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A Transition Model for Patient Conditions Based on Hospital Information System Data

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Abstract

For efficient use of hospital beds, it is important to know each patient's stage of hospitalization and be able to estimate when the patient may be discharged. In this study, we constructed a time-related transition model based on hospital information system (HIS) data in order to recognize the stage of hospitalization by classifying patient's daily conditions into clusters, and calculating the transition between these clusters for all patients. To classify all patient's daily conditions into clusters, we applied Ward's method, a hierarchical aggregative clustering method. We then constructed a transition model of patients with brain infarction using HIS data of the University of Tokyo Hospital from April 1 2004 to March 31 2005. Validation of the model and generalization of this method to other data sets and diseases are future goals for this project.

Keywords:

Transition Model, Cluster Analysis, Hospital Information Systems, Brain Infarction

Introduction

In large hospitals where many patients are treated, the proper management of inpatients and efficient use of beds is vital. In order to achieve this, it is important to know each patient's stage of hospitalization. The overall goal of this study is to devise a general method for constructing a reference model, based on hospital information system (HIS) data. Prior to generalization of the model, the objective of this preliminary study is to construct a time-related transition model, from admission to discharge, for patients with brain infarction. By comparing the condition of a new inpatient to the transition model, we can elucidate the patient's current stage of hospitalization, predict possible changes in the patient's condition, and estimate when the patient may be discharged.

Methods

Construct of the transition model was carried out in three steps.

Defining patient's daily condition

The accounting data, part of the recorded HIS data, of inpatients diagnosed with brain infarction on the day of admission or on the following day was used for analysis. Three kinds of items were excluded from the data.

- Items unrelated to the medical intervention; e.g., additional fee for special room.
- Items showing the names of drugs or laboratory tests; e.g., AST (aspartate aminotransferase).
- Items that appeared only five times or less.

As a result, 57 items of medical intervention (intravenous drip, physiotherapy, chest X-ray roentgenogram, etc.) were selected, and a patient's daily condition was defined based on the status of these 57 items (being carried out (= 1); or not being carried out (= 0)). Each condition was then plotted on a 57-dimensional binary space.

Classifying patient's daily conditions

The daily conditions of every patient were classified by applying Ward's method ([1], pp.142-145), a hierarchical aggregative clustering method, in the 57-dimensional binary space, to form five clusters.

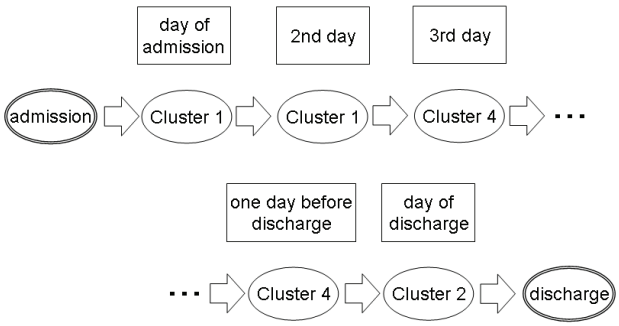

Figure 1 - Transition of one patient's conditions.

Constructing time-related transition model

The transition of each patient's conditions was represented by listing the clusters that the patient was classified into, from admission, the first transition condition, to discharge, the final transition. An example of the transition of one

patient's conditions is shown in Figure 1. A time-related transition model was then constructed by measuring the transition rate between clusters for all patients.

Results

The transition model was conducted using the accounting data stored in the HIS of the University of Tokyo Hospital from April 1 2004 to March 31 2005. The data for 60 inpatients (mean age, 68.2 years (SD = 15.2); male, n = 43; female, n = 17) were selected for analysis, and the total number of inpatient days was 2,561. The characteristics of the five clusters, referred to as Cluster 1 - Cluster 5, are shown in Table 1. Almost all patients were classified into Cluster 1 on the day of admission, and more than three quarters of all discharges followed a Cluster 2 classification (Figure 2).

Discussion

If accurate accounting data can be obtained for a patient on any given day, the cluster in which the patient's daily condition exists can be calculated using Ward's method in the 57-dimensional binary space. This indicates the patient's stage of hospitalization, and calculation of the discharge date and discharge rate of the patient can then be performed by comparing this to the transition model constructed in this study. In order to use this model for this purpose, it is necessary to examine the validity and reproducibility of the model, particularly when created from other data sets. It is also necessary to generalize this method, in order to apply it to other diseases. These challenges will be undertaken in the next stage of this project.

Conclusion

A new method was proposed for constructing a time-related transition model of patient conditions for patients diagnosed with brain infarction, using HIS data. Validation of the model and generalization of this method are future goals of this project.

References

[1] Anderberg MR. Cluster Analysis for Applications. New York: Academic Press; 1973.

Table 1 - Cluster characteristics. This table shows the appearance rate of five items in each cluster. The item with the highest appearance rate in each cluster is shaded

Cluster No.	intravenous drip	subcutaneous injection or intramuscular injection	gastrogavage	physiotherapy	central infusion
Cluster 1	0.873	0.172	0.007	0.318	0.005
Cluster 2	0.054	0.347	0	0.235	0.015
Cluster 3	0.318	0.811	0.992	0.273	0
Cluster 4	0.125	0.040	0	0.863	0
Cluster 5	0	0.017	0	0.473	0.757

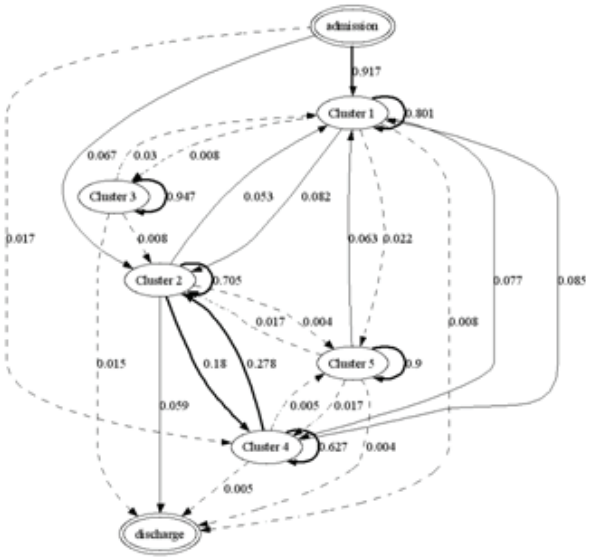

Figure 2 - Transition model of patient conditions. Bold lines indicate a transition rate over 0.1; while dashed lines indicate a transition rate under 0.05. Numbers indicate transition rates.

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