The evaluation of trustworthiness to identify health insurance fraud in dentistry

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ABSTRACT

Objective: According to the investigations of the U.S. Government Accountability Office (GAO), health insurance fraud has caused an enormous pecuniary loss in the U.S. In Taiwan, in dentistry the problem is getting worse if dentists (authorized entities) file fraudulent claims. Several methods have been developed to solve health insurance fraud; however, these methods are like a rule-based mechanism. Without exploring the behavior patterns, these methods are time-consuming and ineffective; in addition, they are inadequate for managing the fraudulent dentists.
Methods: Based on social network theory, we develop an evaluation approach to solve the problem of cross-dentist fraud. The trustworthiness score of a dentist is calculated based upon the amount and type of dental operations performed on the same patient and the same tooth by that dentist and other dentists.
Results: The simulation provides the following evidence. (1) This specific type of fraud can be identified effectively using our evaluation approach. (2) A retrospective study for the claims is also performed. (3) The proposed method is effective in identifying the fraudulent dentists.
Conclusions: We provide a new direction for investigating the genuineness of claims data. If the insurer can detect fraudulent dentists using the traditional method and the proposed method simultaneously, the detection will be more transparent and ultimately reduce the losses caused by fraudulent claims.

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1. Introduction

Medical expenditures have increased sharply in recent years due to the aging of the population. To properly allocate medical resources, many health insurance policies have developed programs such as fee for capita and fee for quality, cost containment methods like diagnosis-related groups (DRG), and prospective payment systems like global budget, etc., to help people access adequate health care service with affordable costs. In most countries, such as Taiwan, Germany and Canada, national insurance allows the patients to pay a small amount of money, called a *co-payment*, when they consult a physician. The physician, in turn, files a claim for medical expenses after the medical treatment. The health insurance authority then reimburses the expenses according to the claim. This reimbursement procedure has an advantage in that the patient does not need to pay a significant amount of money when visiting the doctor. The major fiscal load is lifted from the public; the health provider has the responsibility of obtaining reimbursement for the treatment fee instead. However, this type of reimbursement procedure creates a moral hazard in that the physicians may generate bogus claims, especially when the patients do not fully understand what medical services they received. For instance, a dentist may request a reimbursement for providing a dental filling treatment to a patient who does not need or even does not actually receive the treatment. Fraudulent claims for these types of filling treatments in dentistry often occur because the patient is normally not aware or does not confirm how many and upon which teeth the filling treatments are performed.

The ratio of fraudulent claims varies across different departments. In some departments, patients have knowledge regarding the common diseases (e.g., colds and fever) as well as regarding their treatment. If physicians in these departments file fraudulent claims, the insurer can easily audit or verify them. However, in other departments, such as the dental department, it is hard for patients to know what medical services they receive because most of them

lay down on the chair, open their mouths and have no precise idea about what type of treatment they are receiving; in addition, dental treatment is normally conducted only by the dentist in a dental clinic; no other nurse or staff witnesses the treatment. Thus, dental clinics have a higher ratio of fraudulent claims, especially for dental filling operations, which are the hardest claims to verify [1].

The Federal Bureau of Investigation (FBI) defined fraudulent claim for medical service [2], such as upcoding of services, duplicate claims, unbundling, etc; simply, it is an intentional deception or misrepresentation made by a physician or a subscriber who can gain some inappropriate benefit from the fraudulent claim. The United States General Accounting Office [3] reported that health care fraud costs are at least 10% of total health care costs annually. Over the past decade, the Economist [4] specifies that: "*fraud added as much as $98 billion, or roughly 10%, to annual Medicare and Medicaid spending—and up to $272 billion across the entire health system in 2012*". Similar fraud and abuse have been reported for the health insurance programs in other countries. Studies [5,6] also noted that over 10% of the total expenditure on health care was wasted by fraudulent claims. In Taiwan, the amount of money wasted by fraudulent claims is estimated NT$181.4 billion dollars (approximately USD 3.5 billion), accounting for 10% of the total health care expenditure from 2006 to 2009 [7]. If the fraudulent claims cannot be effectively prevented or detected, this type of loss will pose a serious threat to the health insurance system.

To detect fraudulent claims, insurers used to hire specialists to manually review each reimbursement application submitted by the physician. If there is any suspicion, the insurer would investigate to verify whether the application was fraudulent or not. This manual method is very time-consuming, especially given the large volume of government-sponsored insurance programs. Recently, computer-assisted review methods [8–11] have been introduced to facilitate the detection of fraud. These methods investigate fraudulent patterns based on rules and heuristics provided by experienced specialists. For example, the statistical analysis method can identify physician fraudulence if claims fall too often in the outlier area with respect to the service amount, treatment distribution, costs of medicine or procedures without the support of evidence. However, some fraud still cannot be detected because some physicians file sophisticated claims that are not outliers and satisfy all of the practical guidelines. The analysis methods are silent in such cases.

