guarantee an optimal way for the management of their medicines, achieving better health quality for patients. It is proposed that the system will also provide on-line and immediate up-to-date statistics for stake holders and policymakers about patients, illnesses,

and the extent of diseases conditions in the population. As well, the system will provide more accurate predictions about medication quantities required for the next coming months. Thus it is hoped that patients will avoid illness consequences due to medication shortages.

Fig. 4. Mother Notification Message

6. Conclusions

This proposal is mainly concerned with demonstrating the significance of introducing and integrating RFID technology into Maternal Child health in Jordanian hospitals. The employment of this model, which centers on replacing paper-based records with electronic records, would be of crucial significance, the statistics yielded form the model, will help policy makers and program implementers in strengthening of programs and activities to improve maternal child care services, and expected to improve the care quality, and provide a comprehensive strategy for restructuring maternal child care delivery system.

A technical explanation of how this model operates was provided, though I strategically aimed to communicate the technical details in a non-technical way as a way to guarantee the reception, on the part of non-specialists, of the signal of this piece of research.

References

[1] R. Khresheh, and L. Barclay, "Implementation of a New Birth Record in Three Hospitals in Jordan: a study of health system improvement". Health Policy and Planning, doi:10.1093/heapol/czm039, 2008.

[2] R. Khresheh, "Investigating the feasibility of introducing a consolidated birth record: the first step in an information system that identifies outcomes and enables improvements", Ph.D. Thesis, University of Technology, Sydeny, 2006.

[3] B. AL-Mahadeen, "Using RFID Technology for Chronic Care Management and Improvement in Jordanian Public Hospitals", Journal of Computing, Vol. 3, Issue 1, January 2011.

[4] J. Schwierenl, and G. Vossen, "A Design and Development Methodology for Mobile RFID Applications based on the ID-Services Middleware Architecture", IEEE Computer Society, Tenth Inter-national Conference on Mobile Data Management: Systems, Service and Middleware, 2009.

[5] S. Tzeng, W. Chen, and F. Pa, "Evaluating the business value of RFID: Evidence from five case studies", Int. J. Production Economics, 112, pp. 601–613, 2008.

[6] E. Ngai, K. Moon, F. Riggins, C. Yi, "RFID research: An academic literature review (1995–2005) and future research directions", Int. J. Production Economics, 112, pp. 510–520, 2008.

[7] K. Ahsan, H. Shah, P. Kingston, "RFID Applications: An Introductory and Exploratory Study", IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 1, No. 3, pp. 1-7, 2010.

[8] J. Bohn, "Prototypical implementation of location-aware services based on a middleware architecture for super distributed RFID tag infrastructures", Pers Ubiquit computing, Vol. 12, pp. 155-166, 2008.

[9] W. Shang-Wei, C. Wun-Hwa, O. Chorng-Shyong,L. Li, C. Yun-Wen, "RFID applications in hospitals: a case study on a demonstration RFID project in a Taiwan hospital", Proceedings of the 39th Hawaii International Conference on System Sciences, 1-10, 2006.

[10] D. Baumgart, "Personal digital assistant in healthcare: Experienced clinicians in the palm of your hand?", Lancet Medical Journal, Vol. 366, No. 9492, Oct. 2005.

[11] S. Stroud, C. Smith, and E. Erkel, "Personal Digital Assistant Use by Nurse Partitioners: A Descriptive study", Journal of American Academic Nurse Practice, Vol. 21, 2009.

[12] S. Lam, and W. Chung, "Uses of Internet and Mobile Technology in Health Systems for the Elderly: A Case Study of Hong Kong", iJIM, Vol. 4, Issue 2, April 2010, pp:40 – 47.

[13] U. Raja, D. J. McManus, J.M. Hardin and B. C. Haynes., "Collaborative Rural Healthcare Network: A Conceptual Model", iJIM, Vol. 5, Issue 3, July 2011, pp:20-23.

[14] D. Acharya, and H. Han, "Advances in Integrated Vehicle Health Monitoring Systems", iJIM, Vol. 5, Issue 3, July 2011.

[15] R. Oktem, and E. Aydin, "An RFID based indoor tracking method for navigating visually impaired people", Turk J Elec Eng & Comp Sci, Vol.18, No.2, 2010, c_ T¨UB˙ITAK doi:10.3906/elk-0904-3.

Bassam M. AL-Mahadeen is with the Computer Department, Tafila Technical University, Tafila, Jordan. He is the Associate Professor of CIS. He received his BSc in Computer Science in 1991 from Mutah University, Karak, Jordan. He obtained his MSc in Computer Science from Al-Bayt University, Mafraq, Jordan, in 1999. In 2005, he received his PhD in Computer Information Technology from the Arab Academy, Amman Jordan. His research interests are in wireless sensor networks, interconnection networks, image processing, RFID applications, and healthcare information systems.