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Discrete Event Simulation Analysis for Optimization of Outpatient Flow

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Abstract

The Okayama Central Clinic is a community hospital located in a city with a population of 680,000. A routine customer-satisfaction survey showed that the most important and critical issue of the clinic is "long waiting-time." The purpose of this study was to utilize discrete simulation analysis to optimize outpatient flow and resource allocation.

Discrete simulation analysis (DES) using Simul8 software (Simul8, Inc., Boston, MA) was used to model a work flow of the clinic, and to identify the bottlenecks of the model. Time data was derived from the time survey at the clinic.

Baseline data showed that the average waiting time before examination by a physician was 35.3 minutes, and only 1.6% of the patients waited for less than 10 minutes. The physician's examination was identified as the bottleneck of this model. The DES demonstrates that setting up warm-up time is an efficient way to decrease average patient time spent at the clinic without increasing the physician's workload.

Keywords:

discrete event simulation, process optimization, outpatient

Introduction

The Okayama Central Clinic is a community hospital located in a city with a population of 680,000. A routine customer-satisfaction survey has demonstrated that the most important and critical issue of the clinic is the "long waiting-time." The "long waiting-time" is also a critical issue at hospital emergency rooms in the U.S.A. [1]. The patients' satisfaction is one of the factors constituting to the quality of care, and it is clear that the long waiting-time will lead to the degradation of quality of care.

Systematic problem solving of ambulatory care is needed for a long time. Identification of bottlenecks and planning countermeasures may have been considered in hospitals, however, it seems that practical applications of improvement plans are difficult.

Simulation is one of the most widely used operation research and management science techniques for evaluating systems. Discrete Event Simulation is one of the simulation techniques, that has been used to analyze ambulatory care [2, 3]. Improvement plans for ambulatory care can be inspected by the simulation, and it can prevent risks attending application of the improvement plans directly to the real world.

The purpose of this study is to simulate outpatient flow in a primary care clinic, identify the bottleneck of the flow, and develop a quality improvement plan.

Materials and methods

Figure 1 shows a work flow of the Okayama Central Clinic.

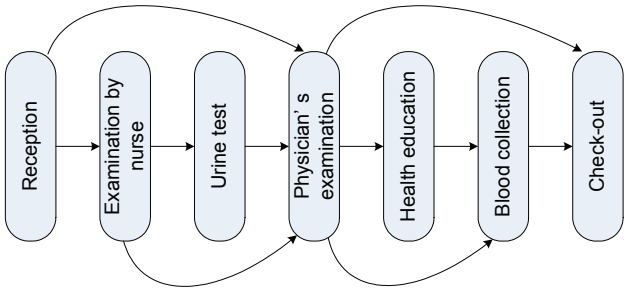

Figure 1 – Simplified Work flow at the Clinic

All patients were required to check-in at the reception desk. There were two types of patients: those with and without an appointment with the physician. Depending on the patient conditions, patients would receive (1) an initial interview by the nurse, (2) a urine test, or (3) both. Subsequently, all patients see a physician for examination. Some patients would have blood collected, and others may need health education for diet and exercise. Finally, all patients were required to check out.

We used Simul8 software (Simul8, Inc., Boston, MA) for the discrete simulation. Time data was derived from the time study at the Okayama Central Clinic.

Prerequisites

1. Table 1 shows the time data from the time study at the Okayama Central Clinic

Table 1 – Simulated Patients' time Spent at the Clinic

Name of Work Station	Patient's Time spentminutes
Reception 1	8
Reception 2	5
Nurse's Inquiry with urine test	10
Nurse's Inquiry without urine test	15
Urine examination	20
Physician's examination	10
Blood collection	5
Blood examination at Laboratory	30
Check out	10

2. Patients

   According to the average distribution at the clinic, 70% of patients received the nurse's inquiry with urine examination, 20% received nurse's inquiry without urine examination, and 10% passed through the steps of nurse's inquiry.

3. Resources

   One doctor, three nurses, four receptionists, and four laboratory technicians were used in this model.

4. Operation time of clinic

   The opening time of the clinic is 9:00 AM. Patients were accepted until 12:00 PM. Patients arrived at the clinic every 10 minutes.

Results

Baseline data show that the average waiting time before the physician's examination was 35.3 minutes, and patients waiting less than 10 minutes were 1.6%. The physician's examination is identified as a bottleneck of this model.

The time pattern used by the physician shows that the doctor did not work for 40–45 minutes after the opening time of the clinic because the patients had not been ready to have physician's examination at that time.

Table 2 reveals the result of the simulation. Average time spent at the clinic can be decreased without increasing physician's time (which is more important) if we set-up a one-hour warm-up time (i.e., the first patient is asked to visit the clinic at 8:00 AM, although the scheduled time is 9:00 AM). However, little difference was observed in number of patients who visited the clinic.

Table 2 – Simulated Patients' time Spent at the Clinic

Patients' time spent at the clinic	Average Time Spent(minutes)	Number of Patients
Open at 9:00 AM	99.9	23
Open at 9:00 AM with 1 hour warm-up	85.5	24
Physician start work at 8:45 AM	81.5	24

Conclusion

This analysis demonstrates that we could increase the efficiency without increasing the bottle-neck or the physician's workload. Further analysis is needed to identify the optimal resource utilization to improve the availability of the doctor and throughput of the system.

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