Implementation of Wireless Group Support System in Mobile Healthcare

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Abstract

In Mobile healthcare service, Wireless Group Support System can assist physicians or nurses in improving the quality of care and saving valuable time for emergency patients. Medical practitioners (often nurses) collect various physiological signals, as well as subjective parameters. Physiological signals may include ECG, EEG, SpO2, temperature, continuous blood pressure etc. On the contrary, subjective parameters may include level of pain, level of alertness, awareness, behavioral responses etc. After successful accumulation of these data, a scoring system is utilized for early detection of critical illnesses. In many cases, the existing mechanism of scoring is performed manually, where the medical practitioner ticks on to a scoring board. In some cases the information from scoring board is relocated to a PC, where the software performs the scoring calculation. This paper demonstrates a new approach of using mobile phones to calculate the scoring. In the proposed system, the medical practitioner inputs the parameters directly on to their mobile phone while collecting the parameters from the patient. The score is automatically calculated by miniature java based software running inside the mobile phone. Based on the score, level of urgency is ascertained by the intelligent program. At the end, specialists are contacted automatically by messaging services. Moreover, the results of the scoring are transmitted to the hospital server. The proposed mobile phone based intelligent scoring system is integrated with SMS, MMS and HTTP capabilities. With the proposed mobile phone based scoring mechanism in place, volunteers without medical knowledge will be capable of patient monitoring. During any catastrophic event, required number of medical professionals is often absent. Therefore, assistance from civilians with mobile phone based medical intelligence can save precious life.

Keywords*: Arterial Blood Gas, Early Warning Score, Glasgow Coma Scale, Hospital Server*

1. Introduction

Scoring system is popularly utilized to judge students at educational institutions, teams or players in sports, employees at organizations etc. It is inseparable from the existing patient management systems at hospitals. Many of the hospitals uses a specific scoring technique, often referred to as Early Warning Scores (EWS) or calling criteria systems to assist in the early detection of critical illness.

In this paper, we introduce the concept of mobile phone based EWS, calling criteria and hospital server communication that is suitable for remote monitoring of patients at a war or disaster affected zone. The whole system automates the manual processing of hospital scoring system that usually requires prior experience and expertise of the patient monitoring person. The Wireless Application Protocol (WAP) is the mechanism used here in case of integration of client (Mobile) and Server (Web Server). Apache Tomcat is the web server used for the interaction with Database Server.

1.1 Interface Design

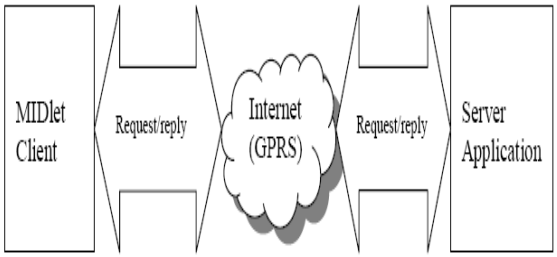

Fig. 1 Communication between server and MIDlet

The structure of the system is divided into two components: The client-side MIDlet application which resides on the mobile device, e.g., mobile phone. The server-side JSP/MySQL based application.

Modules:

i. APVU / EWS Scoring.
ii. GCS Scoring.
iii. ABG Scoring.
iv. Server Communication.

Modules Description:

i. AVPU Scoring:

AVPU scoring system is a MIDlet application which serves an aggregated physiological score or weighted score provides the combined information of systolic blood pressure, heart rate, respiratory rate, body temperature.This simplified level of consciousness includes four major factors containing Alert, Respond to Voice, Respond to Pain, Unconscious (AVPU). When a certain score is attained, expert assistance is sought following a set protocol. This scoring system comprising of the Table, the interval for patient review as well as when and where to contact for specialist assistance, is well documented. The aim of this project is to evaluate the ability of a EWS to identify medical patients at risk; and to examine the feasibility of EWS as a screening tool to trigger early assessment and admission to an HDU or ICU.

ii. GCS Scoring:

The Glasgow Coma Scale or GCS, sometimes also known as the Glasgow Coma Score is a neurological scale which aims to give a reliable, objective way of recording the conscious state of a person, for initial as well as continuing assessment. GCS was initially used to assess level of consciousness after head injury and the scale is now used by first aid and doctors as being applicable to all acute medical and trauma patients. In hospital it is also used in chronic patient monitoring, for instance, in intensive care. GCS is ascertained by three types of behavioral responses including eye opening (4 scoring values), verbal response (5 scoring values) and motor response (6 scoring values).
GCS values ranges from 3 (deep coma state) to 15 (normal). When GCS values start to decrease from 12, concern is raised. Coma state is confirmed when GCS<8.

iii. ABG Scoring:

Arterial blood gas sampling is a medical technique used to check gas levels in the blood. It typically involves using a thin needle and syringe to puncture an artery, usually in the wrist, and withdraw a small amount of blood. This technique is useful for making sure that certain parts of the blood's chemistry are normal. This technique is commonly used on patients whose breathing is controlled by a mechanical respirator or who are having serious difficulties with breathing. Based on the level of pH, PaCO2 and HCO3 in arterial blood, the MIDlet can determine nine different acid-base disorders by scoring (Respiratory acidosis, Metabolic acidosis, Respiratory alkalosis, Metabolic alkalosis, Respiratory acidosis with metabolic compensation, Metabolic acidosis with respiratory compensation, Respiratory alkalosis with metabolic compensation Metabolic alkalosis with respiratory compensation, Mixed metabolic and respiratory alkalosis).

iv. Server Communication:

The server is contacted by the mobile phone when calling criteria are encountered. During different stages of scoring, several medical professionals might need to be contacted by the automated scoring mechanism.
The server contains the addresses and contacts of the medical personnel. Therefore, the mobile phone only transmits messages to the hospital server that retrieves the contact details of the appropriate personnel to be notified.
Each of the messages contain five major parts namely the patient ID, patient attendee ID, scoring type, scoring value and time stamp. Messages are sent via HTTP. The Servlet that handle the MIDlet interaction perform various database based queries. The server create different patient reports (in PDF) and stored in server ,when server receive score submission from patient attendees from the mobile phone submits scores via HTTP, the links are saved within the MySQL database (back end). This server Communication is used for connecting the server to the mobile client using Stream Socket Connection. For the connection the remote desktop IP address is given in the mobile and then connected. Jar file is created using J2ME wireless toolkit & installed into the cellular phone through the USB port.

2. Previous Work

Typical group decision support systems (GSS) are implemented in a room that contains a network of computers and public display screens, where multiple participants can meet together to solve problems at the same time. GSS can support multiple participants working on unstructured problems, and facilitate participants to generate ideas, analyze issues and rank alternatives in a group meeting. However, this typical method may be inappropriate for decision makers, with new situations and technologies appearing in recent years. With the changes in the global competitive arena, group decision making needs to become more convenient and efficient in order to complete the task in a timely manner.

3. Present Work

Advanced wireless technologies facilitate group decision making conducted from a wired network to a wireless network. The main objective of this paper is to implement GSS with wireless technology, where emergency patients can be monitored and treated quickly. In a non hospital scenario, where patients are monitored, attended and treated by amateur volunteers, conformance to EWS / Calling Criteria needs further technological assistance. The Scoring System serves automated calculation of EWS which will benefit the volunteers in camps near a war or disaster zone. The whole system automates the manual processing of hospital scoring system that usually requires prior experience and expertise of the patient monitoring

person. With this system in place, the naive user only provides required inputs inside his mobile phone, and the mobile phone automatically decides when and what action to take. In case, of an extreme scoring value, the mobile phone retrieves the contact details of the specialist requiring attention from the hospital server. The particular medical expert is then notified and informed about the deteriorating condition of the patient.

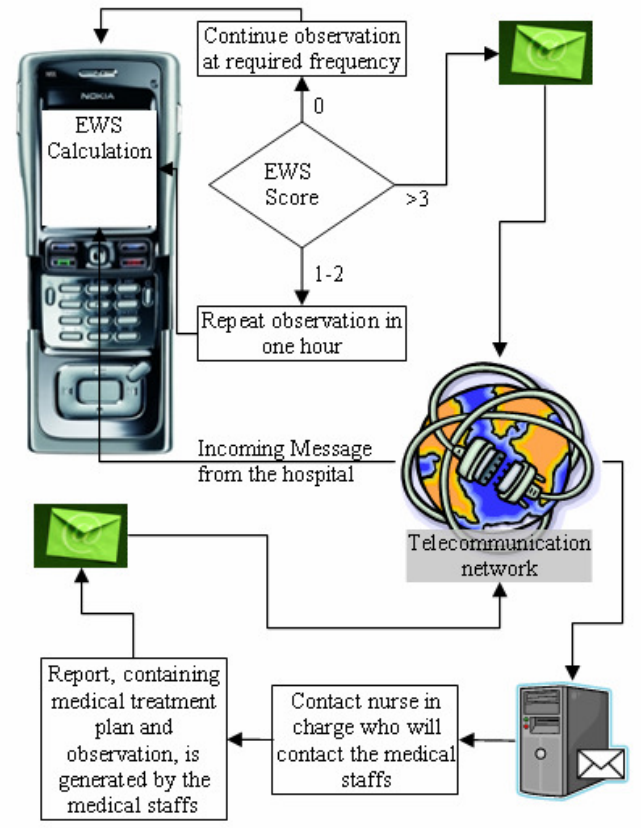

Fig.2 System architecture of mobile phone based scoring mechanism

3.1 Glasgow Coma Scale: GCS

Assessing a patient's level of consciousness is an essential component of a neurological examination, which is usually performed alongside an assessment of pupil size and reaction, vital signs and focal neurological signs in the limbs. The Glasgow coma scale is the most widely used assessment tool for measuring a patient's level of consciousness.

