ABSTRACT

Patient safety culture or climate (PSC) is a relatively new topic in patient safety studies, and the current paper maps the intellectual structure of the works in this area, investigating the evolution of this literature. We searched the Web of Science database collection and obtained relevant study sample published from the oldest to 2013. The most-cited articles and cited references were also profiled and analyzed using HistCite analysis to create a historiograph, using social network analysis to map sociogram, while main path analysis was carried out to draw the developing path. The results show that the paradigm shift from organizational climate studies to safety culture studies, and from safety culture studies to patient safety culture studies. It is also evident that the patient safety culture is important topic in patient safety studies, and provides a clearly picture of the relationship between patient safety studies and patient safety culture studies. This study also presented the developing paths and divided into three stages. We introduce researchers to the concepts of profile history and development, which can help both academics and practitioners to understand the evolution of the PSC.

INTRODUCTION

Extensive research on patient safety has been conducted during the past decades (Wang, Lee, Chou, Kuo, & Hsieh, 2014). Many scholars have investigated the relevant literature to learn more about the evolution of patient safety. Huang et al. (2011) using co-citation and social network analysis found that patient safety culture or climate (PSC) was one of the new topic in patient safety studies between 2005 and 2009 period from Web of Science (WOS) database. Rodrigues, van Eck, Waltman, & Jansen (2014) using citation and cluster analysis identified that PSC was an important cluster, which publications in the period 2000-2010 related to patient safety were retrieved in the Scopus bibliographic database. More recently, several studies show that safety culture and the related concept of safety climate are related to such clinician behaviors as error reporting (Braithwaite, Westbrook, Travaglia, & Hughes, 2010; Gillespie, Gwinner, Chaboyer, & Fairweather, 2013), reductions in adverse events (Stock, McFadden, & Gowen III, 2007; Singer, Lin, Falwell, Gaba, & Baker, 2009; Wang, et al., 2014), reduced morbidity and mortality (Haynes, et al., 2011; Braun, et al., 2013), and suggests that interventions can improve perceptions of safety culture and potentially reduce patient harm (Weaver, et al., 2013; Groves, 2014).

Safety management techniques used in other highly hazardous industries, such as nuclear power and aviation industries, have also been embraced by health- care organizations (Flin, 2007; Grote, 2012). In order to contribute to the overall reduction of health- care accidents or incidents, patient safety has been studied from different points of view. Whether technical or psychological, these viewpoints lead to the promotion of a positive safety culture, a concept intrinsically linked to organizational culture (Choudhry, Fang, & Mohamed, 2007; Alharbi, Ekman, Olsson, Dudas, & Carlström, 2012). Many studies have confirmed that, regardless of the organizational culture (Alharbi, et al., 2012), safety culture (Groves, Meisenbach, & Scott-Cawiezel, 2011), and patient safety culture (Chen, Ng, & Li, 2012) plays an important role in patient safety activities. Furthermore, a number scholars deemed that the safety culture is a component of organizational culture (Cooper, 2000; Guldenmund, 2000), and the concept of patient safety culture was originated from research of safety culture (Nieva & Sorra, 2003; Morello, Lowthian, Barker, McGinnes, Dunt, & Brand 2013). However, these articles do not provide the intellectual structure of organizational culture, safety culture and patient safety culture. This work introduces a new approach, HistCite analysis (Lucio-Arias & Leydesdorff, 2008; Garfield, 2009; Bornmann & Marx, 2012), to identify the most influential publications to draw the historiograph of the
organizational culture, safety culture and patient safety culture. Thus can help academics and practitioners in the healthcare industry to understand the relationship of the PSC studies.

