



Neonatal Anti-theft System and Outpatient Transfusion Management System Based on Internet of Things

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This paper first briefly introduces the development of the recent years Internet of things application in hospital management. Then this paper analyzes and describes the design of the neonatal anti-theft system and mobile outpatient transfusion management system. Finally, this paper analyzes the improvement of doctor-patient relationship and reduction of outpatients' transfusion waiting time after the two systems implemented. This paper particularly focuses on the analysis of reduction in outpatients' transfusion waiting time. The results show a decrease in outpatients' transfusion waiting time ($P < 0.05$) and a CPK increase from -0.02 to 0.42 after the transfusion management system implemented. The results verify the validity of the neonatal anti-theft system and the mobile outpatient transfusions management system, and the results also shows a prosper prospect of the Internet of things application in hospital management.

1. Introduction

Computer technology, with the emergence of the Internet of things, combined together greatly promote the hospital digitization and informatization, and the latest Internet of things technology accelerated the hospital digitization progress, impact the hospital in various ways, such as hospital management, medical safety and hospital security, Feki, M. A (2013) reported. The Internet of things bring new opportunity for the digital hospital, make real-time monitoring and real-time reaction possible, help the hospital achieve continuous improvement in medical safety. New tools of medical management also possible with the application of Internet of things, such as digital medical quality control tools, new form of medical safety evaluation index. This paper mainly described two system integrate with Internet of things, the neonatal anti-theft-system and mobile outpatient transfusion management system. Internet of things in the foreign country is called the "savior" of the era's crisis, and now due to the global economic recession in many developed countries, they began to regard the development of the Internet of things as new opportunities to promote the development of the economy. Although the concept of Internet of things is not new, and has not yet fully mature, but the current economic situation, industry environment and technology development, all kinds of application of Internet of things has been gradually pushed around the world, Perera, et al (2013) reported. Many well-known companies also provide positive research, such as the Internet of things technology at the University of California, they set up of strategic alliance. As the research of the pioneers in the field of Internet of things, large companies involve in many well-known colleges and universities of research on internet of things. Japan launched the latest Japanese informatization development strategy - "I - Japan", to promote information integration in all aspects of technology, Like service, intelligent medical and intelligent education training. Strive for to 2015, the use of the Internet of things technology in Japan is aim to realize "the new administrative reform", Kim, J. T. (2014) reported. The internet of things simplify the work flow, improve the work of standardization, transparency and efficiency, promote the electronic medical records, remote medical treatment, and all other aspect of medical practice.

2. Neonatal anti-theft system based on internet of things

Newborns hospital security is widely aware by the parents and the attention of the hospital, on a world scale, newborn baby stolen events occur within the hospital not really rare to happen. This is associated with the

special circumstances of the newborn, weak and cannot express or alarm on his/her own, not easy to distinguish, also, hospital as a public environment, the people who come to visit sometimes is hardly to discern their motives. The administrators of the hospital must spend great deal of efforts to make sure the safety of the newborns and the medical staff also required of a lot of attention for the security of the ward. The neonatal anti-theft system can relief the safety concerns of the parents to their baby, also solve the problem of the hospital management for the administrators, will help the administrators focus on other part of medical safety and quality. The system use the world advanced radio frequency identification (RFID) technology, and baby dress up the signal wireless intelligent electronic tag, the tag's signal frequency will not cause ham to human body, Dominikus, S et al, (2014) reported. The tag has a unique ID signal recognition, it can transmit information in real time, continuous monitoring and tracking the position of the baby, once the position is away from normal, the tag will immediately trigger the alarm system. The anti-theft system operating continuously for 24h of every day, free the human resource and improve the overall safety and management level of the hospital.

2.1 The principles of the system

(1) Safe to use with neonates

System design according to the human engineering, cause no allergic to the newborns on skin contact. In addition, the system of the wireless transmission power is greatly lower than the wireless signal power safety standards of human body.

(2) Protect the neonates' safe

When unscrupulous people carry the baby to leave maternity or neonatal wards, as soon as they go through the ward entrance, electronic card reading installed in the door will detect the tag and trigger various alarm device, remind the security staff and medical staff. If the bad guys want to cut off the wrist strap to escape detection, it's also impossible because the system designed to trigger the alarm when the wrist tag is cut off.

