A Total Design and Implementation of an Intelligent Mobile Chemotherapy Medication Administration

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Abstract. The chemotherapy medication administration is a process involved many stakeholders and efforts. Therefore, the information support system cannot be well designed if the entire process was not carefully examined and reengineered first. We, from a 805-teaching medical center, did a process reengineering and involved physicians, pharmacists and IT engineers to work together to design a mobile support solution. System was implemented in March to July, 2013. A 6" android handheld device with 1D BCR was used as the main hardware. 18 nurses were invited to evaluate their perceived acceptance of system based on Technology Acceptance Model for Mobile Service Model. Time saved was also calculated to measure the effectiveness of system. The results showed positive support from nurses. The estimated time saved every year was about 288 nursing days. We believe our mobile chemotherapy medication administration support system is successful in terms of acceptance and real impacts.

Keywords. chemotherapy medication administration, double-checking, handheld device, ICT technology, mobile support system, Technology Acceptance Model for Mobile Service Model

Introduction

The chemotherapy medication administration process has been a very time-consuming nursing task with great safety responsibility [1]. This process is consisted of many safety two-nurse double-checking points to assure the correctness of key information and operations and mental loads to calculate the right volume and set the right IV drop and pumping rates. It is even more challenging because many pieces of key information do come from various sources, such as the pumping rate prescribed by physicians and the preparation of barcode labels and contents are done in pharmacy, such that the design of nursing information system alone cannot help too much if these key data were not well coded from the beginning. For example, the pumping rate order prescribed by physicians in our hospital was used to be coded as free texts, such as "in N/S 250 ml IVD 30 min on Day" which made nurses difficult but necessary to calculate pumping rates manually. Therefore, it appears that we could not implement a good chemotherapy medication administration support system which really save nurses'

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efforts and reduce the chance to make mistakes without examining the entire process. Moreover, a successful chemotherapy medication administration was almost impossible if no ICT technology was used. This does not only imply to develop an information system but also involved the use of right hardware. An information system could indeed provide nurses with orders made from physicians but nurses still need a "right carrier" to bring these data to bed side where point of care happens. We had developed a pilot mobile support system with handheld device and the results were promising [2]. Therefore, this paper will introduce how we designed a new chemotherapy medication administration support system which involved all key stakeholders and was based on our experiences in pilot study.

1. Materials and Method

This study was done at a 59-bed Hematology and Oncology Ward of an 805-bed teaching medical center, which serves 5300 chemotherapy patients every year, in Taipei from March to July of 2013. A task force, lead by Informatics Nursing Supervisor, was organize to develop this new system. This team is consisted of informatics nurses, oncology physician, pharmacist, IT engineer and mobile solution consultant. The reengineering mentality and approach was used in this project to assure the new design was done from a total perspective. The results of a pilot study done in 2012 were reexamined [2].

The MioCare A100 one-hand handheld Pad with 6" display screen and 1D bar code reader was chose as the hardware. The OS for the pad is Android 4.0.3. This device was designed to meet the special requirements needed for healthcare professionals such as splashproof, infection control and drop resistance. A native app was developed using Eclipse IDE. The HIS in this study was homemade. A PHP Web Service was developed to connect the app to the HIS through DB2 Native Driver. The system was shown in Figure 1. Security requirements in this study are the same others in HIS. MAC ID was used to control the entrance in firewall.
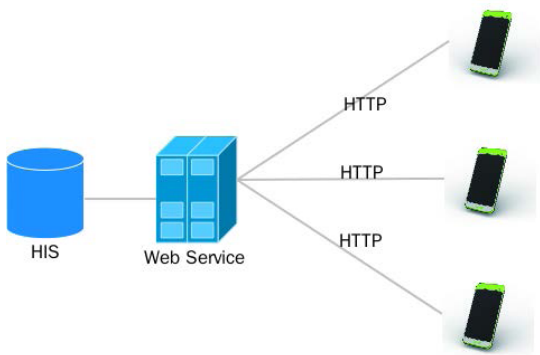

Figure 1. System structure between mobile system and HIS

The system was implemented on line on July and 18 nurses were invited to evaluate the perceived usability of the system. A 4-point Likert scale questionnaire designed by Technology Acceptance Model for Mobile Service model [3] was used to

evaluate all nurses' acceptance of the system. Time for nurses to complete a typical chemotherapy medication administration before and after the mobile system was calculated to measure the effectiveness of the mobile system.

