Chapter 4
Intelligent Medication Adherence Monitoring System

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ABSTRACT

This chapter presents the architecture and implementation of an automatic medication dispenser specifically for users who take medications without close professional supervision. By relieving the users from the error-prone tasks of interpreting medication directions and administrating medications accordingly, the device can improve the required level in compliance and prevent serious medication errors. By taking advantage of the scheduling flexibility provided by medication directions, the device makes the user's medication schedule easy to adhere and tolerant to tardiness whenever possible. This work is done collaboratively by the medication scheduler and dispenser controller in an action-oriented manner. An advantage of the action-oriented interface between the components is extensibility, as new functions can be added and existing ones removed with little or no need to modify the dispenser control structure. This chapter first describes the action-oriented design, major components and hardware structures of the smart device. It then provides an overview of the heuristic algorithms used by the medication scheduler and their relative merits. The different available user options will be presented depicting the user-specific operating modes of the device/service. The scope of this chapter is to describe the development of a smart electronic drug dispenser unit for the pharmaceutical adherence of patients.

INTRODUCTION

Thanks to years of advances in medical and pharmaceutical technologies, more and more drugs can cure or control, previously fatal diseases and help people live actively for decades longer. The benefits of the drugs would be even more wondrous were it not for the high rate of preventable medication errors (Veacez, 2006; Lisby et al., 2005; Law et al., 2003; Wertheimer, 2003). Medication errors are known to occur throughout the medication use process of ordering, transcription, dispensing, and administration.

They lead to many hundred thousands of serious adverse drug events, thousands of deaths and billions of Euros in hospital cost each year. These alarming statistics have motivated numerous efforts in research, development and deployment of information technology systems and tools for prevention of medication errors (Kuperman et al.,2007 ; Baron et al.,2005).

Medication adherence usually refers to whether patients take their medications as prescribed, as well as whether they continue to take a prescribed medication. Medication nonadherence is a growing concern to clinicians, healthcare systems, and other stakeholders because of mounting evidence that it is prevalent and associated with adverse outcomes and higher costs of care. To date, measurement of patient medication adherence and use of interventions to improve adherence are rare in routine clinical practice. The proposed solution aims to develop a medication adherence monitoring system, comprising of a portable medication dispenser with communication capabilities and a software platform allowing monitoring by medical personnel and/or carer. The patient data recorded by the dispenser (rate of medication intake) will be collected and will be transmitted in real-time to the hospital (via any Internet link), where it will be analyzed, and any alerts will be raised.

This will enable the doctors to:

- Monitor the progress of the patient and intervene in the case of an anomaly.
- Monitor treatment compliance of the patient.

On the other hand, it will also enable the carer to:

- Monitor the depletion of one or more medication.

Our system addresses the needs of patients with chronic illnesses that require encouragement and supervision with their medication. Monitoring is achieved through the use of a medication dispenser, which collects information about the patients' medication adherence. The dispenser will contain electronics that record automatically the time and date the dispenser is accessed. These data will be transmitted via an Internet connection to the clinical team base.

BACKGROUND

According to the International Society for Pharmacoeconomics and Outcome Research (ISPOR), adherence is "the extent to which a patient acts, in accordance with the prescribed interval, and a dose of a dosing regimen." Medication nonadherence can affect patient health adversely, negatively impact a patient's relationship with his/her care provider, skew results of therapy clinical trials, and increase health resource consumption. Medication nonadherence remains a common health care problem. Poor adherence causes approximately 33% to 69% of medication-related hospitalizations and accounts for $100 billion in annual health care costs. Irrespective of disease, medication complexity, or how adherence is measured, the average adherence rate to chronic medication therapy is approximately 50%. Adherence monitoring should be performed routinely to ensure therapeutic efficacy, avoid unnecessary dose and regimen changes, contain health care costs, and in certain cases, prevent resistance to therapy from emerging.

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