3.1.1 Methods of evaluation

The Glasgow coma scale is based on three aspects of a patient's behaviour - eye opening, verbal response and motor response. A score is applied to each category and then added up to give an overall value ranging from 3 to 15. As well as calculating a total Glasgow coma score (GCS), a score for each of the three components must be calculated and recorded separately.

3.1.2 Patient assessment

The following are important points to note when assessing a patient's level of consciousness using the Glasgow coma scale and calculating a GCS:
The arms give a wider range of responses and, for this reason, are always observed using the Glasgow coma scale. Spinal reflexes may cause the arms or legs to flex briskly in response to pain and must not be interpreted as a response;
Always record the best arm response. If the motor response is different on each side, the better response is used. Responses must be recorded on the patient observation chart in black ink. Changes in neurologic function, pupil response or GCS must be recorded in relevant nursing documentation including the date, time and signature; As the GCS is an assessment of consciousness level, it cannot be determined accurately in patients who are receiving anaesthetic agents. Where anaesthesia is being used, neurological assessment should focus on pupil responses; A GCS can still be determined in a patient who is sedated, although it must be noted that the score obtained might not be an accurate reflection of what the patient is capable of. In neurosurgical intensive care and high-dependency units, a patient's GCS must be assessed at verbal handover or at the beginning of a shift by both nurses (at the same time) in order to avoid misinterpretation and facilitate continuity; When a patient with an impaired level of consciousness is transferred to another ward or department, such as recovery or ICU, a GCS must be assessed by both the nurse escorting the patient and the nurse receiving the patient (at the same time) in order to avoid misinterpretation and facilitate continuity of assessment; Although the Glasgow coma scale should be communicated using its individual components, a score from 3-15 may be used to summarize the scale. A deterioration of one point in the 'motor response' or one point in the 'verbal response' or an overall deterioration of two points is clinically significant and must be reported to medical staff.

3.2 Early Warning Score

Early warning scores (EWS) are used to identify physiological deterioration in patients. Studies to date have primarily focused on the correlation between trends in serially recorded EWS of inpatients and clinical outcomes. This study examined the predictive value of an EWS calculated immediately on presentation to hospital for acute medical patients.

3.3 Arterial Blood Gas Analysis (ABG)

Arterial blood gas (ABG) analysis is used to measure the partial pressures of oxygen (PaO2) and carbon dioxide (pacO2)' and the pH of an arterial sample. Oxygen content (O2CT), oxygen saturation (SaO2) and bicarbonate (RCO3 -) values are also measured. A blood sample for ABG analysis may be drawn by percutaneous arterial puncture or from an arterial line.

Fig.3 Login to Scoring System

Fig.4 Selecting an Option in Scoring System

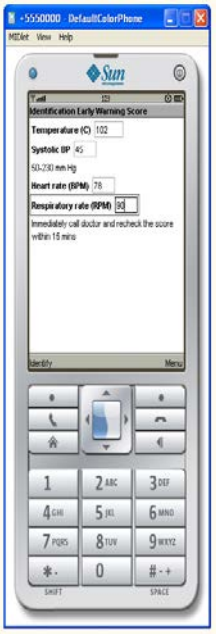

Fig.5 Identification Early warning Score

4. Conclusions and Future Work

We conclude that during the past decade, proliferation of technology has shifted the doctor centric health care approach to the patient centric healthcare. Before 21st century, calculation of heart rate was predominantly done by the doctors, wearing stethoscopes. However, in recent days watches that automatically calculate heart rate is commonplace to athletes and overall health conscious community. People are using Blood Pressure Machine, Diabetes Checking Machine, Wearable ECG, Pulse Oximetry etc. from the comfort of their home. Modern society is more aware and knowledgeable about their health than ever before. Technology and innovation in healthcare have bestowed us with the facilities that once prevailed only inside medical institutions. The proposed scoring system is another exposure of doctor's knowledge to patient (or patient attendee) by utilizing mobile phone. With the exponential growth of mobile phone usage, total number of mobile phone connections will soon reach the total world population. Transmission of health messages (through SMS, MMS, and HTTP) with medical scoring MIDlets will certainly bring about revolution for remote patient care. We have successfully demonstrated the feasibility of running MIDlets inside the mobile phone for identification of critical illness and possible health breakdown. In many of the cases, inexpensive mobile phones can substitute the requirement of an additional computation platform for medical information processing tasks. Most importantly, people outside the medical domain can now step forward for patient monitoring, since medical knowledge can be embedded within the mobile phone.

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