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Application and Effect Evaluation of Infusion Management System Based on Internet of Things Technology in Nursing Work

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Abstract

Purpose: Discussion on the application and effect evaluation of infusion management system based on internet of things technology in nursing work. Method: A total of 108 patients who were hospitalized and treated with intravenous infusion in November 2016 were selected as objects of study. Patients using the infusion management system for the first 3 days were the management group, and patients who used the infusion management system for later 3 days were the experimental group. Conclusion: The application of infusion management system based on internet of things technology optimized infusion work process, monitored infusion process in real-time. Nurses can take the initiative to master the instantaneous information in the patient's infusion process. Working mode changes from passive call to planned active scheduling, which alleviates the nurses' pressure and improves work efficiency. The whole process closed-loop path management of the intelligent and refinement of intravenous infusion in the ward is realized.

Keywords:
Intravenous infusion, Infusion Management System, information technology.

Introduction

The intravenous infusion is the most effective and common treatment in clinic [1]. With an advantage of prompt drug delivery as well as quick therapeutic effect, it has been playing a significant role in treating and saving patients. Statistics show that 90% to 95% of inpatients in China receives intravenous infusions [2]. As the infusion has taken up most of the nursing work, its scientificity and safety is directly related to the quality of nursing service and patients' satisfaction [3]. With an expanding market, intravenous infusions in a traditional way have gradually exposed some problems, mainly as follows: 1. belated change of solutions; 2. difficulty in detecting abnormal conditions during infusion; 3. no trace of infusion process; 4. disturbance of patients' rest.

To effectively reduce the possibility of infusion related accidents, nurses must master related techniques; they should also discover potential safety hazards posed in infusion process in time and make an improvement accordingly so as to enhance safety management of intravenous infusion treatment [4]. Nurses should actively ask patients about their detailed symptoms and check from time to time whether the solution is flowing smoothly and the infusion tube clear. Literatures [5] recorded successful information connection between circulating nurses and patients via wireless calling, meeting the requirement on whole-course verification and check on every step as well as practicing and improving the rule of taking responsibility with signing. Record cards of intravenous infusions hanging beside sickbeds would inform nurses of the treatment and medication process, help in condition observation and reduce the amount of nursing work, thus to cut down malpractices in infusions [6]. Inspection cards of intravenous infusions and signatures of both parties could ensure the right of informed consent to patients and their families, who could then learn the medication details and have their problems solved [7]. With inspection cards, nurses could be more accurate and timely and less blindfold in inspection and observation on patients receiving an intravenous infusion. The above could only be achieved with nurses' frequent ward rounds, resulting in large quantities of nursing work in departments with a large amount of patients. So when nurses are engaged in processing physician orders and other treatment assignments, ward rounds might not meet requirement or replacement of solution could come belated [8].

Above all, a system that automatically monitors infusion, accurately transmits information and inerrably saves date is gaining attention. The infusion management system is an infusion management platform which combines information, intelligence and digital technologies. Without any change of the original infusion way, the management mode of infusion is improved and centralized monitoring, quantitative management and normative service of infusion is achieved. This system could make plans on intravenous infusions, precisely management the dripping speed, monitor and record the whole infusion process and automatically sound an alarm when necessary, which would reduce labour intensity of nurses and ease patients' tensions and anxiety during infusion. This could make intravenous infusions more scientific and safe as well as raise the information management level in modern hospitals [9]. Since October 2016, our department has adopted an intelligent infusion management system which could monitor the whole course of intravenous infusion and sound alarm as well. With simple operation, it could monitor the infusion process and sound alarm of multi-beds simultaneously; at the same time it is associated with the catheter slippage risk and intravenous extravasation risk, reliable and effective.

Methods

Objects of studies

108 patients who were hospitalized in November 2016 and received intravenous infusions are the objects. Selection criteria: patients of the same number in the same ward,

conscious and having the ability of judgment, who received routine intravenous infusions in hospital. Exclusion criteria: patients with mental disorders, or were not treated with intravenous infusions. Taking the circumstances in the three days before and after the infusion management system was adopted as a management group and an experimental group, the ring amount of two groups were compared.

The management group: in the three days before using infusion management system. Each patient took 8 to 10 bags of solution daily, precisely with an average of (8.56±1.15) bags; Nurses did routine rounds of the wards; patients and their families took parts in the infusion management and asked for nurses with a beeper when the infusion was completed or the dripping speed was abnormal. Data of the whole infusion process was typed-in manually and statistically analysed.

The experimental group: in the three days after using infusion management system. Each patient took 6 to 9 bags of solution daily, precisely with an average of (8.07±1.51), and the smart infusion management system was adopted.

