

## COMPARISON BETWEEN SEQUENTIAL EVACUATION AND SIMULTANEOUS EVACUATION IN A HOSPITAL STAIRCASE

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### ABSTRACT

Even though operation management of emergency evacuation in the event of a disaster has become a major challenge for risk managers in healthcare facilities, it is still difficult for hospitals to develop effective evacuation plans considering patients' mobility. In this study, a simulation comparison of simultaneous evacuation and sequential evacuation with staircase evacuation methods for the hospital studied was conducted, corresponding to the movement characteristics of patients who need transportation equipment and caregivers. As a result, it was clarified that simultaneous evacuation is more appropriate in this hospital where many patients requiring helpers stay at the upper floors.

### 1 INTRODUCTION

Operation management of emergency evacuation in the event of a disaster has become a major issue amid the increasing occurrences of natural disasters. Regarding operational analysis of evacuation from buildings in the event of a disaster, many are based on the walking speed of healthy adults. On the other hand, in evacuation in the case of hospitals, there is a mix of patients who need transportation equipment such as wheelchairs and stretchers and those who need assistance such as from nurses. In evacuation of patients with different characteristics in hospitals, it has not been adequately examined whether evacuation methods that assume healthy adults are applicable or not. Based on this study of patient evacuation from an actual hospital building, it should be emphasized that when the number of patients who needed evacuation support from two helpers using blankets increases by 10%, the evacuation completion time increases by 2.43 times (Yokouchi 2017). In this case study, with staircase evacuation methods in hospital buildings, the aim is to analyze whether it is more appropriate to conduct simultaneous evacuation for all patients on each floor or sequential evacuation from the upper floors.

## 2 CASE STUDY

The hospital in this case study, Iwasa Hospital and Maternity, is located in Gifu, Japan. The hospital has five floors and 132 beds in three wards for inpatients. The patients were divided into three transfer types according to evacuation ability: type 1 for patients transferred on stretchers with 2 assistants, type 2 for patients transferred on wheelchairs with an assistant, and type 3 for patients who can walk without assistance. The three types of patients were assigned with specific moving speed and areas from which to evacuate; the moving speed also varied according to the area's crowd density (Togawa 1958; Ohnishi et al. 1986). The inpatients started evacuation from each room via the two exit to staircase simultaneously. It was decided that two groups of four staff members each for the staircase section would transport Type 1 and Type 2 patients allocated based on the floor transportation experiment data. Two models were constructed with Arena version 14.5 on this study. In the simultaneous evacuation model, evacuation of patients of each ward on the 4th, 3rd and 2nd floors was started simultaneously from the rooms to the first floor exit. In the sequential evacuation model, the evacuation starting time of patients on the 3rd and 2nd floors were assigned 2 minutes and 3 minutes after evacuation of patients on the 4th floor. The time when the patients passed through the exit on the first floor was considered the evacuation completion time. A comparison was conducted using two indicators, completion time and required time of evacuation.

## 3 RESULT

Evacuation time was the longest averaging 59.04 minutes for Type 1 patients in the ward for rehabilitation and internal medicine service at 4th floor in the case of simultaneous evacuation, as shown in Figure 1. For the ward at 4th floor only, the time required for evacuation in the sequential evacuation model was less, compared with the sequential evacuation model. While for the wards with other floors, the time required for evacuation was less in the case of the simultaneous evacuation model. Regarding evacuation completion time, it was slowest at 74.48 minutes for Type 2 patients in the ward at 4th floor as shown in Figure 2, and there was a tendency for evacuation completion time to be on the whole slower for sequential evacuation.

## 4 SUMMARY

From the simulation results, it should be emphasized that sequential evacuation from upper floors demonstrated in the case of building fires in general was not effective in the case of this hospital indicating the possibility of delay in evacuation completion time. It can be considered that in the case of this hospital, the given composition of hospital beds, especially the large number of patients who needed assistance in the upper floors had an influence over the evacuation operations of the total hospital stairs.

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