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

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Introduction

- 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 in order to recognize the stage of hospitalization.
- 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**.

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Methods - Overview

Date	Patient No.	Item
2006-06-01	Patient01	intravenous drip
2006-06-01	Patient01	additional fee for special room
2006-06-02	Patient01	chest X-ray roentgenogram
2006-06-02	Patient02	physiotherapy
…	…	…

Data for analysis (the accounting data). Excluded items were shaded.

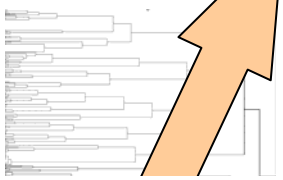
Defining patient's daily condition by plotting on a 57-dimensional binary space

Patient No.	Days from hospitalization date	Item name (57items)			
		intravenous drip	chest X-ray roentgenogram	physiotherapy	…
Patient01	1	1	0	0	…
Patient01	2	0	1	0	…
…	…	…	…	…	…
Patient60	97	1	0	1	…

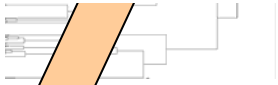
"item name" = 1 (being carried out)

or

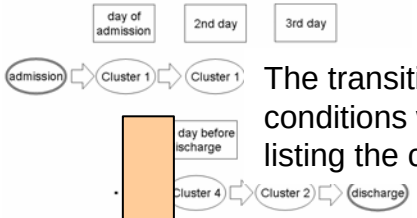
"item name" = 0 (not being carried out)



Classifying patient's daily conditions by applying Ward's method

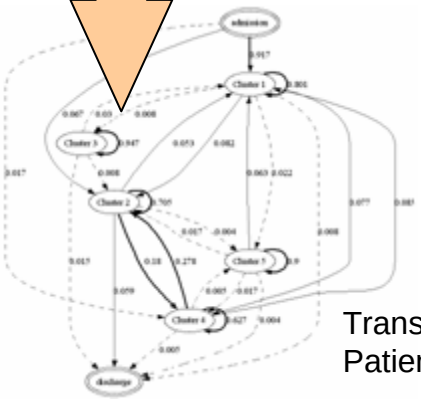


Patient No.	Days from hospitalization date	Cluster No.
Patient01	1	Cluster 1
Patient01	2	Cluster 1
…	…	…
Patient60	97	Cluster 2



The transition of each patient's conditions was represented by listing the clusters

Constructing time-related transition model by measuring the transition rate between clusters for all patients



Transition Model of Patient Conditions

Methods - Defining patient's daily condition

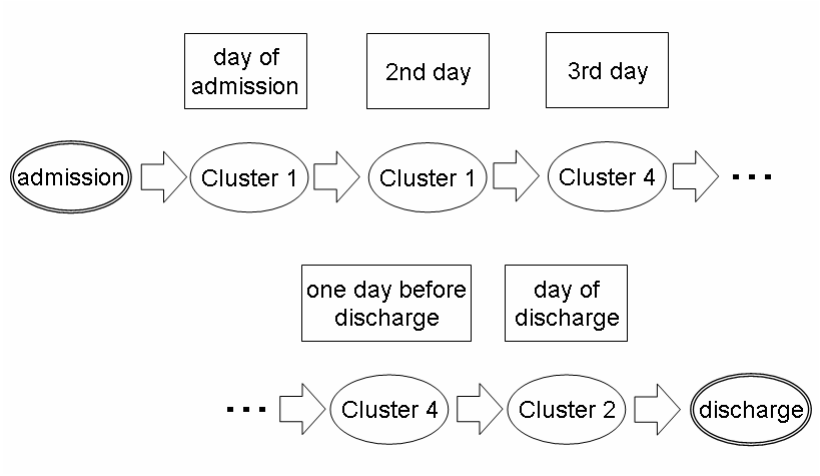
- Data for analysis
  - The accounting data (part of the recorded HIS data)
  - The data of Inpatients diagnosed with brain infarction on the day of admission or on the following day
  - 57 items of medical intervention were selected.
    - intravenous drip, physiotherapy, chest X-ray roentgenogram, etc.
    - Three kinds of items were excluded from the data.
      - ✓ Items unrelated to the medical intervention
        - additional fee for special room, etc.
      - ✓ Items showing the names of drugs or laboratory tests
        - AST (aspartate aminotransferase), etc.
      - ✓ Items that appeared only five times or less.
- Defining patient’s daily condition
  - Defined based on the status of these 57 items
  - Each condition was plotted on a 57-dimensional binary space.
    - “item name” = 1 (being carried out)
    - “item name” = 0 (not being carried out)

Methods - Classifying patient's daily conditions

- Ward’s method ([1], pp.142-145)
  - a hierarchical aggregative clustering method
- The daily conditions of every patient were classified by applying Ward's method.

