Abstract — This paper presents a medicine dispenser suited to the elderly population who are consuming numerous medications daily. The device is capable of detecting contraindicative drugs by utilizing the Canadian Adverse Drug Reaction Information System (CADRIS) and can be accessed remotely by a health practitioner to access patient drug history. The maximum number of different medications that can be stored in the device is 6 and software configuration is completed using a barcode scanner, hexadecimal keypad and Liquid Crystal Display (LCD). The device is expected to cost $384 exclusive of fabrication costs and minor components.

Index Terms -- Drug delivery systems, adverse reaction detection, medical services

I. INTRODUCTION

Adverse drugs reactions (ADR) are the accidental, negative consequences associated with the use of different medications. With increased specialization in the health industry, it is common for a single patient to consult two or more doctors for their illnesses. This not only increases the likelihood of contraindicative drugs being prescribed but results in complex drug consumption regiments which the patients may find difficult to follow accurately.

The design was evaluated against the following criteria. The initial capital cost and maintenance cost of the device must be minimized. Most elderly have little disposable income therefore an expensive device will limit accessibility. The device must be reliable and easy to operate because the users may not be proficient with electronic technology.

The device was developed within the following major constraints. It must be able to detect ADR’s and implement an updateable software framework. This requirement enables the device to work reliably over a long life span. The device must also feature a method to access the patients’ drug history. An assumption that has been made is that all medicines will be in pill form and contain a unique barcode. [1]

This paper presents an improved medicine dispensation device which will detect ADR’s and allow medical professionals to remotely access medical history. The device is also updateable via the internet and its cost is comparable to the monthly average pension payout [2].

According to our research there is no product on the market which includes ADR detection and networking capability. Current solutions are only able to dispense medicine following a schedule and alert the patient using sound [3] or phoning them [4] when it is time to consume their medication.

II. CONCEPTUAL DESIGN

A. Overall Design

This device will feature an Optrex F-51320 LCD and Kwik-Byte KB902 microcontroller running the ARM Linux kernel. The ADR detection engine will utilize the CADRIS database and the user will be alerted using an integrated speaker and flashing light. Medication name will be scanned using a barcode. The device will have a permanent internet connection to facilitate communicate with the National Drug Database (NDD) and CADRIS. ADR detection will be performed when the drug is first entered into the device.

The device will feature six compartments each storing a different medication. When it is time to dispense the medicine, the device will notify the user and indicate which compartment to open. The device will verify using a sensor that the correct compartment has been opened and display the dosage information. The user will take the correct number of pills as indicated on the LCD and close the compartment. Once the compartment is closed, the system will check if more medicines need to be dispensed.

B. Major Components

1. KB0902 Microcontroller
2. Optrex F-51320 LCD
3. Hexadecimal keypad
4. CueCat scanner
5. Jameco 13W transformer power supply

III. DETAILED DESIGN

A. Microcontroller

The KB0902 microcontroller has been selected. It implements the Atmel architecture and is factory preinstalled with Ethernet, MMC/SD reader and ARM Linux kernel. It will execute the timing system and run software to perform all actions.

B. Prescription Recognition

The drugs will be scanned using their National Drug Code (NDC). The CueCat scanner will be used to acquire the 13 digit barcode which will be searched on the NDD to find the product name. The scanner is connected via USB however the drivers will need to be installed into the operating system.

C. ADR Detection

The device will connect to the internet using the TCP/IP protocol and embedded Ethernet controller. Initially the drug being added is searched in CADRIS, if it is not found, then no known adverse drug reactions exist. If the drug exists in
CADRIS, then the drugs that the patient is currently using are checked to ensure they do not react with the drug currently being added. Once the drug being added is verified the patient is informed of the status. If the drug causes an ADR the patient will still be allowed to complete adding the drug to the device after they confirm the ADR with their physician. This has been included because there are cases when the benefit of the medicine outweighs a minor or rare ADR.

D. Database
Copies of the CADRIS and NDD are stored locally to enhance lookup time and decrease internet dependence. The device periodically checks the update server on a specified port which contains the CADRIS and NDD databases. Port 81 is an available TCP/IP port which can be utilized for bidirectional communication between the ADR device and the server containing the updates. The device will periodically poll the server checking for a two bit flag. A bit set of 10 and 01 indicate an update is available for CADRIS and NDD respectively. The total memory usage is expected to be 90MB however 150MB has been allocated to allow for future expansion.

E. Dispensation System
The dispensation mechanism has been designed for durability and simplicity. The opening and closing of the compartment will be done by the user at the appropriate time. Each compartment moves within a central linear slide. The slide is attached to the base of the device. The slides are designed such that when the compartment is fully open the torque does not cause it to derail and fall out.

F. Remote Access
The device can be remotely accessed by a health care professional using a web browser and the IP address of the device. The device will be listening on port 82 and when a connection is established encryption keys will be exchanged to make the connection secure. Once the ADR device has verified the hospital's identity, it will provide them with the medical history of the patient.

G. Compartment Sensor
Each compartment will be equipped with a sensor to detect if it is open or closed (Figure 1). A flat conductive plate is mounted on two springs at either end. When in the rest state the conductive plate is away from the connectors producing an open circuit. Closing the container will push the plate towards the connectors thereby closing the circuit. When port A1 is raised to a high voltage port A2 will detect this change if the circuit is closed.

An alarm system is used to notify the user when it is time to take their medication. An integrated speaker has been installed to produce an audible notification when it is time to consume a medicine. For the hearing impaired, a flashing red light has been added as a secondary signal.

IV. DISCUSSION
The device provides a comprehensive feature set at a competitive price. A drawback of the design is that it relies very heavily on availability of a functioning internet connection. In many cases a working internet connection may not be available but in order to provide a reliable, up to date ADR detection engine it is not possible to avoid using the internet.

The next generation of this device will need to use a centralized method to store the CADRIS and NDD. The price of the product should also be reduced but this will only be possible if numerous refinements are made to the design.

REFERENCES