(3) Human centered

By the implementation of this set of systems to ensure the safety of the newborn, reduce the pressure on the medical staff, build up the trust of the newborn's family, also the system is an embodiment of the "human-oriented" service concept on medical industry.

2.2 The system design

2.2.1 Mandatory equipment

(1) Electronic Wristbands

Electronic wristband is the core component of the whole system, it inherited a variety of electronic components and powerful functions, easy to launch and cut-resisted, though the design of the system is light weight, comfortable, the wristbands do not stimulate the baby tender, soft skin. Its unique identity verification on the baby who wears it, this identity save in the system, shared with all the surveillance cameras, make sure the baby's safety. Also, the wristbands can be adjusted according to the baby's arm diameter, won't make babies feel oppressed and uncomfortable.

(2) Reading Unit

The reading unit is electronic receiving equipment; the unit can receive wide areas of wireless signal from the electronic wristband. Reading device reads the information on the wristband then compare with the data on the management server at any time, if there is any abnormal information, the reading unit will immediately notify management.

(3) Entrance Monitor & Alarm Unit

Entrance monitor in the system used to monitor and control entrance to the ward, general installation in a controlled area next to the entrance. The monitor provides valuable video information to the reason why the alarm is triggered. The entrance monitor also records the wristbands signals. The alarm unit will notify the relevant personnel.

(4) Communication Gateway

Integrated communication gateway is communication equipment, general installed between different equipment; make sure the connection in a standard and consistent way. The communication gateway also collect, processing the maternity and neonatal ward entrance reading unit and monitor information, and connect all the equipment to the hospital server, make sure the information is shared in the whole system.

(5) Software

The software control the related hardware components, responsible for system operation and management, usually installed in the nurse station. Client software can show the maternity or neonatal ward building structure and the baby's personal information, maternal data and wristbands information.

2.2.2 Optional equipment

(1) GPS Locator

To locate each newborn's position accurately, the GPS locator is needed, the GPS locator will also provide convenient and detailed information of the baby activity and route.

(2) The cellphone Message platform

According to the center control unit, this unit will sent text message to the parents or the medical staff of the alarm contents.

2.2.3 The system topology

Integration of all the necessary equipment and optional equipment, neonatal security system as a whole system topology is as follows (Figure 1).

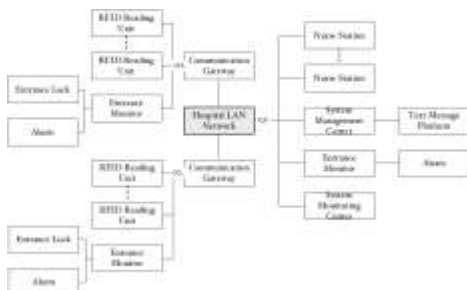


Figure 1: Multi floor neonatal anti-theft system topology

Neonatal equipped with electronic wristband constantly sends out a radio signal, under normal circumstances, the same reading unit close to the floor will constantly receive the signal; At critical situation, the signal will be received by the entrance monitor. All monitors use the same communication gateway, the gateway collect the reading unit and entrance monitor information then upload to the hospital server.

2.3 The system functions

(1) The software function

The software function includes user management, login and logout, newborn information maintenance, display working condition, the operational log, and alarm records, display the wristband map.

(2) The alarm function

The alarm will trigger in two conditions, the wristband been cut off or the wristband leave the ward or go through the ward entrance. And the alarm set in different places; include the nurse station, hospital security room.

3. Outpatient transfusion mobile system based on internet of things

The outpatient transfusion system mainly relies on bar code, mobile intelligent, wireless LAN and wireless paging technology, the system can complete the patient identity verification, transfusion content verification, patient's active smart page, and system auto smart reminder functions. This system will greatly reduce the medical accidents; improve the procedure of outpatient transfusion treatment.

