Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 60 (2015) 342 – 351

Procedia Computer Science

19th International Conference on Knowledge Based and Intelligent Information and Engineering Systems

Visualization of key factor relation in clinical pathway

Takanori Yamashita[a, b, *], Brendan Flanagan[b], Yoshifumi Wakata[a], Satoshi Hamai[c], Yasuharu Nakashima[c], Yukihide Iwamoto[c], Naoki Nakashima[a], Sachio Hirokawa[d]

[a]*Medical information center, Kyushu University Hospital, 3-1-1 Maidashi Higashi-ku Fukuoka 812-8582, Japan*
[b]*Graduate School of Information Science and Electrical Engineering, Kyushu University, 6-10-1 Hakozaki Higashi-ku Fukuoka 812-8581, Japan*
[c]*Department of Orthopaedic Surgery, Graduate School of Medical Sciences, Kyushu University, 3-1-1 Maidashi Higashi-ku Fukuoka 812-8582, Japan*
[d]*Research Institute for Information Technology, Kyushu University, 6-10-1 Hakozaki Higashi-ku Fukuoka 812-8581, Japan*

Abstract

The secondary use of medical data to improve medical care is gaining much attention. We have analyzed electronic clinical pathways for improving the medical process. The analysis of clinical pathways so far has used statistics analysis models, however as issue remains that the order, and multistory spatial and time relations of the each factor could not be analyzed. We constructed an Outcome tree system that shows the greatest significant relation for each factor. The Hip replacement arthroplasty clinical pathway was analyzed by the system, and the outcome variance of the clinical pathway was visualized. The results indicate the path of patient's who have a long hospitalization stay and extracted four critical indicators.

Peer-review under responsibility of KES International

Keywords: Outcome tree; Spanning tree; Clinical pathway; Critical indicator; Hip replacement arthroplasty

1. Introduction

Recently, techniques of data analysis (statistics, visualization, graphing, machine-learning, etc.) have improved, and are being used in various fields. In the medical field, a vast quantity of medical data has accumulated due to the digitalization of medical treatment along with the spread of hospital information systems, and the importance of

* Takanori Yamashita. Tel.:+81-92-642-5971; fax: +81-92-642-5889.
E-mail address: t-yama@info.med.kyushu-u.ac.jp

Peer-review under responsibility of KES International
doi:10.1016/j.procs.2015.08.139

medical data utilization is increasing. The secondary use of medical data is expected to improve the quality and the efficiency of medical care, and promote the resolution of medical social issues.

The clinical pathway is a standard medical process for the treatment, test, and operation on the disease of the inpatient, and has progressively become digitized. The Japanese Society for Clinical Pathway[1] promotes the construction of a standard electronic clinical pathway aiming at the standardization of medical treatment, improvement in medical processes, and the spread of the clinical pathway methods by team medical treatment. Specifically, the fundamental outcome called BOM (Basic outcome master) has been defined. When many medical institutions use BOM, the standardization of medical examination spreads, and this enables the analysis and evaluation between medical institutions. The PDCA cycle also is actively used. This is also expected to improve medical management by advancing standardization. We have examined using the clinical pathway data for purpose of extracting CIs (Critical indicators). A CI is the pathway outcome that has the greatest affect on the last outcome (e.g. hospitalization days, discharge destination, outcome, and cost), and is recognized as being sufficiently important.

In the present paper, we constructed an Outcome tree system that applies a spanning tree algorithm, and can visualize and detect as early as possible the causes of long-term hospitalization. We consider important factors from the outcome variance in the clinical pathway that lead to the long-term hospitalization of patients with Hip replacement arthroplasty.

2. Related Work

2.1. Clinical Pathway

There are some previous researches on clinical pathways that study the optimal outcome from medical events and treatment logs[2,3,4], and nursing order[5,6]. Wakata et al.[7] reported analysis conducted using statistical analysis models with the postoperative length of stay as an objective variable, and patients' attributes and clinical pathway outcomes as explaining variables. However an issue remains that the spatial and temporal layer relations of action order, and the importance of pathway outcomes could not be analyzed. Furthermore, the temporal factors of clinical pathways or workflows were considered, however they weren't able to evaluate the medical processes[8,9,10]. In this study, we examine the evaluation of medical processes from the temporal factors of clinical pathways.

2.2. Visualization of Word Relations as a Directed Graph and the Generation of Spanning Trees

Characteristic outcomes of long stay inpatients can be extracted, however it is necessary for the results to be checked by experts to determine if the extracted outcomes are reasonable or not. A Graph of nodes representing the extracted outcomes, and edges representing their relations, are helpful in the interpretation of outcomes. However, a naive co-occurrence graph that connects all the co-occurring outcome pairs would be too complex, because of the large number of edges. There is no appropriate threshold to restrict the number of edges. We can find clusters of outcomes if we draw an undirected graph. However, we cannot see the causal relation of outcomes.

We use the conditional probability and date of the outcomes to formulate causal relation between outcomes of clinical pathways. Then we construct a spanning tree of the target variance using this relation.

Visualization of feature words and their relation is an effective tool for summary of search results and for query expansion. It has been proposed that KeyGraph can be used to capture the structure of documents and core words[11]. The source documents of KeyGraph are expected to be written by an author for some purpose for his/her intension. Thus, the search results of a query are out of scope. Hirokawa et al.[12] proposed the concept graph to generate a hierarchy structure given a query. The concept graph is a directed graph whose nodes are feature words of the search results. Two words are drawn as a directed edge when they have a larger co-occurrence probability than a given threshold. The word with a large frequency is shown in the source of the directed edge and the word with a small frequency is shown in the target of the edge. However, these graphs containing closed loops tend to be hard to show as a tree.

Hirokawa et al.[13] proposed a method to generate a spanning tree where only one node is selected as its parent when a tree is expanded. This algorithm can be applied as long as the words are sorted with some order relation.