

Statistical Process Analysis of Medical Incidents

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Abstract: Recently, in an effort to construct a system that reduces the risk of medical care, people engaged in the medical field have implemented continual improvement by team activities. Knowledge in total quality management (TQM), especially statistical process analysis and control (SPC) developed in the industrial field, seems to be applicable to medical care.

This paper describes the application of statistical process analysis and control to continual improvement in medical care.

Key Words: incident analysis, C-control chart, CART

1 Introduction

In several years, people engaged in medical care have striven to continuously improve the occurrence rate of incidents, an incident being defined as an event having an assignable cause and involving risk. We have supported these activities as members of an improvement team whose responsibility is to perform data analysis by applying the concept of TQM and statistical methods for SQC.

We have proposed an approach for minimizing risk and have constructed a system for reducing risk in total team activity. This paper describes the advantages of using SQC, through examination of data obtained as the foundation of integrated medical risk management.

2 The step of improvement

Berwick (2000) has pointed out that continual improvement processes are classified into three types:

Type 1: Reducing defects in quality as experienced by the customer.

Type 2: Reducing costs while maintaining or improving the experience of the customer.

Type 3: Creating and meeting a new demand, or satisfying a pre-existing demand at an unprecedented level of performance.

These three types form a hierarchical structure as shown in Fig. 1: Type 1 is of the lowest level, Type 2 is of a level higher than that of Type 1, and Type 3 is of a level higher than that of Type 2.

Judging from the structure, we decided that the current state of the improvement process at the hospital concerned falls between Type 1 and Type 2, because the improvement activities are centered by a QC circle.

We started by preparing for and analyzing the data set under the above-mentioned phase of the improvement process. The data set consists of 845 cases arranged on the basis of incident reports as shown in Table 1, which was constructed according to the classification code table shown in Table 2. The reports were collected from January to June 2001.

We applied the following SQC techniques and then analyzed as follows:

(1) To grasp the control state of daily medical care management, we analyzed the daily incidents by applying a C-control chart.

(2) To pursue the incident process, the CART (Classification And Regression Trees) technique was applied to the incident process.

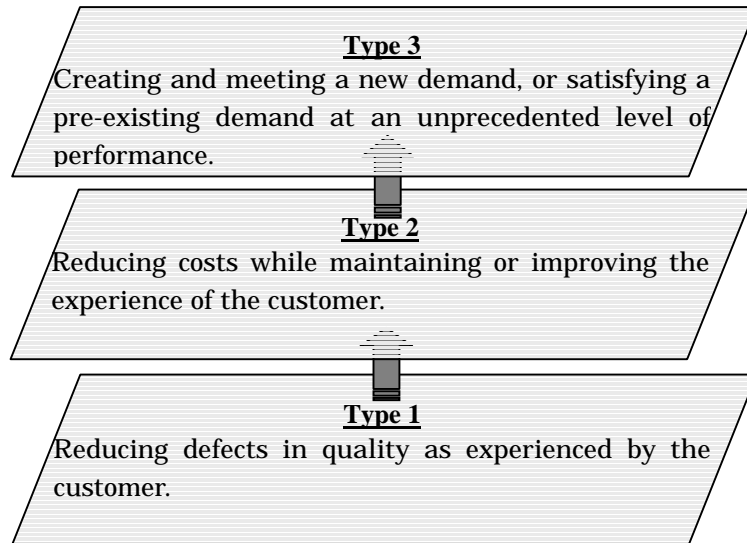


Figure 1. Structure of the Improvement Process

3 Analysis by C-control chart

We constructed a C-control chart having a subgroup composed of the number of incidents per day, and examined whether the daily incidents were controlled. The chart is shown in Figure 2. Since the out-of-control points from the upper control limit exist for 6 days, the occurrence of incidents is not under a statistically stable state.

Figure 3 shows the Pareto diagram in which the incident cases are arranged by job classification. As seen in Figure 3, the rate of incidents attributable to nurses is the highest, at about 80%. After classification of the incidents attributable to nurses into nursing tasks as shown in Figure 4, we can see that medication (classification A) accounts for more than 40%.

