June 21, 2011 (Tuesday) 55th EOQ Congress

CONCURRENT SESSIONS — **Tuesday 13:30 – 17:30**

KEMPINSKI HOTEL CORVINUS — **Erzsébet tér 7-8, Budapest V.**

SALON CORVINUS — **Tuesday 15:30 – 17:30**

14.1. QUALITY DEVELOPMENT AND MEASUREMENT METHODS

Session Chair: ***Miflora M. Gatchalian****, Quality Partners Co. Ltd., Philippines*

15.55 A Study on a Method of Planning Countermeasures by Error-Proofing
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A study on a method of planning countermeasures by Error-Proofing

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Summary

Medical incidents, which often occur in hospitals, are considered a social problem. In this study, an error proofing method is applied to reduce the medication incidents related to working methods. In order to simplify the process involved in planning error-proofing countermeasures, the following approaches are employed in this study: (1) extracting improvement objects from working methods by analyzing medication incidents; and (2) correlating the improvement objects with error-proofing solutions that should be adopted. The factors arising will be arranged and presented in the form of a map and a list, respectively. Moreover, these tools are summarized as a procedure.

Keywords

Error proofing, Working method, Countermeasure, Human error, Medication incidents

1. Introduction

In order to provide high-quality healthcare, it is necessary for hospitals to guarantee the safety of their healthcare. However, despite the efforts of hospitals to prevent medical incidents, such events continue to remain common. This is especially the case with regard to medication incidents, which tend to occur when drug injections or internal medicines are administered to patients at a high dosage in hospitals. These incidents therefore require urgent preventative measures.

In general, there are two measures that can help prevent medication incidents: training medical staff, and improving working methods. The improvement of working methods, however, is the more effective of the two for preventing medication incidents. Nakajo [1] demonstrated that error proofing countermeasures can effectively prevent incidents caused by inappropriate working methods. Error proofing (EP) is a device that lowers the probability of human error and has been adopted in various manufacturing processes, in a way that has effectively prevented human error. This approach, however, has not been exploited to any great extent in hospitals. Despite this, many solutions have been proposed by analysts based on their own experiences and ideas. For example, in many hospitals, a staff member involved in making an error is, invariably, simply given a warning. As a consequence, the same medical incidents tend to reoccur.

In this study, and a method for analyzing medication incidents and systematically planning EP countermeasures in order to improve working methods, is proposed, in the hope that it might contribute to the reduction of medication incidents. In addition, the application of the proposed method to a hospital situation will be demonstrated.

2. The Conventional Study and the Approach of the Present Study

2.1 The Conventional Study

Nakajo *et al.* [2][5] added the viewpoint of EP achievement to its principle, and supplied a list of questions for the realization of EP countermeasure. They also showed that EP countermeasures can be systematically generated by answering questions with regard to each error.

Based on the principle of EP, Kawano[3] suggested a technology that could help to both prevent and reduce errors. Subsequently, the ideas and elements of the m-SHEL model were combined, and the procedure relating to the planning of EP countermeasures was proposed.

Ozaki *et al.*[4] extracted human errors and factors from 175 incident reports relating to the process of administration of medication. They also proposed guidelines for planning EP countermeasures against each Error factor. The guidelines are shown in Table 1.

Table 1 the guidelines for planning error-proofing countermeasures (extract)

<table>
<tr><td rowspan="2">Error-proofing solutions
Error-factors</td><td>Complete Substitution</td><td>Part Substitution</td><td>Centralization/Communization</td><td>. . .</td><td>Accommodation</td></tr>
<tr><td>people do not need to work</td><td>assist a part of the work's function</td><td>reduce the differences and the change</td><td>. . .</td><td>make things which are suitable to people's ability</td></tr>
<tr><td>Scattered information</td><td rowspan="3">connect</td><td rowspan="3">visualization of information
instruct and record</td><td>grouping
synchronization
centralization</td><td>. . .</td><td>portable
immobilization</td></tr>
<tr><td>Dependence on memory</td><td>regularize</td><td rowspan="2">. . .</td><td rowspan="2">portable
to reduce the amount and time of memory</td></tr>
<tr><td>Interruption of the work</td><td>remove the interruption</td></tr>
<tr><td>. . .</td><td colspan="5">. . .</td></tr>
<tr><td>Resemblance of name</td><td rowspan="2">machanization</td><td rowspan="2">sample and cage</td><td>. . .</td><td rowspan="2">. . .</td><td rowspan="2">. . .</td></tr>
<tr><td>Indication method of the information</td><td>. . .</td></tr>
</table>

