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Combined medical quality assessment using the evidential reasoning approach

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ABSTRACT

Due to increasing demand for healthcare, medical quality has attracted significant attention in recent years. Most studies to date have tried to assess medical quality from objective quality indicators or subjective expert judgments or patient feedback perspective. In this study, the evidential reasoning approach is employed to combine objective quality indicators, subjective expert judgments and patient feedback in a multiple criteria framework to assess the quality of hospitals systematically and comprehensively. The evidential reasoning approach has the advantages of consistently handling both subjective evaluations and objective indicators under uncertainty within the same framework, and it can help to provide a robust alternative ranking. This study contributes to the literature with not only a novel medical quality assessment and aggregation framework, but also a pragmatic data transformation technique which can facilitate the combination of quantitative data and qualitative judgments using the evidential reasoning approach. A case study of three top-ranked teaching hospitals in Beijing is presented to demonstrate the framework and methodology proposed in this study.

1. Introduction

Due to increasing demand for healthcare, rising medical costs, restricted medical resources, and inevitable variations in medical practice, medical quality has attracted significant attention in recent years. Governments hope to allocate limited resources to hospitals based on medical quality (Contencin, Falcoff, & Doumenc, 2006; Normand, Wolf, & McNeil, 2008; Rees & Dineschandra, 2005; Ritchey et al., 2012). The public craves high-quality healthcare services, and people choose appropriate hospitals on the basis of medical quality information they can collect about target hospitals (Dijs-Elsinga et al., 2010; Glazer, McGuire, Cao, & Zaslavsky, 2008; Marang-van de Mheen et al., 2011). Meanwhile, hospital managers seek to improve medical quality, as quality is the key factor for attracting public or private funding and healthcare service consumers (Campbell, Roland, & Buetow, 2000; Carlucci, Renna, & Schiuma, 2013; Glazer et al., 2008; Normand et al., 2008). In developed countries such as the US, healthcare researchers have conducted systematical medical quality research since the 1960s (Donabedian, 1966; Donabedian, 1968; Feinstein, 2002; Mcqueen, Mittman, & Demakis, 2004). However, research on medical quality in developing countries lags far behind. In China, due to rapid economic growth in the past several decades, medical quality has been attracting increasing attention from both the government and the public. In 2009, the Chinese government launched a new wave of healthcare reform. The reform was intended to reduce healthcare costs, and improve healthcare quality and patient safety. To achieve these goals, the current healthcare strategy in China links the medical quality of hospitals with the allocation of healthcare resources such as government funding. Therefore, how to assess medical quality objectively and comprehensively so as to achieve a convincing quality ranking of hospitals has become a hot current research topic in China.

In the literature, a globally accepted medical quality framework was proposed by Donabedian (1966), Donabedian (1968), who suggested that medical quality could be assessed from the aspects of medical structure (MS), medical processes (MP), and medical outcomes (MO). Donabedian's medical quality model has become a practical and standard framework for medical quality researchers since it was first proposed. Although arguments are still being made about whether it is better to assess medical quality from a process perspective or from an outcome perspective (Feinstein, 2002; Ploeg, Flu, Lardenoye, Hamming, & Breslau, 2010), objective indicator methods, or subjective expert judgments, or patient

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feedback have been employed to assess medical quality under Donabedian's framework (Feinstein, 2002; Kerr et al., 2007; Untachai, 2013). We briefly discuss the three types of assessment methods as follows.

In objective indicator methods, indicators are derived from electronic medical records (EMRs), electronic health records (EHRs) or administrative data sets. Normand et al. (2008), Benin et al. (2005), and Cebul, Love, Jain, and Hebert (2011) conducted medical quality assessment based on EMRs or EHRs, while Bellows and Halpin (2008) extracted quality indicators from administrative data sets. Some studies (e.g. MacLean et al., 2006) show that there is no obvious bias in using the two different data sets if similar indicators are employed, and clinical data performs better if the totality of care that can be measured by each data source is measured. From an outcome aspect, indicators used for quality assessment include hospital readmission rate (Halfon et al., 2006; Weissman et al., 1999; Wray, Peterson, Souchek, Ashton, & Hollingsworth, 1997), hospital mortality rate (Baker et al., 2002; Bottle & Aylin, 2008; Chae, Kim, Tark, Park, & Ho, 2003; Glance, Dick, Mukamel, Li, & Osler, 2010; Hofer & Hayward, 1996; Kipnis, Escobar, & Draper, 2010; Rosenthal, Shah, Way, & Harper, 1998; Thomas & Hofer, 1999), and some other negative indexes (Heineken, Charles, Stimson, Wenell, & Stimson, 1985). From the aspects of structure and process, indicators used for assessment can be adherence to practice guidelines (Ashton et al., 1994).

Expert judgments are frequently used in practice audits, peer reviews, or practice visits for assessing medical quality (Pearson et al., 2000). As no EMRs or administrative data can reflect the entire medical process or medical outcome, subjective expert judgments are complementary to objective indicators in medical quality assessment. Research shows that there is moderate to high agreement between these two different types of assessment methods (Kerr et al., 2007).

