RFID and NFC in Hospital Environments. Reaching a sustainable approach

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Abstract. The increase of safety and the improvement of care received by the patient during their healthcare process are one of the main challenges facing health professionals. Obtaining patient traceability and minimising the occurrence of adverse events during the perscription-validation-dispensing-administration process of medication to patients, encourages making measures of improvement to ensure the quality of the processes that take place in the clinical practice of a hospital. It is therefore essential to study current leading technologies such as RFID and NFC in a sustainable way to determine the feasibility of its application in the healthcare environment.
Keywords: RFID, NFC, security, patient traceability, medication administration, healthcare.

1 Introduction

Nowadays, one of the greatest obstacles of ensuring patient safety in a healthcare environment is the appearance of adverse events during the care process. Various studies show that 38% of adverse events occur during the process of prescribing-validation-dispensing-administration of drugs [1].

Furthermore, patient traceability represents a monitoring process at the hospital, enabling information acquisition about real time situations as well as the routes followed during the stay at the hospital. For example, this allows to measure the time that the patient waits for a diagnosis or for a test or simply the time spent waiting. Traceability could also be applied to the identification of patients, to the dosage units of medication and to the binomial *patient/drug* prescribed.

This paper presents the application of RFID[4] technology for obtaining the traceability of patients and medicines in Emergency and Pharmacy departments. Besides, we also propose a more sustainable complement to the RFID system by using NFC[5] technology on patients, nurses and drugs for identification, and control of medication administration, preserving the main functionalities and maintaining the user interactive effort.

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[4] http://www.rfid.org/
[5] http://www.nfc-forum.org/home/

2   Related Work

RFID technology can be integrated in automatic generation of stocks in pharmacy warehouses, prostheses, surgical material, laundry services, medical reports, etc. However, the greatest challenge is to integrate RFID into the process of prescribing-validation-dispensing-administration of medication to the patient. Its most immediate consequence is that it would help to minimise the occurrence of adverse events and thereby increase patient safety. Besides, it would allow the traceability of the patient which results in a greater control over the care process received, from their entry into the care network until they have left the hospital. Currently, there are projects on the application of RFID in healthcare designed to obtain the traceability of patients and medicines [2] but few have succeeded in becoming more than merely pilot projects. It is also important to note that there are few solutions that combine both objectives simultaneously.

The use of NFC technology as support in hospital care is suitable because of the mobility and dispersion of these environments, and the low cost of deployment. Benelli and Pozzebon [3] propose the use of mobile phones with NFC technology to exchange patient data between doctors and nurses. Also, Marcus et al. [4] have developed a system using NFC-enabled mobile phones to facilitate the tracking and care of patients in a low-resource environment. In [5], Fontecha proposes a system based on NFC technology and touch interaction to help nurses to perform several patient care tasks. Unlike RFID, NFC technology can be integrated into universal devices such as mobile phones, reducing the cost of the system because dedicated devices are unnecessary. The combination of both technologies (RFID and NFC) was proposed by Lahtela in [6]. In our case, this enables the deployment of location, traceability and monitoring services in a more sustainable way. We believe the integration of "transparent" and accessible technologies to users, without requiring an extra interactive effort or previous knowledge, facilitate data management and patient monitoring, reducing time and minimizing errors among other advantages.

3   RFID and NFC Architecture Approaches

Two subsystems have been developed considering each of the technologies.

- *Patient tracking.* To know with great accuracy the location of the patient in the Emergency Department and analyse the course of a patient from their entry until they leave the hospital allows us to increase the efficiency of the service. In this case, the patient has an active RFID WIFI tag on the wrist bracelet and the RFID locating engine calculates its position with an accuracy of between 1 and 4 meters. An advantage of the selected architecture is that it is possible to use the WIFI network available in the hospital and the manufacturer's software components enable the configuration hardware devices among other features.

  We propose an alternative approach based on NFC for drug administration and identification tasks. Although it is possible to develop a patient location

subsystem with NFC, we consider that the use of RFID is a good option when a RFID infrastructure exists in the environment. NFC technology needs a simple user-tag place interaction to determine the location of the user. Tag place identifies the place where the user (patient or medical staff) is in.

– *Preventing adverse events*. Minimizing adverse events is to reduce the possibility of error when the nursing staff administer a drug to a patient. The drug must be prescribed by the doctor and is found in adequate dispensing conditions (route, dose, pattern, etc.), including the patient identification through a passive RFID tag (with their Medical Record Number - NHC) attached to his bracelet. In order to identify all drugs, the Pharmacy Service must attach the corresponding RFID tag to each dosage unit, storing the id, name, lot number, expiry date and administering advice. The medication administration is aided by a software application that runs on a handheld device (PDA) which reads the passive tag from the patient bracelet as well as the one attached to the unit dosage of the drug to be administered (see Fig. 1 (a)).

In the case of NFC, we need the same elements, i.e. passive tags or bracelets for patients, and a tag reader/writer for doctors and nurses. However, in this sense, the NFC reader can be integrated into the mobile phone. Thus, the device capabilities can be used to deploy services whenever the user interacts with a tag through his mobile device. In our case, drug administration is the main service to be deployed when interaction happens. Fig 1 (b) shows the drug administration task by means of the use of an NFC mobile phone. A nurse interacts with an NFC patient bracelet or identification tag for displaying information about the medication prescription. Then, the nurse only has to interact with the appropriate medication tags to control their administration. The result of this task can be sent to the main system thanks to communication capabilities from the mobile phone.

(a) (b)
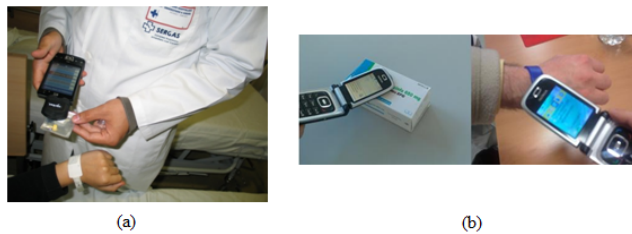
Fig. 1. Medication administration through: (a) Handheld with RFID capabilities, (b) NFC-enabled mobile phone

Features			
Development resources	*Infrastructure*	*Cost*	*User-Device Interaction*
NFC capabilities have a reduced cost of manufacturing. In fact, mobile phones can integrate NFC technology. NFC application development depends on the Operative System of the mobile device and it does not depend on the specific hardware according to manufacturer's specifications as with RFID.	Deployment of the RFID platform needs more architectural elements such as antennas, reader/writer devices, passive and active tags and the related software components. NFC uses only the mobile phone, passive tags and the software application.	The general cost of the RFID system is higher than with NFC technology because of the infraestructure components. With NFC, we need a mobile device with NFC reader (e.g. NFC mobile phone) and passive tags.	In both cases, the system needs a simple interaction between the user device and the tag to deploy services. Otherwise, deployment of patient location service depends on the RFID signal without requiring an explicit interaction. User interacts in a natural way by "tag touching" actions.

Table 1. RFID and NFC systems comparison

4 Reaching a sustainable contactless system

In this paper, we have used two approaches based on RFID and NFC technologies to solve a set of tasks in a healthcare environment. This leads to a comparison between the two systems focused on several features shown in Table 1. Besides, both approaches are being evaluated.

In conclusion, we believe a more sustainable system can be developed by means of the application of NFC technology instead of RFID. However, RFID features are more suitable in user location services, but also more expensive.

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