In order to plan EP countermeasures efficiently and systematically, the following two steps are important. First, improvement factors should be easily identifiable from the context of the incident. Second, the EP solution that is most appropriate for application to the identified improvement objects should also be easy to identify. However, although the method involved in planning measures is outlined in the former two studies, the means of identifying both the Error factor and the improvement objects was not provided. Therefore, it is not an easy method for the medical staff to adopt. The latter study, on the other hand, describes a method for analyzing incidents in detail. However, since the "Error factor" represents an abstraction, it is difficult to designate which objects in relation to the working method need to be improved, even when the Error factor has been identified. As a result, this gives rise to difficulties in the planning of concrete countermeasures.

2.2 The Approach of the Present Study

If the improvement objects relating to the Error factor is able to be identified and the necessary error-proofing solution can also be specified, the problem mentioned in section 2.1 can be solved.

This study thereby suggests a tool for solving this problem. The tool has been developed according to the following steps: (1) correlation of the Error factors with the improvement components relating to them, and (2) correlation of the improvement components with the EP solutions that should be adapted to them. These steps are described in chapter 3 and 4 and the procedure involved in the analysis of medication incidents and the planning of EP countermeasures is shown in chapter 5.

3. Correlate the Error Factors with the Improvement Objects

3.1 The Process of Extracting Improvement Objects

In order to correlate the Error factors with the corresponding improvement objects, it is necessary to (1) analyze medical accidents, extract the improvement objects, and then arrange the results, and, thereafter, (2) correlate the Error factors with the improvement objects.

Medication service involves a series of processes, beginning with a doctor’s prescription of medicines for a patient and ending with the administration of relevant medicines by nurses to the respective patients. It is, therefore, necessary to extract the improvement objects for each working method. To achieve this, it is also necessary to divide the operations into appropriate units. In this study, Error factors are used. Then, extract the improvement objects that can help solve the work factor. The process for extracting the improvement objects is outlines below as an example.

[Case example 1]

There are SSA, SSB and SSX, three choices in a sliding scale list (SS. List). Based on the prescription from the doctor, the nurse decides whether to administer the medicine to the patient by way of a BS check. In this example, doctor A checks the SSX of patient B on the prescription and the SS. List. However, nurse C, who takes care of Pt. B, misconstrues SSX as SSB and chooses SSB. As a result, Nurse C does not prepare the medicines for Pt. B.

From the example mentioned above, it is clear that the nurse has chosen the erroneous information because of the existence of various options (three choices) in an SS. List when she comprehended the order of administration. Because there were various options printed on the SS. List, the nurse recognized the erroneous information. Therefore, “Error factor” can be identified as “various choices”.

3.2 A Map of Error Factors and Improvement Objects

In order to make the analysis more straightforward, it is useful to rearrange the Error factors and the improvement objects related to them in a systematic way. We therefore produced a similar analysis as shown in section 3.1 relating to 581 medication incidents that arose as a result of the working practices in Hospital A and Hospital B. The Error factors were identified first. Based on these, the extracted improvement objects were then identified. Finally, these were systematized using the KJ method. As a result of relating the Error factors to the improvement objects, a “map of Error factors and improvement objects” was constructed. This map is set out in Table 2.

Table 2 Map of Error factors and improvement objects (extract)

Error-factors \ Improvement objects		Information media	Information content	Medicine	Equipment	Work tool	Perception	. . .	Patient placement	Time	Place
Skipping Error	Scattered information	●	●			●	●				●
	Dependence on memory	●	●					. . .	●	●	
	Interruption of the work	●							●	●	
	. . .	. . .									
Mistaking Error	. . .	. . .									
	Resemblance of name		●	●	●	●			●		●
	Various choices	●	●	●	●	●		. . .	●		
	Indication method of the information		●	●	●	●	●				

From this map it can be seen that the vertical axis gives the Error factors and the horizontal axis shows the improvement objects. The Error factor is required to be initially located for a certain incident along the vertical axis according to this map. Following this, the positions which correspond to the vertical axis need to be found. Thus, it is possible to specify the improvement objects related to the Error factor easily and efficiently that ensures the improvement objects are not overlooked.