In addition to the aforementioned two assessment methods, patient feedback on health care is a measure of patient perception of the quality of care, and therefore it is considered to be an important outcome of health care and essential element of quality assessment (Chang & Chang, 2013; Donabedian, 1966; Farley et al., 2014; Untachai, 2013; Vasudevan, Arachchi, & van Langenberg, 2013). In developed countries such as Britain, assessing patients' evaluations of health care has been a requirement for some general practitioners (Pouwer & Snoek, 2002).

Due to the fact that single indicators derived from objective data, subjective expert judgments or patient feedback can only measure medical quality from limited perspectives, they may not be able to reflect the quality of medical care of one hospital as a whole (Rosenthal et al., 1998). In the literature, various aggregation methods have been employed to combine multiple quality indicators. Reeves et al. (2007) and Normand et al. (2008) used simple average sum methods to aggregate multiple quality clinical indicators. Goodson and Jang (2008) employed the Bayesian network to combine multiple objective quality factors. Büyüközkan, Çifçi, and Güleryüz (2011) extended traditional analytic hierarchy process (AHP) methodology to a fuzzy AHP to combine subjective and vague expert judgments about multiple quality factors. Büyüközkan and Çifçi (2012) combined a fuzzy AHP and a fuzzy technique for order performance by similarity to ideal solution (TOPSIS) to aggregate patient feedback on multiple quality factors.

However, each aggregation method used in the literature has its merits and limitations. More specifically, simple average sum methods are indeed simple to implement, but the combinatorial contribution or orthogonal sum of multiple factors cannot be reflected in the result. Bayesian network has the advantages of using powerful algorithms for probabilistic inference. However, the complexity of a Bayesian network increases exponentially with the increase of parameters used in the network and also Bayesian inference depends on prior distributions, the credibility of which in turn relies heavily on sampling method used for data collection. These requirements make it difficult for researchers to generate necessary parameter values or probabilities to conduct robust analysis in real life applications. Fuzzy AHP extends the traditional AHP method in dealing with vague subjective judgments about multiple criteria and has the advantages of converting subjective judgments to numerical values, but the problem of rank reversal exists in the method, which means that the ranking of alternatives may change when new alternatives are added. Similar to fuzzy AHP method, fuzzy TOPSIS method has the advantages of handling fuzzy judgments about multiple criteria, but it has the problem of rank reversal as well. Moreover, the aforementioned aggregation methods are for combining either multiple objective indicators or multiple subjective evaluations, and few studies in the literature have dealt with aggregating a mixture of objective indicators, subjective expert judgments and patient feedback to produce a more comprehensive and informative quality assessment result.

In this study, we propose to aggregate objective quality indicators, subjective expert judgments and patient feedback to assess medical quality (Kong, Ma, Zhao, & Zhang, 2013), and the work is conducted under Donabedian's medical quality framework. The indicators that we use in this study are from a MO perspective including *inpatient mortality rate* (IMR), *readmission rate* (RR), and *adverse event rate* (AER). The data sources for deriving objective indicators are the inpatient medical record summaries (IMRSs) from January 2006 to December 2010 of three top-ranked teaching hospitals in Beijing. We invited 10 area experts from hospitals and universities to provide anonymous judgments about the medical quality of the studied hospitals from the medical facilities (MF), medical staff (MSf), MP, and MO perspectives. Note here that we use MF and MSf as substitutes for MS. Furthermore, we surveyed a random sample of patients who were believed to have visited the studied hospitals during the study period using questionnaires via WeChat (http://www.wechat.com/en/). The analytic approach we employed to aggregate objective indicators, subjective judgments and patient feedback is the evidential reasoning (ER) approach (Yang & Singh, 1994; Yang & Xu, 2002). The ER approach, which provides a modeling framework and analysis method for handling both qualitative and quantitative attributes under uncertainty, has the advantages of dealing with both subjective evaluations and objective indicators under uncertainty such as vagueness or incompleteness, and can overcome the shortcomings of those aggregation methods as discussed above. In this paper, the ER approach is applied to assess the overall quality of medical care of hospitals based on both subjective evaluations and objective quantitative indicators for the first time, and a pragmatic method for transforming numerical indicators to qualitative assessment grades with a belief structure is proposed.

In the remainder of the paper, the Methods section introduces the source data, the indicators, the questionnaires that we used for acquiring expert judgments and patient feedback, the ER approach, and detailed data aggregation procedures. The Results section presents the medical quality assessment results based on IMRSs, expert judgments and patient feedback. Specifically, quality trends from 2006 to 2010 and quality ranking per year of the studied hospitals are provided. Finally, the Discussion and conclusions section summarizes the contributions and limitations of this study, and suggests future research directions.

2. Methods

2.1. Data

Because of legal and ethical concerns, it is difficult to obtain EMRs or EHRs data in China. For administration purposes, IMRSs