Table 1. Incident Report

Safely Report									
01. Incident			02. Accident			03. Find			
Patient	※Name			※Sex			※Age		
	※Distinction	Others()		※Section			Others()		
	※Disease								
Reporter	※Job	Others()		In find, also enter partner's occupational description.					
	※Assignment	Others()		※Job			Others()		
	Experience (Present)			Y	Experience (Present, Post)			Y	
	Condition								
Problem	※Generating day	D/M/Y (A.D)		※Generating time					
	※Generating place	Others()		Background			※Generating cases		
	※Progress:								
	※Classification			Others()		Cause④		Others()	

Table 2. Classification code table

		Safety Report Classification Code Table							
Distinction	Distinction	01. Visitor	02. Hospitalization	99. Others	Gender	01. Male	02. Female		
		The department of medical care section	01. Internal medicine	02. Inside of nerve	03. Neuroscience	04. Pediatrics	05. Obstetrics and gynecology	06. Surgery	07. Esthetic surgery
Reporter	Type of job	09. Ophthalmology	10. Otolaryngology	11. Dermatology	12. Radiology	13. Anesthesiology	99. Others		
	Assignment	01. Doctor	02. Nurse	03. Midwife	04. Pharmacist	05. Inspection engineer	06. Radiation engineer	07. Physiotherapist	08. Clinical engineer
		10. Licensed cook	11. Assistant nurse	12. Clerical employee	99. Others				
		01. Visitor	02. Second floor ward, east wing	03. Fourth floor ward, east wing	04. Third floor ward, north wing	05. Fourth floor ward, north wing	06. Fifth floor ward, north wing	07. Sixth floor ward, north wing	08. Seventh floor ward, north wing
		09. Kidney center	10. Operating department	11. Pharmacy	12. Inspecting room	13. Radiology	14. The department of rehabilitation	15. Being home	16. The department of nutrition
			99. Others						

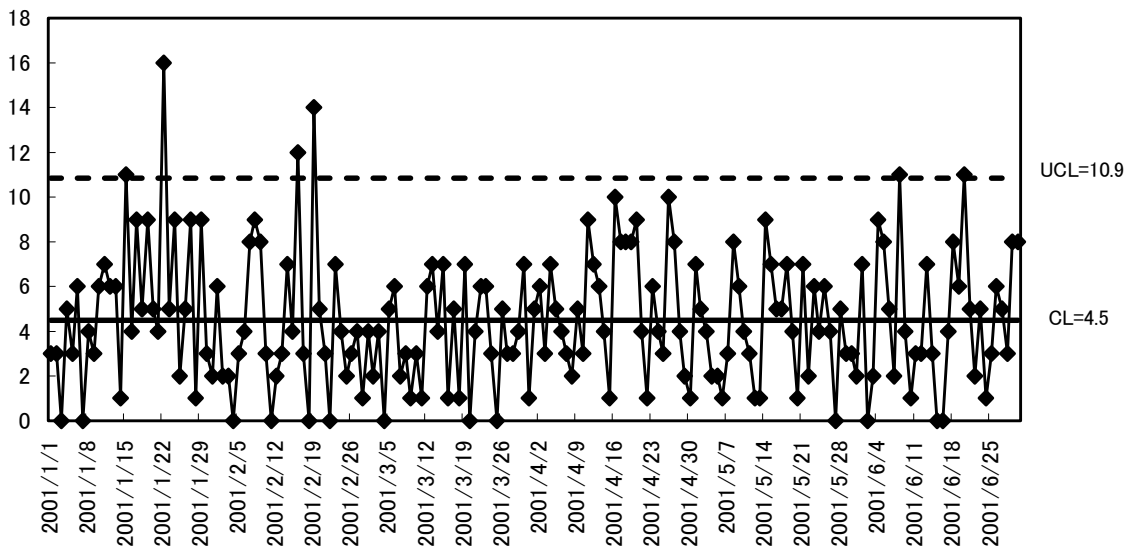


Figure 2. C-control Chart of Daily Incident Cases.

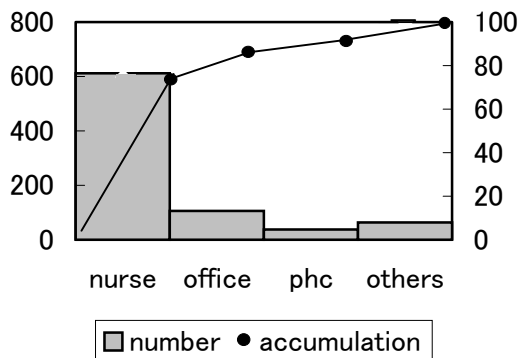


Figure 3. Pareto Diagram by Job Classification.