Review articles are available on specific topics of PSC, for example, reviews on the measure tools of PSC (Colla, Bracken, Kinney, & Weeks, 2005; Flin, Burns, Mearns, Yule, & Robertson, 2006), reviews on conceptual culture of safety model (Sammer, Lykens, Singh, Mains, & Lackan, 2010; Halligan, & Zeecevic, 2011), and reviews on causal model of PSC (Morello, et al., 2013; Weaver, et al., 2013; Groves, 2014). However, there are no review articles that give a high-level view of PSC. This is due to the multifactorial, multidimensional and cross disciplinary character of the topic. Therefore, insight into the arrangement of PSC literature is needed to give structure for future research in this field. Because the conventional approach does not give sufficient view, an alternative approach is needed. The bibliometric method has been widely applied to the analysis of scientific production and research trends, one of citation analysis (Nicolaisen, 2007; Khan & Ho, 2012; Gundolf & Filser, 2013) and co-citation analysis (Small, 1973; Pilkington & Meredith, 2009; Backhaus, Lügger, & Koch, 2011) are essential research tools for evaluating the core knowledge of an academic field. Recently, a number scholars (Lee & Su, 2010; Huang, et al., 2011; Al, Soydal, & Alir, 2012; Jang, Lee, and An, 2012) integrate bibliometric analysis and social network analysis as a valuable research tool for the development of research topics. Another scholars (Liu & Lu, 2012; Lu & Liu, 2013; Xiao, Lu, Liu, & Zhou, 2014; Hung, Liu, Lu, & Tseng, 2014) through an extension of the citation-based main path analysis to explore technological change or knowledge diffusion. The current study describes social network analysis and main path analysis based on bibliographic data to analysis the literature on PSC studies to understand the evolution of the PSC studies.

METHODS
Materials
Data Sources
Data was obtained from the Web of Science (WOS), which comprises two citation databases, namely the Science Citation Index (SCI) and the Social Sciences Citation Index (SSCI). The results reported in this study are not thus limited to any specific field. The WOS is a standard tool used by most citation studies worldwide, offering more detailed citation analysis results than can be obtained with other databases (Falagas, Pitsouni, Malietzis, & Pappas, 2008). The WOS website provides a substantial amount of factual information about these databases, including the number of records and lists of indexed journals. It also offers powerful browsing, searching, sorting and saving functions, and allows data to be exported to citation management software. So, we chose it as our data sources.

Search Strategy
Two search strategies, the journal and key term approaches, have long been used to build citation and co-citation analysis databases. As patient safety culture is a relatively new topic, and which does not have any specific journals listed in the WOS database, it is not possible to focus this examination only on articles in specific publications. Thus, in this study, we searched for papers in the online WOS using keywords on March 20st, 2014. Papers contain any of these keywords in the title, abstract, author keyword or Keywords Plus® fields were retrieved from the database. We decided to adopt the materials published in WOS database from the oldest to the December 31st 2013 as the studying samples for this study, in order to get the latest developing trend.

Methods and Analysis
Growth Curve & Loglet Lab Software
A growth curve is an empirical model of the evolution of a quantity over time. Values for the measured property can be plotted on a graph as a function of time. Growth curves are employed in many disciplines besides microbiology (Zwietering, Jongenburger, Rombouts, & Van’t Riet, 1990), particularly in technology forecasting (Chen, Chen, & Lee, 2010), which has an extensive literature on growth curves (Liu, Lu, Lu, & Lin, 2013). The Loglet Lab is a software package for analyzing logistic behavior in time-series data (Meyer, Yung, & Ausubel, 1999). It offers a rich analysis of data sets that exhibit complex growth, and ease of use allows us to envision several scenarios in a manner of minutes, as we can quickly run these models several times with
different parameterizations. Therefore, this study uses the bibliometric analysis to collect useful data, and further adopted Loglet Lab 3.0 javascript edition for the growth curve model to forecast the development of patient safety.

**HistCite and Historiograph**

HistCite is a software package used for bibliometric analysis and information visualization that was first developed by Eugene Garfield (2004, 2009). It is a system designed to help identify the most cited papers retrieved in searches of the WOS. Once a marked list of papers has been created, the resulting file is processed by HistCite to create tables ordered by year, author, journal, cited reference or keyword. Although there are many approaches to and applications of data visualization, HistCite performs one specific function; that is, it converts bibliographies into diagrams called historiographs. In this study we selected the most-cited articles to draw a historiograph to understand the history of patient safety studies.