2. Results

The entire workflow was reexamined as Figure 2 and the process was improved before the design of system.
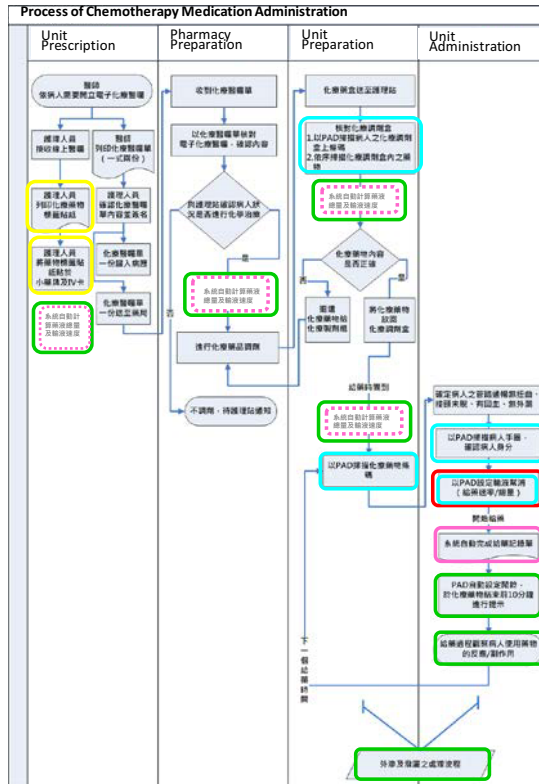

Figure 2. The reengineered chemotherapy medication process. All marked blocks were operations needed to be reengineered and supported by system. The blocks in Yellow means the original manual process was replaced with the system; Blocks in pink are the process simplified or removed; Blocks in blue is the mDoubleCheck module; Blocks in green are supported with decision support module; and Block in red is the our original design.

Related components in HIS were redesigned. For example, the CPOE system was changed that physicians need to enter the order through structured data entry form, Figure 3, so calculations of volume and pumping rate could be done automatically without causing nurses burdens of manual calculations. All nurses were trained with new design in new process.
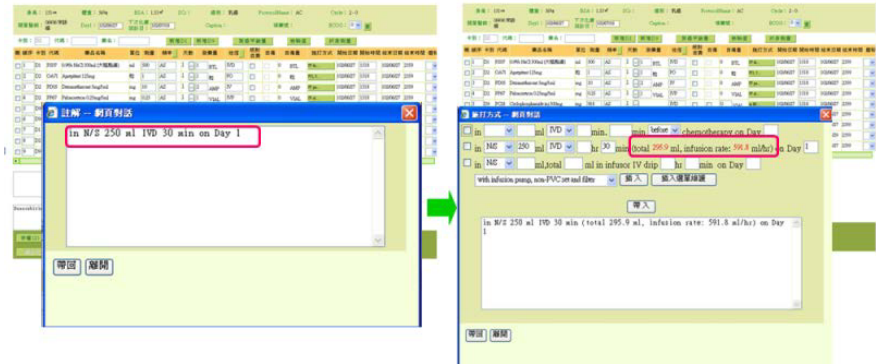
Figure 3. Left: the old interface for physicians to enter pumping rate order; Right: a new structured data entry form was added.

Mobile app was shown in Figure 4 in which usability was highly considered. Some features were added to reduce the loading caused to nurses, such as clock alarm to remind nurses for the next run of medication administration, Figure 5. SOPs for incidents and important process were added so nurses could know to respond once it was needed, Figure 6.

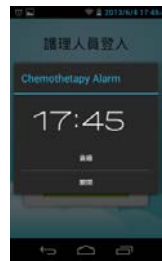**Figure 4**. Mobile Chemotherapy Medication Administration Support System.