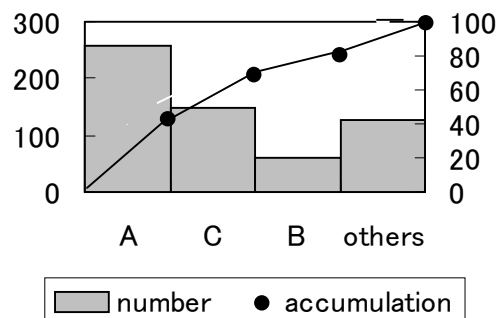


Figure 4. Pareto Diagram by Causes of Incident by Nursing

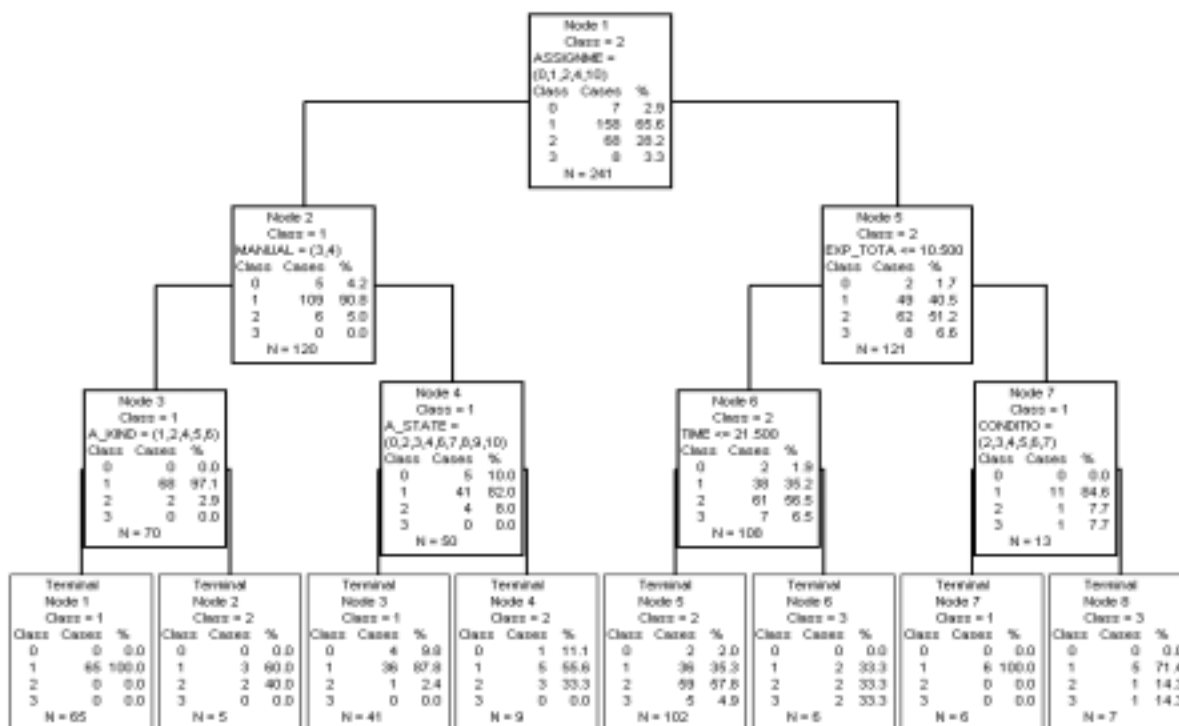


Figure 6. Incident Classification tree

4 Incident process analysis by CART

In the next stage, we used CART to analyze the process of the classification A (mediation in nursing tasks). The Degree of risk to a patient is set as the response variable, and In-charge of-nursing station, Years-of-experience, and Existence of nursing manual (standard operation procedure, SOP) were set as predictors. Figure 6 shows the result of analysis. Existences of a manual, Kind of administration, Situation of administration, and Working-hours were employed as split variables so as to construct a classification tree. As seen in this figure, the cases where the risk becomes high are terminal nodes No. 6 and No. 8.

The path to terminal node No. 6 is as follows: the root path is divided by In-charge of-nursing station (to the right); Years-of experience splits the second branch from the root (to the left); the last split variable is Working-hour, which leads to the terminal node.

Meanwhile, the path to No. 8 is as follows: the same path as that of terminal node No. 6, up to Years-of-experience, but if the variable is ten years or more and the nurse's health condition is not good, then the high risk terminal node, No. 8 is reached.

5 Conclusions

This paper reports the progress of application of the concepts and methods developed in TQM to

reducing medical incidents. Current progress is summarized as follows:

- (1) Because the tasks within a nursing process are not always standardized, the current phase of quality improvement is near the layer of Type 1. Recognizing the present status and advancing improvement from this stage are important.
- (2) Medical incident path analysis by application CART is thought to be useful in causal analysis for reducing medical errors.
- (3) The basic concepts of statistical quality control developed in the industrial field can be useful when adapted to the nursing process.

The authors are participating in the improvement team and assisting activities for attaining stable state of nursing incidents and reducing patient risk.

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