**Social Network Analysis and Sociogram**

Originating in sociology, social network analysis (SNA) has become increasingly popular over the past decades (Borgatti, Mehra, Brass, & Labianca, 2009). It allows the study of communication networks using a theoretical approach and provides a family of statistical techniques to study social structures and map relationships among individuals within social networks. Although these individuals are most often persons, they may also be groups, organizations, nation-states, websites or citations between scholarly publications (Butts, 2008). In the study of scientific communications, bibliographic coupling can be used to investigate and render visible the relationships among articles using the coupling of elements in bibliographic records. Coupling strength is measured as the number of coupling units between two records. In the current study, we examined the most-cited references to build a co-citation matrix, and used Ucinet and NetDraw software to map its sociogram to explore the invisible knowledge nodes of the patient safety studies.

**Main Path Analysis and Developing Path**

Main path analysis is a bibliometric method capable of tracing the most significant paths in the citation network, and is commonly used to trace the developing paths of research fields (Gao and Guan, 2012; Bhupatiraju, Nomaler, Triulzi, & Verspagen, 2012). Main-path techniques examine connectivity in acyclic networks, and are especially interesting when nodes are time dependent, as they select the most representative nodes at different moments of time. In a citation network, the links are assigned a direction based on time, and each node represents a distinct event in time. A node that links many nodes will probably be part of the main path, with this main path highlighting the fact that the focal paper is based on prior papers, while also acting as an authority with regard to later works. In this work, we examined the most-cited references to build a co-citation matrix, and used Main Path (Liu and Lu, 2012; Lu and Liu, 2013) and Pajek software to map its developing path to explore the invisible knowledge nodes of the patient safety studies.

**RESULTS**

**Organizational Culture and Safety Culture**

We obtained a list of the most-cited works from “organizational culture” sample, and then created a historiograph using the HistCite software, based on higher local citation score (LCS). A historiograph of the top 30 most-cited articles from 1973 to 2003 is presented in Figure 3-1, which in red nodes clearly showed the relationship between organizational culture and safety culture. The earliest highly cited article is “Guion RM, 1973”, which reported that the idea of “perceived organizational climate”. In addition, the article “James LR, 1974” mentioned three measurement approaches for organizational climate, and the article “Schneider B, 1975” built a framework for guiding future organizational climate research. Finally, the article “Guldenmund FW, 2000” reviewed the literature on safety culture and safety climate and provided a model specifying either the relationship of both concepts with safety and risk management or with safety performance. In general, the highly cited article in red nodes clearly showed that the paradigm shift from organizational climate studies to safety culture studies.

**Safety Culture and Patient Safety Culture**
We obtained a list of the most-cited works from “safety culture” sample, and using the same analytical method as presented above to draw a historiograph based on higher LCS. A historiograph of the top 30 most-cited articles from 1980 to 2006 is presented in Figure 3-2, which in blue nodes clearly showed the relationship between safety culture and patient safety culture. The highly cited article “Guldenmund FW, 2000” also presented in Figure 3-1, which reported the nature of safety culture. And then the articles in blue nodes include “Neiva VF, 2003”, “Colla JB, 2005” and “Flin R, 2006” focus on patient safety culture or climate. Moreover, the article “Singer SJ, 2003” and “Pronovost PJ, 2003” also focus on the survey of safety culture in healthcare organizations. It is evident that the patient safety culture is important topic in safety culture studies, and also showed that the paradigm shift from safety culture studies to patient safety culture studies.

Patient Safety and Patient Safety Culture

We obtained a list of the most-cited works from “patient safety” sample, and using the same analytical method as presented above to draw a historiograph based on higher LCS. A historiograph of the top 30 most-cited articles from 2000 to 2010 is presented in Figure 3-3, which in purple nodes clearly showed the cluster of patient safety culture. And the articles in blue nodes include “Neiva VF, 2003”, “Singer SJ, 2003”, “Pronovost PJ, 2003” and “Colla JB, 2005” also presented in Figure 3-2. It is evident that the patient safety culture is important topic in patient safety studies.