3.1 Procedure

The outpatient transfusion procedure based on Internet of Things is described below:

- (1) Wait for transfusion patients arrive (nurses in transfusion room receive drugs, arrange transfusion chair, print the seat number and transfusion bottle label).
- (2) Nurses in dispensary room label the transfusion bottle, dispense the medicine according to the doctor's advice.
- (3) Patients wait in the assigned seat.
- (4) Transfusion room nurses check the patient's identification with mobile terminal, then inject the medicine.
- (5) After receive the patients call of ending the transfusion, nurses in transfusion room go to the patients' seat and pull out the needle, change the status of patient and seat on the mobile terminal.

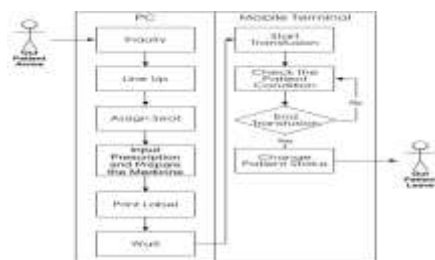


Figure 2: Flow chart of mobile outpatient transfusion system

3.2 The system function

3.2.1 Desktop PC functions

Desktop PC mainly completes the task of transfusion.

Transfusion management function on PC can manage transfusion on patients. (1) Complete the classification prescriptions of own hospital patients and print labels. (2) For other hospital's patients, complete the prescriptions type in and classify, print the labels. (3) Other functions like change the status of transfusion and seats, line up patients.

3.2.2 Mobile terminal functions

Mobile terminal mainly complete the transfusion treatment, system maintenance and mobile terminal maintenance functions.

(1) Transfusion treatment. Transfusion treatment function achieves the patient's identity verification, intravenous injection, changing bottles, confirm transfusion to start, end the transfusion functionality.

(2) System maintenance: maintain the transfusion system, such as the basic operating parameters and transfusion room structure and seats.

(3) Mobile terminal maintenance. Configure the parameters of the mobile terminal, such as brightness, volume.

3.3 The advantage of this system

Compared to the traditional transfusion system, the outpatient transfusion system combined with internet of things has an application advantages in the following seven sections:

(1) The patients' transfusion safety

Because of drugs, transfusion bottle, patient, seats were given a only barcode, transfusion nurses simplify the "three check seven confirm" process with mobile terminal, once anything wouldn't fit, the mobile terminal will trigger the sound alarm, voice prompt, and avoid the dosing error or mismatch.

(2) The patient transfusion information managed with bar code

Patients' barcode contain rich information, covering the patient ID, name, gender, age, drug information, doctors, nurses in transfusion room could easily complete the drug verification and identity check easily.

(3) The patient transfusion information automatic matching

The mobile terminal can scan the barcode of the patient, automatic check the transfusion medicine and patient identification, ensure the transfusion safety.

(4) Wireless manage the patients' transfusion process

Nurses can receive the patients' call or request with the mobile terminal; manage the work wireless in the hospital.

(5) Patient autonomy call

In each patient's transfusion chair equipped with a wireless call button, once the patient press the button, the transfusion room mobile terminal will immediately received signal terminal box, the nurses must make timely response, satisfy the needs of patients anytime and anywhere, Yang, C. (2013) reported, this function will greatly help the transfusion patients not convenient to move.

(6) Efficiency in daily routine work

With the advantage of mobile terminal, such as mobility, scan and computing ability, the nurses can easily accomplish the information collection, information check, and patient location query. The system simplifies the work procedure, improve the transfusion management efficiency and safety.

(7) The improvement in the hospital environment

Through wireless pager, mobile terminal, utilization of electronic tags, line up system, all make patient convenient, easy for nurses to check, the patient will wait in order, reduce the movement of patients, the system provide a quiet, comfort and order hospital environment. The function of the system consists of desktop PC functions and mobile terminal functions, shown in figure 3.

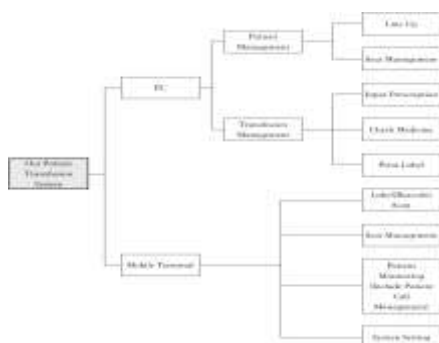


Figure 3: The outpatient transfusion system structure

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