Many researchers [12–19] propose using data mining techniques [20] to discriminate between normal and suspicious claims (see the survey [21] in more detail). These techniques extract characteristics of fraudulent claims by mining past fraudulent claims and then scanning the new claims for characteristics that match the fraudulent ones. This technique is time-consuming. For example, a predictive data mining method is time-efficient after the supervised model has been constructed; however, it probably takes much time in the supervising phase. In real-world applications, data mining is adopted to decision support and specialists (users) manually revise their judgments by tuning the parameters. The extant research detects fraudulent claims using statistical techniques, data mining, neural networks, fuzzy and classification algorithms, and so on, all of which analyze the characteristics of the overall or individual claims data. However, there are some sophisticated frauds that are qualified in the overall viewpoint (i.e., are not outliers) and considered to be normal from the individual viewpoint (i.e., conforming to all claims rules).

In this paper, we evaluate the trustworthiness of each dentist rather than determining whether these claims are fraudulent. For the dentists with a low degree of trustworthiness (i.e., a high degree of suspicion), the authority can investigate the related patients and patient records to clarify the suspicion. The computation for the trustworthiness of each dentist is based on the analysis of the treatments, especially for cross-dentist filling operations. For

cross-dentist filling operations, we employ a social network to represent the precedence relationship of the dentists and then adopt the page-ranking concept (discussed later) [22,23] used in search engines to compute the trustworthiness degree for each dentist in the social network.

Our method considers not only the social network among dentists formed by cross-dentist treatments but also the medical behavior and factors affecting dentist trustworthiness (such as the time gap between visits). By using reliable trustworthiness scores for dentists, claims reviewers can understand the trustworthiness of each dentist and easily process a large number of claims because they only need to examine the claims filed by dentists with low trustworthiness scores. Our method can help to ease their workload, improve their review efficiency, and ultimately reduce the loss caused by fraudulent claims.

2. Preliminaries

2.1. Scenarios: health insurance fraud in dentistry

Previously, research on fraud detection primarily analyzed the characteristics of claims data from a micro viewpoint, like whether a patient is qualified to receive a health services, or from a macro viewpoint, like whether the claim of a patient falls in the outlier. However, neither of these viewpoints globally consider that fraud may exist in cross-physician treatments. For instance, fraud may exist if more than one physician filled the same tooth of the same patient, but the fraudulent claim is qualified in the micro viewpoint for a patient and in the macro viewpoints for a physician. We employ a social network to globally represent the precedence relationship of the dentists. Then we adopt the page-ranking concept [22,23] used in search engines to compute the trustworthiness degree for each dentist in the social network. The page-ranking criterion uses two mechanisms, namely, the hub and authority, to rank the pages in the Web space. A type of web pages, called authority pages, are important if they have links pointing to many important web sites; while another type of web pages, called hub pages, are also important if many important web sites having a link pointing to them.

In dentistry, a cross-dentist filling operation relates to two dentists, called *first-hand* and *second-hand* dentists. A fraud suspicion exists between these two dentists. Similar to the page-ranking concept, the first-hand dentist has a higher suspicion degree if many of his/her patients who had received a filling operation by the dentist receive the same filling operation for the same tooth again by other subsequent dentists; while the second-hand dentist has a higher suspicion degree if the second-hand dentist always provides a filling operation to the patients who had received a filling operation for the same tooth by other dentists beforehand.

Below are two examples to illustrate the situation: the first example is of fraud committed by the second-hand physician; while the second is committed by the first-hand physician.

Example 1. Assume that patient A has a toothache in one of his/her teeth and that he consults dentist α for treatment (step 1 in Fig. 1). Dentist α provides a dental filling to the tooth of patient A (step 2 in Fig. 1). After the treatment, dentist α applies for reimbursement for the dental filling of patient A from the insurer (step 3 in Fig. 1). The insurer offers payment to dentist α (step 4 in Fig. 1). Later, patient A consults dentist β for some other treatment (step 5 in Fig. 1). Dentist β does not provide a dental filling for the same tooth treated by dentist α to patient A, but he still applies for reimbursement for the dental filling for the same tooth from the insurer (step 7 in Fig. 1). The insurer also offers payment to dentist β (step 8 in Fig. 1).

Example 2. Patient A visits dentist α for some dental disease (step 1 in Fig. 2). Dentist α does not provide a dental filling to patient A for