The Growth Curve of Patient safety culture

This study searched for works using the keywords “patient safety” and “culture*” or “patient safety” and “climate*”, identified a total of 1,141 documents from 1992 to 2013. A logistic growth curve analysis was carried out using the Loglet Lab software based on the annual number of PSC documents, to summarize the developing trend of literature and predict its future growth. Figure 3-4 shows that the number of works published follows a continuous upward trend from 1992 to 2013, and this curve midpoint is 2012. The PSC studies being in a growth stage, and there are expected to continue to increase in the future.

The Main Journals of PSC Studies

Table 3-1 lists the top 10 journals with regard to publishing PSC studies, which together account for over 27% of all the articles considered in this work. The top three journals are Quality & Safety in Health Care, BMI Quality & Safety, and BMC Health Services Research. Among the top 10 journals, six of them are categorized as covering the fields of health care sciences and services. It is obvious that this body of literature mainly from healthcare viewpoints. In addition, two of the top 10 journals are focused on nursing, and thus it can be seen that PSC is now an important issue among this group of professionals.

The Historiograph of PSC Studies

We obtained most cited articles from “patient safety culture” sample, and using the same analytical method as presented above to draw a historiograph based on higher LCS. Figure 3-5 presents the network map of 15 most-cited articles from 2003 to 2010, and we tentatively assigned colors to the cluster on the basis of our own interpretation of the articles. These articles of red nodes focused on the survey of teamwork in intensive care units, blue nodes focused on the survey of patient safety culture in hospitals, and purple nodes focused on the development of measuring tools for patient safety culture. In additional, yellow nodes focused on to explore the influence factors of patient safety culture and to develop relationship between safety culture and safety performance. In general, it seemed that the studies of patient safety culture are divided into three stages, development of measurement tools, implementation of hospital survey, and establishment of causal model.

The Sociogram of PSC Studies

We retrieved a total of 41,201 cited references on the basis of 1,141 studies related to patient safety culture or patient safety climate, and then tabulated the co-citation matrix of the frequency. We obtained a list of the most-cited references and adopted Ucinet and NetDraw software to map the sociogram based on higher co-citation frequency. A sociogram of the top 26 most-cited references from 1992 to 2013, shown in Figure 3-6, provides a clearly picture of the relationship between patient safety studies and patient safety culture studies. We tentatively assigned names to the nodes on the basis of our own interpretation of the references. The blue nodes represented “adverse events studies”, and the red nodes represented “errors models & management”. In addition,
the pink nodes focused on “teamwork in medicine”, the yellow nodes focused on “safety culture in health care”, the purple nodes focused on “relationship between safety climate and safety performance”, and the green nodes focused on “safety culture or climate”.

The Developing Path of PSC Studies

The developing path in this work was mapped using the Main-Path and Pajek software with the key-route method. The results are shown in Figure 3-7, which are tentatively divided into three stages on the basis of our own interpretation of the articles. The first stage tried to develop the measurement tools of PSC, and conducted PSC surveys in hospitals. The second stage, further explored the relationship between a safety culture and patient safety performance, to establish the comprehensive and integrative causal models with regard to how patient safety is produced and sustained through a safety culture. In the third stage, the hospital survey on patient safety culture (HSOPSC) to apply them to many countries. In addition, there is also appeared the research of patient safety climate in VA hospitals in this main path.

DISCUSSION

Trends in the PSC literature

The results of this work show that the literature on PSC has continued to grow over the last decade, and that while the original focus of such works was on the concept of a “patient safety climate”, this later shifted to a “patient safety culture”. The results also show that the field of PSC studies has moved from looking at the issues of organizational culture, patient safety culture, and patient safety climate, to examinations of individual attitudes and behaviors towards patient safety (Morello, et al., 2013). In addition, the citation analysis carried out in this work identified BMJ Quality & Safety (previously Quality & Safety in Health Care) as the most influential journal in this field. This is one of the earliest journals in the SCI database that published articles about safety in health care, with the aim of encouraging innovation and creative thinking to improve the quality of health care.