The Error factors and the improvement objects set out in Table 2 constitute the results of the analysis regarding 581 medication incident cases that occurred in hospital A and B during a period of 30 months, and consequently it should be considered that we obtained almost major Error factors and improvement objects related to them even though there is a little possibility of other Error factors that have not occurred in this period.

4. Correlate Improvement Objects with EP Solutions

In order to efficiently identify which EP solutions should be adapted to the improvement objects identified in chapter 3, this chapter considers the correlation of each improvement object extracted with the appropriate EP solutions.

As the EP solutions represent no more than an abstraction, and in order that medical staffs are able to exploit this more easily with regard to planning countermeasures, the EP solutions have been outlined in the form of a question. Part of the result is shown in Table 3 .

Table 3 Question type regarding EP solutions (extract)

Improvement Objects	EP solution	Questions	Countermeasure Sample
1. Information medium	Remove	1.1 Is there any unnecessary information?	The work has been down, install the past prescription to the place of the appointment immediately
	mechanization	1.2 Can we become the medium to mechanize or computerize?	Introduce an effective ordering system.
	Grouping	1.3 Can you put the connection information mediums in one place?	Put the connection prescription in one place.
・・・	・・・		
5. Memory	visualization of information	5.3 Even if a worker does not memorize it, how is it that the information. can always be visible?	Make a sticker reading " STOP-please check the name band" and complete it
	sample and cage	5.4 In some kinds of situations, why is it that a worker does not memorize information and cannot always confirm it?	I will outline instructions for the day on a white board beforehand and can confirm them anytime
・・・	・・・		

By referring to Table 3, just answer the question of EP solutions identified from Table 3, the EP countermeasures can be planned easily.

5. Procedure Proposal for Planning Countermeasures

Based on the contents of chapter 4 and 5, a procedure for analyzing accidents and planning EP countermeasures is proposed. The details of each step are set out below.

<Step 1> Collecting and classifying medication incidents

1-1) collecting medication incidents

Collect information on incidents when there is a difference between the plan and what occurs in actual work.

1-2) distinguishing medication incidents

In addition to the conventional approach, this study utilizes the classification proposed by Nakajo, in order to select incidents that occur because of the working method. The following steps focus only on those incidents that are classified as problems associated with the working method.

<Step 2> Analyzing incidents in order to classify Error factors

With regard to every incident initially classified as a problem in relation to the working method, the Error factors will be useful.

<Step 3> Selection of the improvement object and the EP solution that needs to be adopted

3-1) selecting the improvement objects

From the Error factor analyzed in step 2, the related improvement objects can be selected by referring to the map(Table 2).

3-2) selecting the EP solution that should be adopted

By referring to the list, the EP solution that should be adopted for the improvement object as selected in step 3-1 can be identified. Following this, the question type for the EP solution identified from table 3 is found.

<Step 4> Planning countermeasures

By answering the question regarding the adopted EP solutions for the improvement objects identified in the previous step, countermeasures can thereby be planned.

6. Application of the Method Proposed in the Present Study

6.1 Application of the Method

The proposed method was applied to incidents that occurred in hospital B. A summary of the accident and processes involved in the application is given below.

[Case example 2]

When the nurse prepared necessary one time medicines from the medicine box where the medicines of patient one day in. However, as there were two medicines and, because the bottle shape and size were similar, the nurse erroneous selected and prepared the inappropriate medicine. The erroneous medicine was consequently administered to the patient.

Because the above mentioned incident came about due to working methods, the method proposed in Step 2 was thus applied.

<Step 2>

By analyzing the above mentioned incident, because there are various similar medicines in the medicine box, the Error factor “resemblance in the appearance” can be identified.

<Step 3>

3-1) First find the Error factor as analyzed in step 2 by referring to the map. Following this, the positions which correspond to the vertical axis can be found. As a result, the improvement objects related to the Error factor can be identified as "Information content," "Medicine," "Recognition," "Action."

3-2) Next, refer to the list to identify suitable EP solutions for the improvement objects selected in step 3-1. For example, we found "Information content." Following this, the positions which correspond to the vertical axis can be found. As a result, the EP solutions "express attention clearly," which can be adapted to the "information content," can be identified, as well as the question type "express attention clearly" by referring to table 3, which is represented by item 5–4).

