NFC-Enabled Smartphone Application for Drug Interaction and Drug Allergy Detection

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Outline

- Motivation
- Paper Objective
- Background
- Related Work
- System Design
- Analysis
- Conclusion
Medication Errors

- **Third** leading cause of death after cancer and heart disease
- **70,000** preventable medication errors causing **9,250 to 23,750** deaths annually
- Medication errors are a frequent cause of adverse drug events
- Drug interactions constitute up to **59%** of Adverse Drug Events (ADE)
- Drug allergies constitute up to **10%** of ADEs
- Lead to significant clinical and financial consequences
Multi-morbidity

Multi-morbidity -> Average of 35-74 Prescription -> Medication errors
Administration Stage

- **61%** at the administration stage
- Lack of appropriate technology solution
- Lack of communication within a treatment team
Present a novel solution using a smartphone integrated with an NFC reader and an NFC application to detect and update drug allergies and drug interactions for people with multimorbidity during medication administration stage.
Background
RFID and NFC Applications in Health Care

RFID and NFC

Identification
- Patients
- Employees
- Care givers
- Medications

Tracking
- Patients
- Employees
- Equipments
- Devices
- Tools
- Incidents

Monitoring
- Blood transfusion
- Activities
- Hygiene
- Patient’s health
- Emergency
Related Work on RFID for Medication Error Prevention

RFID

RFID Only
- eBox II
  - Yu et al, 2006
- iPAQ
  - Aguilar et al, 2006

RFID and Barcode
- PDA
  - Wu et al, 2005
- Computerized drug cart
  - Sung et al, 2008
Related Work on NFC for Medication Error Prevention
System Design

Assumption

- Existence of five rights of the administrating medication
- Tagged patient and drug
- The availability and reliability of a wireless connection.
- The availability and reliability of a cell phone signal.
- The availability of a treatment team
- The hospital uses electronic health record
The system has been implemented using:

- Samsung Nexus S smartphone with Android 2.3.6 platform
- MIFARE Classic 1K tags
- Database populated with 10 patients’ record and 30 medications.
System Design (cont’d.)

NFC Application Interface

- Test (Testing Function)
- Update Drug Allergy (Updating Function)
Testing Functions

Testing Function Phases

1. Reading tags phase.
2. Retrieving information phase.
3. Proceeding or sending alert phase.
   • Drug allergy/drug interaction detection.
   • Safe to proceed.
Testing Function

Testing Function Interface

- Two text boxes.
- Test button.
(1) Reading Tags Phase
(2) Retrieving Information Phase
(3) Proceeding or sending alert Phase
Drug allergy/Drug Interaction Detection Case

Nurse
NFC-enabled smartphone

Alert Message

Internet

Hospital's server

GPRS

Physician

Alert
SMS + @

Pharmacist
Alert Message Sent to the Nurse

Detecting Allergy Case

- DETECTION: Allergy
- USED DRUG: Cataflam
- NEW DRUG: Cataflam
- CLASSIFICATION: Moderate
- DESCRIPTION: Nausea

Detecting Interaction Case

- DETECTION: Drug Interaction
- USED DRUG: Insulin
- NEW DRUG: Gatifloxacin
- CLASSIFICATION: Major

DESCRIPTION: Gatifloxacin may interfere with the therapeutic effects of oral antidiabetic agents and insulin. The use of various quinolones has been associated with disturbances in blood glucose homeostasis possibly stemming from effects on pancreatic beta cell ATP-sensitive potassium channels that regulate insulin secretion. Death has been reported in severe cases. Elderly patients and patients with reduced renal function are particularly susceptible.
Short Message Service (SMS) Alert Sent to the Physician and the Pharmacist

(Urgent Email) Please check your email, Drug Interaction/Allergy Detected

PATIENT NAME: Malik Peterson
Email Alert Sent to the Physician and the Pharmacist

[ Alert: Drug Interaction / Drug Allergy Detected ]

malabdulhafith@gmail.com
to me

4:48 PM (0 minutes ago)

This message may not have been sent by: malabdulhafith@gmail.com Learn more Report phishing

PATIENT FILE NUMBER: 113
PATIENT NAME: Malik Peterson
PHYSICIAN NAME: Amos Workman
NURSE NAME: Rebecca Stark
PHARMACIST NAME: Amir Carver

DETECTION: Drug Interaction
Used Drug: Insulin
New Drug: Gatifloxacin
CLASSIFICATION: Major

DESCRIPTION: Gatifloxacin may interfere with the therapeutic effects of oral antidiabetic agents and insulin. The use of various quinolones has been associated with disturbances in blood glucose homeostasis possibly stemming from effects on pancreatic beta cell ATP-sensitive potassium channels that regulate insulin secretion. Death has been reported in severe cases. Elderly patients and patients with reduced renal function are particularly susceptible.
(3) Proceeding or sending alert Phase

Safe to Proceed Case

Nurse

NFC-enabled Smartphone

Proceed Message

Internet

Hospital’s server
Proceeding Message Sent to the Nurse

Test Result:
No drug interaction or allergy found, please proceed.
Updating Functions

- Updating Function Phases

1. Entering the patient’s information.
2. Posting the information in the patient’s record at the hospital database.
Updating Function

- Updating Function Interface
  - Two text boxes - IDs
  - Drop-down list
  - Text box – Description
  - Update button
(1) Entering the Patient’s Information
(2) Posting the Information in the Patient’s Record in the Hospital Database
Successful Update Message

"Successful Update"
The system was validated for:

1. The performance precision.
   - sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy.

2. Computational and Communicational Cost for Sending a Text Message
   - Time spent for sending a text message (SMS) to physicians and pharmacists.
The Performance Precision

Expected Result

- Total Rejection: 55%
- Drug allergy: 30%
- Drug-Drug Interaction: 15%

Detected Result

- Total Rejection: 65%
- Drug allergy: 23%
- Drug-Drug Interaction: 12%
The Performance Precision (cont’d.)

- Sensitivity: 78%
- Specificity: 100%
- PPV: 100%
- NPV: 91% 96%
- Accuracy: 93% 96%

Graph shows performance measures for Drug-Drug Interaction and Drug Allergy.
Computational and Communicational Cost for Sending a Text Message

![Graph showing the computational and communicational cost for sending a text message. The x-axis represents minimum, average, and maximum times in seconds, and the y-axis represents seconds. The graph indicates an increasing trend with time range highlighted by a red band.](image-url)
Conclusion

The System was able to:

• Detect a drug allergy or drug interaction
• Alert the treatment team
• Provide adequate information
• Enhance the communication
• Update the patient’s health record
Conclusion (cont’d.)

- **Limitation**
  - Difficulty to eliminate the drug interaction and allergy errors if the information missing in the DB
  - Applying the NFC application in a laboratory setting

- **Future Work**
  - Apply the NFC application in a real life scenario
  - Determine the drug allergy /drug interaction classification for receiving an alert message.
Thank you