The results of the keyword citation count indicated that PSC is closely related to organizational culture, safety culture and safety climate. Because PSC is a component of organizational culture, it also includes the shared beliefs, attitudes, values, norms and behavioral characteristics of employees (Nieva & Sorra, 2003). In addition, accurate measurement of PSC is limited by the ability to define measureable components of such a culture (Cooper, 2000). Therefore the demand for relatively low-cost, quick and easy to use assessments of patient safety culture has resulted in a reliance on PSC questionnaires.

PSC and reporting

Voluntary reporting systems are tools that allow front-line healthcare workers to voluntarily report adverse events and near misses, and incident reporting systems are thus viewed as the central mechanisms for patient safety management (Huang, et al., 2011). Although healthcare organizations have expended substantial efforts to promote incident reporting, many observers attribute underreporting to the punitive approach that many such organizations still adopt with regard to safety incidents (Wakefield, et al., 2001; Blegen, et al., 2004; Waring, 2005), and since higher reporting rates are associated with a more positive safety culture (Hutchinson, et al., 2009), it is recommended that this approach is modified.

PSC and communication / teamwork

A safety culture is thought to be based on the shared values, attitudes and behaviors of all staff in healthcare facilities with regard to giving safety priority over efficiency, improving communication and collaboration among care providers, and creating a system that learns about and learns from errors and problems. Both communication and teamwork have been identified as key dimensions of PSC (Colla, Bracken, Kinney & Weeks, 2005), with studies showing that these are particularly important in operating rooms or among surgical teams (Sexton, Makary, Tersigni, Pryor, & Hendrich, 2006; Mills, Neily, & Dunn, 2008). It has also been found that the degree of communication and collaboration between attending and resident doctors with regard to surgical services has a significant influence on patient morbidity (Davenport, Henderson, Mosca, Khuri & Mentzer, 2007).
PSC historiograph

We identified four historical paths based on our own interpretation of the PSC literature. In the first path focused on surveys of PSC or teamwork in ICUs (Thomas, et al., 2003; Kho, et al., 2005; Sexton, et al., 2006; Huang, et al., 2007; Pronovost, et al., 2008; Huaget al., 2010), while the second path carried out surveys of PSC in hospitals (Pronovost, et al., 2003; Singer, et al., 2003; Gaba, et al. 2003; Vogus & Sutcliffe, 2007; Singer, et al., 2009). These results indicate that ICUs and hospitals are important settings for PSC research. The third path, located in the center of historiograph, and thus more central in the literature, focused on the development of valid and reliable measurement tools for PSC (Nieva & Sorra, 2003; Colla, et al., 2005; Modak, et al., 2007; Singer, et al., 2007). In the fourth path, many studies (Pronovost, et al., 2006; Kirk, et al. 2007; Flin, 2007; Singer, et al., 2008; Singer, et al., 2009) attempted to establish causal models between safety culture and safety performance.

PSC main path analysis

The results of the main path analysis using the backward method show that the PSC literature can be divided into three stages, the development of measurement tools from 2000 to 2005, the relationship between safety culture and safety performance from 2006 to 2009, and built the causal models of PSC from 2010 to 2013. It is thus evident that PSC research has now reached a mature stage, and many recent papers (Vogus, et al., 2010; Verbakel, et al., 2013; Singer & Vogus, 2013) have worked towards the establishment of a PSC to improve patient safety in hospitals or primary care units. Works in this more mature stage have also proposed causal models of safety culture (Vogus, et al., 2010; Singer & Vogus, 2013), which indicate that safety climate will affect safety culture, while safety culture will affect hospital errors, and there are causal relationships among all three of these. Future research should be directed toward gathering more empirical evidence to confirm these models.

REFERENCES