

Chapter 10

Intelligent System to Quality Assurance in Drugs Delivery

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ABSTRACT

Improving quality assurance and providing effective healthcare are some of the most important aims of information and communication technologies (ICT). This chapter presents a novel solution to improve quality assurance in drugs delivery, i.e., reduce clinical errors caused by drug interaction and dose. For that purpose, we have proposed an innovative system based on Internet of things for the drugs identification. Internet of things (IoT) is one of the latest advances in ICT, providing a global connectivity and management of sensors, devices, users, and information. Our contribution is a solution to examine drug related problems based on IoT technologies, i.e. smart phones and Web, to support ubiquitous access, 6LoWPAN technology to support ubiquitous data collection of patients, sensors and hospitals, and RFID/NFC to support global identification. These technologies offer a wide range of applications in health-care, which improves the quality of services, reduces mistakes, and even detects health anomalies from vital signs. This chapter presents how IoT technology is applied in a pharmaceutical system to examine drugs in order to detect Adverse Drug Reactions (ADRs), harmful effects of pharmaceutical excipients, allergies, complications and contraindications related with liver and renal defects, and harmful side effects during pregnancy or lactation. Thereby, the system provides an enhanced approach assisting physicians in clinical decisions and drug prescribing.

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The solution presented is based on NFC (Near Field Communication), RFID (Radio Frequency Identification), and barcode identification technologies, which have been integrated in common devices such as smart-phones, PDAs, and PCs. In addition, a remote knowledge-based system based ontologies and rules-engine, has been built to define an intelligent drugs checker, which we have defined as Pharmaceutical Intelligent Information System, where the drug identifies collected from the RFID/NFC tag or barcode is checked, in order to detect whether the identified drug is suitable with respect to the patient's health record.

INTRODUCTION

Severe incidences take place in hospitals worldwide due to clinical errors and negligence are responsible for disabling injuries in about 1 in 25 hospital admissions (Leape, 1991). Most of these injuries are caused by Adverse Drug Reactions (ADR's). These events prolong hospital stay, increase care costs, and nearly double a patient's risk of death (Classen and Pestotnik, 1997; Bates, 1997). About one third of adverse drug events occur during drug administration, when interception is unlikely (Bates, 1995). The confusion caused by expressing the concentrations of drug solutions in different ways is an important cause of dose errors (Rolfe, 1995). Converting between ratios, percentages, international units, moles, micrograms, and milligrams causes substantial difficulty, especially for less experienced physicians. For example, *Epinephrine*, *lidocaine*, *heparin*, and *potassium chloride* are frequently associated with drug errors, it may be no coincidence that the strength of these drug solutions are typically expressed in ratios, percentages, international units, and millimoles, respectively. In addition, Adverse Drug Reactions (ADR's) and harmful effects of pharmaceutical excipients are important clinical issues due to the ADR's rate appearance in hospitals. Some studies present ADR's incidence of about 6.7% of severe cases and 0.32% of fatality (Lazarou, 1998, Classen, 1997) of the total cases presented in hospitals worldwide. The ADR's ratio is 8% in Spain (Azumendi, 2009) and 6.5% in the UK (Lammle, 2003). A recent study by the Royal Liverpool University Hospital (UK) shows an example of the ADR's consequences; 80% of the

cases required hospital admission with a medium bed stay of eight days and a cost of \$847m. The fatality rounded 0.15% of the cases. These problems may be avoided following a deep review of prescribed drugs, interactions and other complications. For this reason, we proposed a drugs checker using Internet of Things and a knowledge-based system to check dose, detect ADR's and drug interactions. Our solution comprises a personal system to check the drug suitability based on mobile devices, such as smart phones, PDAs or laptops. The mobile device identifies the drug by means of NFC (Near Field Communication) or barcode. The compatibility of the drug with the patient profile is checked with the Pharmaceutical Intelligent Information System (PIIS). It detects whether the product is suitable according to allergy profile and medical history of the patient, i.e., Electronic Health Record (EHR). Each time the physician prescribes a new drug to the patient and this drug is added to the patient's history record, the system checks any possible interactions, and warns the doctor of the possibility of alarming interactions.

PIIS is composed of a database, ontology, and a rule-based system. The database is represented in Figure 1, where arrows present the relations and link between the different tables. The content of this database is a detailed drug description, with details such as active ingredients and side effects. The ontology is used to define the patient's profile, including drugs concepts. Finally, it is used a rule-based system to detect allergies and ADR's.

Some initial approaches to the Pharmaceutical Information System can be found in (Tamblyn, 2001; Yamamoto, 1998; Fernandez, 2002). An

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