The infusion management system and method of operation

1. *Equipment*: One management machine, each bed is equipped with a smart terminal equipment which combines a gravity sensor, an acceleration sensor, an energy-saving wireless system and other hardware technologies together with software systems of algorithms and mathematical model building. The infusion management system takes a whole real-time record and management of infusion information, then syncs it to the database of EMR (Electronic Medical Records) and HIS (Hospital Information System) and NIS (Nursing Information System).
2. *Operating principles*: Infusion process is monitored and recorded with the application of gravity sensing and wireless transmission technology. HIS is used for delivering physician orders, hanging solution bags, weighing and screening solution according to weight. With monitoring accuracy within 1 ml, it could ensure the precision of infusion speed and alarm.
3. *Functions*: ① Making accurate identification of the solution. It could identify the type and specification of infusion bottles, connect several bottles as well as add Nml or extract Nml liquid. ② Recognizing abnormalities of infusion. By calculating the infusion dripping speed with a gravity sensor, it could give an alarm on conditions of empty bottle, dripping too fast, too slow or even coming to a stop. ③ Informing nurses information of the infusion status identified by the system through LED display, computers at the nurses station, mobile workstations, PDA, etc. ④ Displaying different interfaces according to different infusion status, with different alarm sound of different levels that could be set manually. When dripping stops, a red triangle icon would appear on the screen; when the dripping speed is too slow or too fast, a yellow arrow icon would appear on the screen; when the left solution is below 5 ml, the interface would become yellow; when infusion is completed, the interface would flicker in red and automatically stay in red after a minute. All infusion abnormalities can be set to voice, warning tone or vibration on the mobile terminal. ⑤ Making statistics and follow-up upon infusion details of a single patient. ⑥ Making statistics and follow-up upon the quality of infusion treatment: abnormalities including a blocking tube, an over-fast or over-slow dripping speed, needles coming off, etc. could be counted; statistical reports could be provided according to requirements from the nursing department; routine quality index could be established by means of the management system; development of the infusion nursing quality could be learned through data analysis. ⑦ Building up infusion database in the background as basis of decision making and evidence seeking for intravenous treatment and nursing management.

Evaluation index

We will compare and analyze the following data, which include the three-days data of before using the infusion management system and the three-days data of after using the infusion management system: (1) the ring rate (including changing infusion fluid, pulling out the injection needle and the abnormal infusion situation occuring) (2) nurses workload (3) inpatient satisfaction (4) infusion abnormalities (discovered by using the infusion management system) and inpatient clinical data.

Statistical method

We use the SPSS 19.0 software for statistical analysis. Measurement data uses t test and count data uses $\chi 2$ test. $P < 0.05$ for the difference is statistically significant.

Results

Comparison of the ring rate of two infusion groups

Patients in the experimental group is significantly lower than patients in the control group, which the difference of the ring rate is statistically significant. ($P < 0.05$, Table 1)

Table 1– The data of the ring rate [n(%)]

Group	The changing infusion fluid	The pulling out the injection needle	The abnormal infusion situation occurring
Control group (N=534)	189 (35.4)	73 (13.7)	13 (2.4)
Experimental group (N=631)	71 (11.3)	17 (2.7)	6 (1.0)
X2	97.22	48.88	4.02
P	<0.05	<0.05	<0.05

Comparison of nurses workload of two infusion groups

The workload of nurses in experimental group is significantly less than that in control group, which the difference of nurses workload is statistically significant. ($P < 0.05$, Table 2)

Using the nursing satisfaction survey of the PLA General Hospital Hospital

Survey two groups of patients and their families satisfactions with nurses (Very satisfied: 5 points; satisfied: 3 points; not satisfied: 0 points), including active inspection, taking the initiative to serve and promptly providing help, which the difference of satisfactions with nurses is statistically significant. ($P < 0.05$, Table 3)

Table 2– The data of nurses workload

Group	Round trips with no clear purpose	Fluid preparation time (t/min)	Ring time to understand the situation (t/min)
Control group (N=534)	393	4.5±1	5.1±1
Experimental group (N=631)	178	1.2±1	1.1±1
X2	110.1	4.4	5.3
P	<0.05	<0.05	<0.05

Table 3– The data of inpatient satisfaction

Group	Active inspection (Very satisfied)	Taking the initiative to serve (Very satisfied)	Promptly providing help (Very satisfied)
Control group (N=534)	499	480	490
Experimental group (N=631)	625	623	615
X2	26.7	41.5	19.3
P	<0.05	<0.05	<0.05

Infusion abnormalities (discovered by using the infusion management system) and inpatient clinical data. (Table 4)

Table 4– Infusion abnormalities (discovered by using the infusion management system)

Objects	Dropping speed too fast (49)	Dropping speed too slow (38)
Sex		
(male)	35	17
(female)	14	21
Age	19~45	44~80 all above
Upper extremity fracture	13	25
Lower extremity fracture	36	13
Suffering from high blood pressure, diabetes, coronary heart disease	<0.05	<0.05

Discussion

The infusion management system optimizes the infusion process

In traditional infusion process, nurses frequently rushed to every wards, when the patient is in a vein infusion. Because of heavy work， nurses can not always observe the patient's infusion. They often passively informed by the pager to know infusion information (Figure 1). Through the application of intelligent management system of infusion, we simplify and integrate traditional infusion process to improve process efficiency (Figure 2).