Methods - 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 to discharge.



An example of the transition of one patient's conditions

- A time-related transition model was constructed by measuring the transition rate between clusters for all patients.

Result

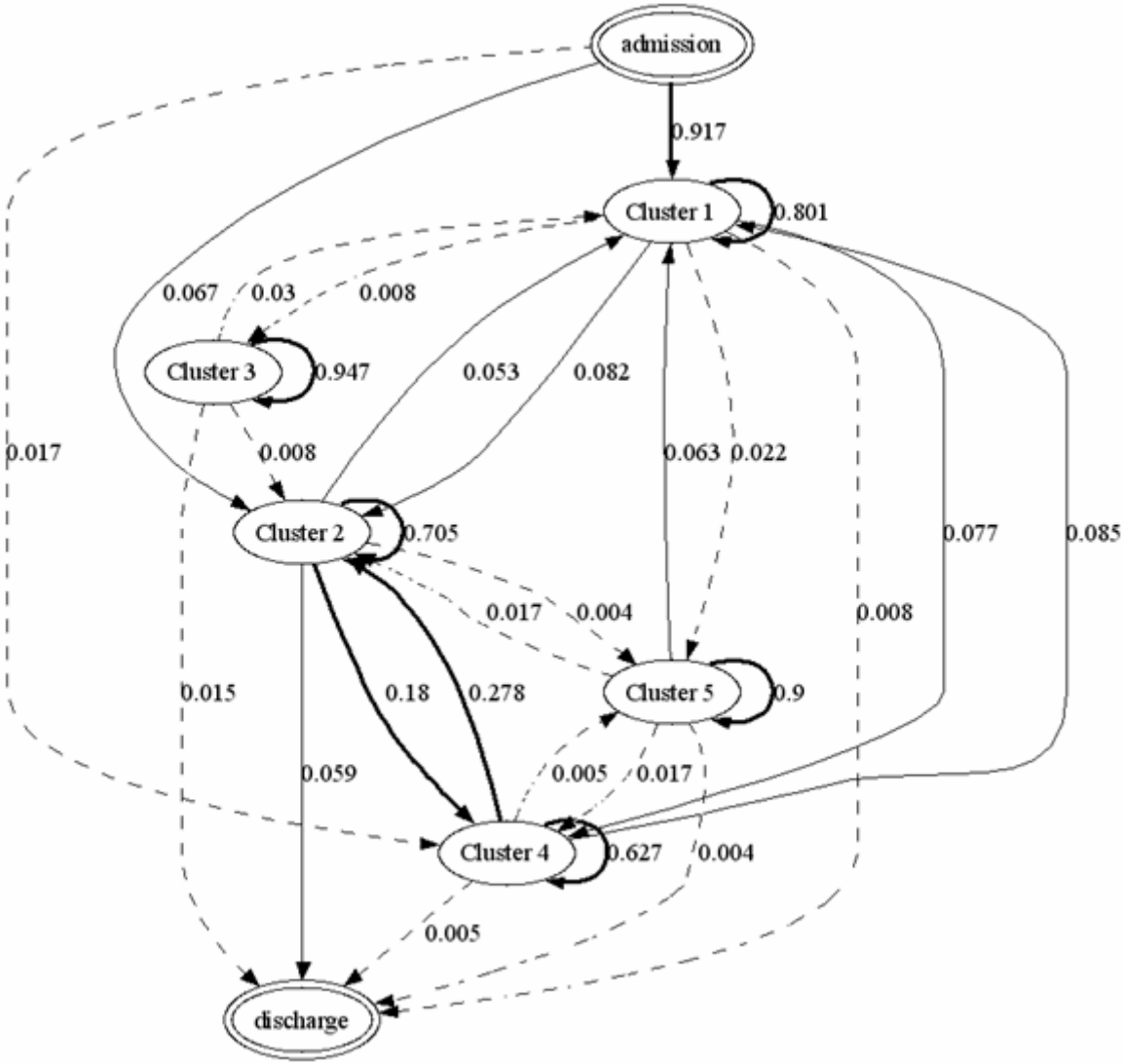
- Data for analysis
  - The accounting data stored in the HIS of the University of Tokyo Hospital from April 1 2004 to March 31 2005.
  - 60 inpatients
    - mean age, 68.2 years (SD = 15.2)
    - male, n = 43
    - female, n = 17
  - The total number of inpatient days was 2,561.
- Almost all patients were classified into Cluster 1 on the day of admission, and more than three quarters of all discharges followed a Cluster 2 classification.

Result - Cluster Characteristics

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

This table shows the appearance rate of five items in each cluster. The item with the highest appearance rate in each cluster is shaded.

Result - 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.

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.
- 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.
- It is necessary to examine the validity and reproducibility of the model, and generalize to apply it to other diseases.

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, Address for correspondence

- References

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

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