Figure 5. Alarm to remind nurses for next run of medication administration.

Figure 6. The SOPs for chemotherapy medication administration.

The results of questionnaire assessment of nurses' perceived acceptance of system were shown in Table 1. The attribute category with the highest score is Acceptance (3.6 out of 4), followed with Ease to Learn (3.37), Satisfaction (3.33), Usefulness (3.14), Ease to Use (3.08) and Trust (2.78). Overall, nurses agreed with the values of mobile solution for their chemotherapy medication administration.

The time saving is significant too. Before the system was introduced, total nursing time from preparation to administration medication was 24 minutes 51 seconds. This time was reduced to 4 minutes 46 seconds afterwards. This implies a time saving of close to 80%. It was estimated that the total saving for the entire hospital for one year was 288 work days, which is equivalent to one normal nurse working for one year.

3. Discussion and Conclusion

The original chemotherapy medication administration process was carefully examined and reengineered before we designed the mobile support system. Both oncology physicians and pharmacists were involved to discuss the necessary changes in their workflow so they could provide needed data in a right format to simplify nurses' efforts latter on. Our IT engineers then modified the HIS components correspondingly. We believe the involvement of these stakeholders really assure a good acceptance of nurses on the mobile system. The evaluation results of nurses' perceived acceptance of system showed the positive supports from nurses. This mobile system was put on live in July of 2013 and nurses' responses to it remain very positive. We believe our design of this mobile chemotherapy medication administration solution do help our nurses to provide quality care for our chemotherapy patients. We keep assessing the effectiveness of this system and would love to report our findings and results.

Table 1. Nurses' perceived acceptance of the system in terms of 18 questions

Question	Strongly Agree 4 n(%)	Agree 3 n(%)	Disagree 2 n(%)	Strongly Disagree 1 n(%)	Ave.	SD	Rank
Usefulness							
1. More convenient to operate	4 (22.2)	12 (66.7)	2(11.1)	0	3.11	0.60	10
2. Save time and get jobs done sooner	2 (11.1)	14 (77.8)	2 (11.1)	0	3.00	0.50	16
3. More convenient for bedside care	6 (33.3)	12 (66.7)	0	0	3.33	0.50	6
4. Better fit care needs	2 (11.1)	16 (88.9)	0	0	3.11	0.33	10
Ease to use							
5. The system layout is easy to understand	6 (33.3)	12 (66.7)	0	0	3.33	0.50	6
6. This system makes documentation simpler	0	14 (77.8)	4 (22.2)	0	2.78	0.44	17
7. It is easy to navigate through system functions	2 (11.1)	16 (88.9)	0	0	3.11	0.33	10
8. Overall, this system is easy to use	2 (11.1)	16 (88.9)	0	0	3.11	0.33	10
Ease to learn							
9. I can quickly learn how to use the system	10 (55.6)	8 (44.4)	0	0	3.56	0.53	3
10. I can easily use the system even without SOP	6 (33.3)	8 (44.4)	4 (22.2)	0	3.11	0.78	10
11. I can become skillful quickly	8 (44.4)	10 (55.6)	0	0	3.44	0.53	4
Acceptance							
12. it is worthwhile to promote to the Pad solutions	12 (66.7)	6 (33.3)	0	0	3.67	0.50	1
13. I am glad to use this system	12 (66.7)	6 (33.3)	0	0	3.67	0.50	1
Satisfaction							
14. I feel this system is what I need	6 (33.3)	10 (55.6)	2 (11.1)	0	3.22	0.67	9
15. I like this system very much	6 (33.3)	12 (66.7)	0	0	3.33	0.50	6
16. I am very satisfied with the convenience from using system	8 (44.4)	10 (55.6)	0	0	3.44	0.53	4
Trust							
17. It will be difficult to make administration errors if I use this system	0	8 (44.4)	10 (55.6)	0	2.44	0.53	18
18. Feel comfortable to use system to care patients	2 (11.1)	16 (88.9)	0	0	3.11	0.33	10
Overall	94 (29.0)	206 (63.6)	24 (7.4)	0	3.22	0.57	

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