Patients' Safety Improvement through the use of RFID in Digital Hospitals

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ABSTRACT: Hospitals are complex institutions with complex processes where mistakes can result in fatal consequences. Thus hospitals are constantly encouraged to improve patients' safety and to reduce medical errors. Information and Communications Technologies (ICT) are being introduced in hospitals as a mean to make the processes more efficient, traceable and secure. The use of RFID combined with wireless technologies allows the development of efficient methods to control treatment protocols, improve patients' identification and assure secure drug administration.

The introduction of these new technologies faces important challenges. This paper presents the development of a system prototype and the results of the pilot run at the Costa del Sol Hospital. This prototype integrates HF RFID (13,56 MHz) together with a Wi-Fi infrastructure (2,4 GHz) and allows the identification of patients and the control of the drug administration processes at the oncology area.

KEYWORDS

RFID, patients' safety, patients' identification, wireless terchnologies, eHealth, digital hospital

I. Introduction

Misidentification of patients is a recognized risk for patients' safety in hospitals. Medical staff interacts with hundreds of patients to provide many different treatment protocols. The identification of the patient is a process that must be repeated constantly, and human errors may occur. In addition, some circumstances may complicate this apparently simple process, such as: change of shift during the treatment, patients with very few communication capabilities (foreign or mentally handicapped people), emergency situations, etc. The identification process is critical, because errors can be put the healthcare of patients at risk.

II. The problem of patients misidentification

Possible incidents related to misidentification of patients can be:

- Administration of the wrong drug to the wrong patient.
- Patient is given the wrong diagnosis.
- Patient receives inappropriate treatment.
- Wrong patient is operated.
- Delays in starting treatment on the correct patient.

Sometimes these incidents may cause terrible consequences. It has been reported that preventable medical errors cause up to 98,000 deaths and 770,000 adverse drug events in the U.S. alone each year (1). Taking into account that the U.S. is the country with the highest healthcare expenditure in the world, these figures are very meaningful. According to the figures published by the Joint Commission on Accreditation of Healthcare Organisations (JCAHO) (2) the situation in Europe is similar.

One of the conclusions of these studies is that a large majority of medical errors are attributed to incidents related with the identification of the patient, such as adverse drug events (ADE) or incorrect blood transfusions (3).

III. The solution

A. IDENTIFICATION METHODS

Different methods have been traditionally used to identify patients in hospitals. Verbal and visual identification, which cannot be considered reliable as it depends on the patients' answer or their visual appearance. Hand written wristband, which has as main drawbacks the small amount of data that can be written and its legibility. Barcodes which are limited because information cannot be updated,

requires line-of-sight to be read and can be easily degraded.

Radio Frequency Identification (RFID) however can help medical staff to improve patient identification procedures and reduce the risk of patient misidentification.

B. SYSTEM DESCRIPTION

A system prototype based on RFID that enables identification of patients and control of the drug administration processes in hospitals has been developed. After the validation of this prototype in simulation environments, a pilot has been deployed with remarkable success at the Oncology Area of the Costa del Sol, Hospital, placed in Marbella (Spain).

The pilot architecture is depicted in the figure below.

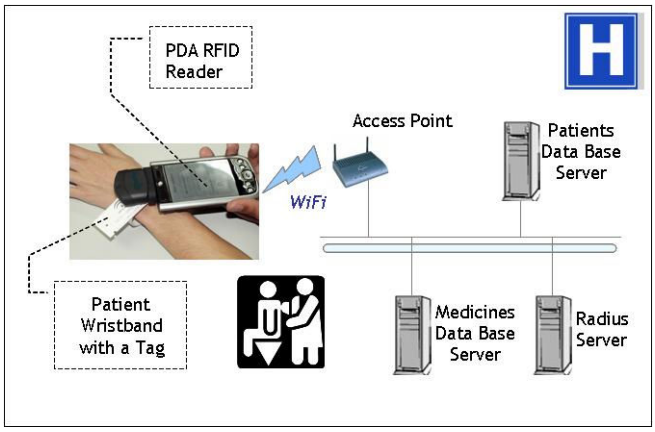

Fig. 1. Prototype architecture

The different components of the pilot are:

- **RFID wristband**: The RFID wristbands used have an embedded RFID tag that allows the storage of patient information. Each patient was given one of these wristbands which store a unique ID number that identifies the patient. Although the wristband can store more information, due to privacy issues only a unique ID number is written, to avoid other potentials RFID readers access to private information about patients.
- **Handhelds** with RFID and Barcode reader capabilities. A dual RFID and Barcode reader device attached to the handheld allows the medical staff to identify a patient, as shown in Figure 3. Handhelds are also equipped with 802.11g (Wi-Fi) wireless connectivity, to allow the medical staff mobility and network connectivity to the hospital's information systems in order to query the medical information needed in each step of the process (such as patient summary, allergies, drugs already administrated, code of the next drug that must be administrated, etc.).
- **Wi-Fi network**: The Wi-Fi network already deployed in the hospital has been used to provide wireless connectivity between the handhelds and the hospital's information systems.
- **Medicines database**: This database stores the different drugs codes and the dose that must be administrated to each patient. Each drug that is prepared by the laboratory for a patient is identified with a barcode and stored in this database.
- **Patient's database**: This database stores all health records containing the clinical histories of patients.
- **Software application in handhelds:** This application allows the control of the treatment protocol, checking that the right drug is administrated to the right patient, in the right dose, at the right time and in the right order. The basic operations that the application runs are: reads patient ID number from wristbands, queries the patients' database, displays useful information to medical staff, read the barcodes of drugs and update the patients' database.
- **Software application to generate wristbands**: This application writes the patient ID number in the RFID wristbands, using the RFID printer.

C. USING THE PILOT

The treatment protocol session for a patient in the oncology area of the hospital takes several hours and follows the steps described below:

I. When the patient arrives at the hospital, a new wristband is generated with the patient ID number (see figure 2) and attached to one of the wrists.

Figure 2. Writing the wristband

II. A blood sample is taken, and the sample is identified by a barcode. Using the PDA the sample barcode is associated to the patient.

III. Analyses are performed and, according to the state of the patient, a particular treatment protocol is decided by the

medical staff prescribing some drugs that must be administrated in a certain order and in a certain dose.

IV. The laboratory prepares the prescribed drugs, identifies them using barcodes and sends them to the oncology area.

V. During the drug administration process, the medical staff of the oncology area performs the following operations using the handhelds:

   a. Identify the patient by reading the wristband (see figure 3).

   b. Identify the drug by reading the barcode.

   c. Check automatically that the drug is the prescribed one and it is the correct according to the protocol drug sequence.

   d. Update the patients' database after the administration of each drug.

Fig 3. Identifying the patient

VI. When the patient treatment protocol is finished and all prescribed drugs have been administrated, the wristband is destroyed before the patient leaves the hospital.

D. PRIVACY AND SECURITY ISSUES

Privacy and security were key issues. During the design of the system and the development of the prototype some of the points considered are given below.

HF RFID technology has been selected due to avoid eavesdropping and multiple readings as the read range is short (10-15 cm). Also, HF does not cause interferences with other medical equipment (electromagnetic radiation is compliant with the allowed range for hospitals, 3 V/m). (7)

To preserve the privacy of patients' information, the wristband only stores the patient ID number. This avoids other potentials RFID readers access to medical private information.

The RFID wristbands are used only once: when the patient leaves the hospital, its wristband is destroyed

Wristbands cannot be removed without destroying. This avoids patients may interchange their wristbands.

Radius (4) and EAP (5),(6) protocols are used to provide authentication and authorization in handhelds connections to hospital's information systems.

IV. BENEFITS ON PATIENTS CARE PROVIDED BY THE SYSTEM

The following benefits and improvements were identified after running the pilot for several weeks:

- Reduction of patient misidentification. The prototype helped reduce patient misidentification errors by reinforcing patient safety procedures.
- Greater accessibility to patient information. The needed data in each step of the process (such as drugs already administrated, allergies, analysis results, etc.) were available only approaching the handheld to the patient wristband.
- Faster access to protocol treatments information: each step of the protocol treatment was recorded in real time in the patient's database using handhelds, and medical staff has accessed to up-to-date information trough the network.
- Reduction of handwritten papers to record some critical information during the process avoiding potential illegibility and human errors.

V. CONCLUSIONS

The main conclusion of this pilot is that RFID combined with other wireless technologies (such us Wi-Fi) is suitable to develop solutions to reduce misidentification risk in hospital processes. The foreseen benefits have been demonstrated and the proposed approach based on RFID technology may be expanded to other hospital processes.

As many other research experiences in hospital environments, this pilot shows that RFID technology is mature enough to became an important tool to help health professionals in many processes, avoiding human errors and improving not only patient' safety, but also efficiency and resources availability. The Digital Hospital concept is more and more near to be a reality, being a clear example the how the technology can help save lives.

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