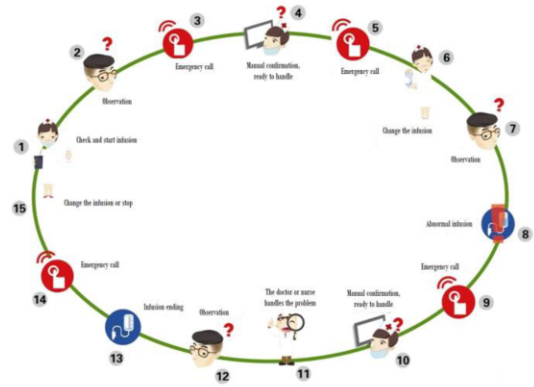

Figure 1– Traditional infusion process

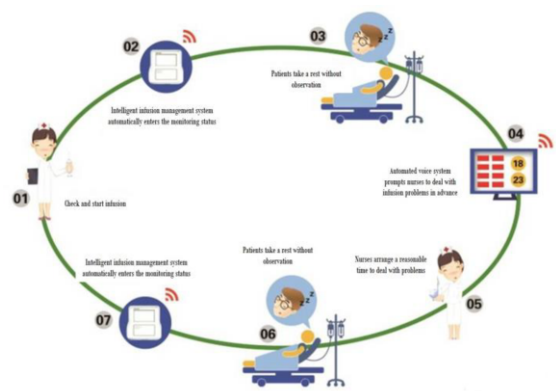

Figure 2– The infusion process of using the intelligent management system

Nurses work efficiency has been greatly improved

There is two challenges in front of nursing managers, one is how to improve the quality of care, and the other is how to improve work efficiency. Modern nursing information technology can effectively solve these problems. Infusion management system can recorde and manage the infusion information in real time. Pre-judge the anomalies that occur in the infusion process and push it to the mobile terminal synchronously. According to the information, nurses distinguish between top-priority and sub-problems and reasonably arrange working routes so as to improve work efficiency. Early warning of various infusion information lets nurses save time and space for the other nursing work, the same time avoiding going back and forth, and reduces the nurses workload and labor intensity [10]. Also improve the efficiency

and flexibility of nursing information system from the structural level (Figure 3).

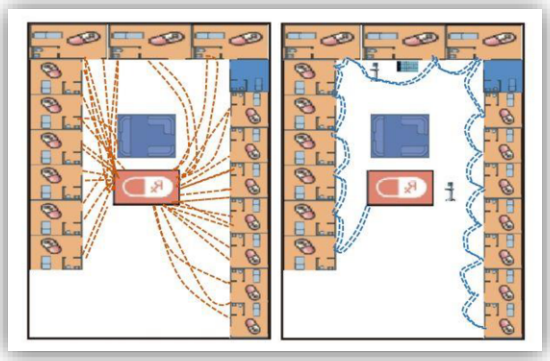

Figure 3– Simulation of nurses activity trajectory before using the infusion management system Simulation of nurses activity trajectory after using the infusion management system

Information technology helps security management

Safe infusion rate is a prerequisite for patients to receive infusion therapy. By using the infusion management system, nurses can be quickly sorted out these problems，which often occurre in the intravenous infusion, for example, fluid extravasation, needle prolapse, infusion pipeline distortion and so on. Patients with special requirements for infusion rate, we can personalize the liquid drip rate range.

Achieve the intravenous infusion of intelligent and sophisticated management in wards

By the internet of things technology， we can carry out monitoring and early warning for infusion problems. Through multiple forms of mobile terminals, the internet of things technology will provide all patients' infusion information in the ward for nurses with all directions. Nurses will do their best preparation and give reasonable treatment for each patient . In this process, the information path is unobstructed and the results of information collection are traceable,what makes it to become a closed-loop management model. The infusion management system can count and track each patient's infusion information. The system can show nurses data in detail, which includes an infusion type, input speed, start and end time of the infusion, the total infusion time and so on.

After statistics，we find that dripping speed too fast occurres in these people，who are age 19 to 45 years old, healthy, with no other chronic diseases and male. Through analysis, these people's the awareness of infusion safety is not very strong, and they often regulate their own infusion speed. So nurses should strengthen the health education of such people's infusion-related knowledge. Also we find that dripping speed too slow occurres in who are usually 44 ~ 80 years old, upper extremity fracture patients, or with other chronic diseases. After analysis, there are some reasons for dripping speed too slow, like fluid extravasation and tubing compression. Therefore, for the infusion of such patients, we choose the contralateral forearm thicker veins to establish venous access and give indwelling trocar, thereby reducing the occurrence of abnormalities. In short, while doing good at education, we must step up active inspections.

Conclusions

Infusion management system based on Internet of Things technology can play a catalytic role in nursing . It can optimize nursing workflow, save time and improve the efficiency of nursing work . At the same time, it promotes the concept of "Internet + Nursing" and provides support for the construction of basic platform for infusion big data for the application of medical big data and evidence-based data for the continuous quality improvement of nursing work.

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