<Step 4>

In this step, we apply the EP solutions to the improvement objects identified in step 3, and answer the question regarding examining the countermeasure for the working method. As an example, we answer the question "Is it possible to express attention to incomprehensible indication or special medicine" to "Information content," a countermeasure can be planned such as "writes the name of appearance similar medicine using red letter to express attention in prescription." Other examples examined are set out in table 4.

Table 4 Examples of EP countermeasures

Improvement Objects	The Solution Of EP	Countermeasures
Information content	Display information	① Write the name of medicines that look similar in a red pen to draw attention in the prescription
Medicine	Iidentification	② Devise a way to clearly distinguish between the appearance of the medicines
	Individualization	③ After the medicines are supplied, arrange them promptly
Recognizition	Do it first	④ The doctor who writes the prescription should prepare the medicines
Action	Remove	⑤ Supply only medicines that are necessary to eliminate the operation of "choosing"
	Mechanization	⑥ Use the bar the bar-code system to choose the right medicine

As table 4 indicates, it is easier to plan various error-proofing countermeasures by answering the question with regard to the adopted EP solution for the improvement objects that have been identified. As a result of discussions with the medical staff, it was judged possible to introduce the countermeasures in order to reduce incidents.

6.2 Verification of the Efficacy of the Proposed Method through Decreasing Incidents

In hospital B, the incident shown in section 6.1 tended to repeatedly occur. We therefore introduced the above mentioned countermeasure into 3 wards of hospital B. We compared the number of the same kind of incidents before and after improvement. From this it could be seen that, 10 incidents occurred 14 months before the introduction of the countermeasure but, on the other hand, no similar incidents occurred up to 13 months after the introduction of the countermeasure. The countermeasure could therefore be seen as effective in preventing and reducing medication incidents.

7. Discussion

7.1 Significance of this study

In this paper, Error factors were identified from 581 incident reports of Hospital A and B. The relationship between Error factors and improvement objects were then clarified through utilizing maps. Furthermore, a list that clearly indicates which EP solutions should be adopted for the improvement objects were suggested. There is, therefore, a significant difference between the proposed and the conventional method, and this makes it possible to plan the EP countermeasures easily.

In addition, when the proposed method was applied to actual incident cases, the improvement objects could also be more easily found that shows how EP countermeasures can thus be planned systematically. Finally, we found that the selected countermeasure is capable of reducing the number of incidents regarding error.

From these discussions, it can be surmised that the proposed method can serve as a useful means for planning EP countermeasures and reducing the number of medication incidents. On the other hand, there are various countermeasures can be planned for one incident by applying the proposed method. In the future, it will therefore be necessary to consider which countermeasure needs to be selected.

7.2 Features of the Proposed Map

The proposed map includes the following features.

(1) Focuses only on the problems of the working method.
(2) Possible to identify the Error factor of an incident rapidly.
(3) Possible to squeeze the importance improvement object.

(1)Today, most improvements in hospitals focus on human problems such as education and training. This, however, fails to make out the effect as we expected. The reason for this is that it is extremely difficult to reduce human error. As “to err is to be human,” any person is therefore likely to make a mistake. On the other hand, the present study has produced a map centering on medication incidents in relation to working methods. It is thereby possible to improve working methods, and become more efficient in preventing medication incidents.

(2)From the map, we can find that the Error factors are limited. This means that when the work factor of incidents is analyzed, similar case incidents can be referred to in the map. It is accordingly possible to identify the Error factor of an incident with greater rapidity.

(3) It is also possible to identify the occurrence tendency of the incidents by using the map. In this respect, it is possible to identify the important improvement objects by applying the proposed method to various incidents that occurred in a certain period. As an example, if we get the highest number of totals of the improvement objects "prescription" after analyzed the incidents. This means that, in order to reduce incidents substantially, it is necessary to improve the root cause "prescription." Therefore, the countermeasure such as order-entry system or electronic chart can be considered. This will make the decrease in incidents far more likely.

8. Conclusion and Future Research

In this study, Error factors, the corresponding improvement objects, and adapted EP solutions were correlated with one another, and a procedure for analyzing incidents and planning EP countermeasures was proposed.

Future research could include a selection method with regard to the planned countermeasures and the application of the proposed solutions to a greater number of hospitals.

References

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