應用於臨床醫學之本體論導向式知識管理方法論

The Ontology-Driven Methodology for the Purpose of Knowledge Management of Clinical Medicine

中文摘要

背景與目的

本體論 (ontology) 一詞，意指某一特定知識範疇內之所有核心概念（包括詞彙及其間關係）。本體論導向式知識管理乃是運用本體論來協調文件內半結構化知識意涵 (semantics) 之一種方法論 (methodology)。就吾人所知，本體論導向式知識管理迄今尚未應用於臨床目的。本研究將應用此方法論，建構一針對嚴重急性呼吸症候群 (SARS) 相關知識之知識管理系統，並測試本體論導向式知識管理在擷取解答臨床情境測試問題之資訊時，是否優於傳統的知識管理方法。

對象及方法

為建立所需知識庫，我們收集了某醫學中心 54 名 SARS 可能病患 (probable case) 之病歷，85 篇 SARS 相關新聞，42 篇為 SARS 制定之標準作業程序文件，及 1233 篇 SARS 相關之醫學文獻。另一方面，SARS 相關知識的本體論將依據一份介紹 SARS 的文獻，及美國國家生技資訊中心 (NCBI, National Center for Biotechnology Information) 刊載於其網站之生醫資料，由人為方式建立而成。為求儘量與既有之醫用本體論一致，建立時將參照具公信的詞彙系統，如 UMLS (Unified Medical Language System)及 MeSH (Medical Subject Headings)。建好的 SARS 本體論再由胸腔科及感染科專家組成的專家會議予以審視，補充及認可。其後，以上述之成品及一個本於本體論 (ontology-based) 搜尋演算法之搜尋引擎，合成了一個統合性知識管理平台（抗煞知識管理系統）。這個本於本體論之搜尋演算法，當其未被關閉時，將整合前述 SARS 本體論所記述之知識，及一份預製之同義字表，來擷取與搜尋字詞有相關概念的文章。此建構好的系統再設置於某醫學中心作評估。評估工作可分三部份：(1) 可用度 (usability) 試驗，包括一個資訊需求調查。 (2) 使用者喜好評估：由使用者主觀決定是否本於本體論之搜尋演算法在擷取可解答問題之資訊時，優於本於關鍵字 (keyword-based) 之搜尋演算法（本於本體論之搜尋演算法關閉）。 (3) 以敏感度 (sensitivity) 及專一度 (specifity) 對本於本體論之搜尋演算法及本於關鍵字之搜尋演算法之效能作估計。

結果與結論

大部份使用者認為本系統易於操作（75%），能提供可靠及有用之資訊（69%），能對其工作有所助益（81%），並能適用於醫療從業人員及非專業人員（65%）。他們也歡迎此系統裝設於其執業處所（81%）。其對資訊需求之?別依序為 (1) SARS 相關之醫學文獻；(2) SARS 病歷記錄；(3) 標準作業程序文件；(4) SARS 相關新聞；(5) SARS 相關之生物醫學資訊。

平均在約半數（50%）的情況下，本於本體論之搜尋演算法在擷取可解答使用者問題之搜尋結果上，被認爲與本於關鍵字之搜尋演算法相當。在其餘情況，大部份（37%）認爲本於本體論之搜尋演算法較優。此現象可由下列事實解釋：本於本體論之搜尋演算法會網羅較多之詞彙供作搜尋，因此會找到更多相關的（也會找到更多不相關的）搜尋結果。

進一步對搜尋演算法效能之研究結果顯示，本於本體論之搜尋演算法及本於關鍵字之搜尋演算法兩者間，不論在敏感度及專一度上均無有意義之差別（$p > 0.05$）。此結果與前段所述使用者喜好評估之結果不相一致，可由下列事實解釋之：搜尋者通常僅於完整搜尋結果中之最先部分找尋相關文章。

結論：當面臨新興及再浮現傳染病之威脅時，吾等需要且應該使用更具效力之方法，來處理不斷變化及大量之醫學資訊。如同本研究之抗煞知識管理系統所示，每有快速更新內容，建立多方來源之知識庫，或建立統合性知識管理系統之需時，本體論導向式知識管理，是一個可選擇的，且較佳的，處理醫學資訊之方法論。

英文摘要

Background and Objective

The term “ontology” means all the core concepts (terms and their relationships) belonging to a specified knowledge domain. Ontology-driven knowledge management is a methodology that utilizes ontology to coordinate the semantics (meaning) in documents laden with semi-structured knowledge. As far as we know, ontology-driven knowledge management has not been used for clinical purpose to date. In this study, we applied this methodology to construct a knowledge management system for the severe acute respiratory syndrome (SARS)-related knowledge domain, and then tested whether ontology-driven knowledge management could be superior to the conventional method of knowledge management in retrieving information that can answer test query questions based on clinical scenarios.

Subjects and Method

To construct our knowledge base, the patient records of 54 probable SARS cases in a medical center, 835 SARS-related news reports, 42 documents about standard operation procedures for SARS, and 1,233 articles of SARS-related medical literature were collected.

On the other hand, the ontology for the SARS-related knowledge was built manually according to an essential SARS text and the biomedical data published on the US’s National Center for Biotechnology Information (NCBI) website. To ensure maximal conformation to existing ontologies in medicine, the authoritative terminology service such as UMLS (Unified Medical Language System) or MeSH (Medical Subject Headings) was referenced. The built SARS ontology was then approved by an expert

panel consisting of domain experts (physicians specializing in chest medicine or infectious diseases) for completeness purpose.

An integrated knowledge management platform (the Anti-SARS Knowledge Management System) was then constructed with the above-mentioned works, plus a search engine with ontology-based search algorithm. This algorithm, if not turned off, would integrate the domain knowledge described in the SARS ontology and a pre-defined synonym table to retrieve target articles with concepts associated with that of the query term.

The built system was then deployed in a medical center for evaluation. The evaluation process consisted of three parts: (1) Usability test, including a survey of information need. (2) User preference evaluation: Users subjectively determined whether the ontology-based search algorithm is superior to the keyword-based search algorithm (ontology-based search algorithm turned off) in retrieving information that can answer a query question. (3) Estimation of efficacy of ontology-based search algorithm and keyword-based search algorithm in terms of sensitivity and specificity.

Results and Conclusions

Most of the users thought this system was easy to operate (75%), did provide trustworthy and valuable information (69%), could be helpful to their career (81%), and could be applied to both healthcare professionals and non-professionals (65%). They also welcomed the deployment of such a system in their workplace (81%). The categories of information needed in their priority are (1) Medical literature about SARS; (2) SARS patient record; (3) Documents for standard operation procedures; (4) SARS-related news; (5) Biomedical information about SASR.

Averagely, in about half conditions (50%) ontology-based search algorithm is considered comparable to keyword-based search algorithm in finding result that can answer a user's query question. In most of the remaining cases (37%), ontology-based algorithm is the preferred one. This can be explained by the fact that ontology-based search algorithm recruited more terms as input for a query, and thus would recover more items of relevant (and also more items of irrelevant) results.

Further study on efficacy of search algorithms revealed that there is no significant difference ($p>0.05$) on the search sensitivity or specificity between ontology-based search algorithm and keyword-based search algorithm in our search engine. This discrepancy from the user preference evaluation result can be explained by the fact that searchers usually look for relevant articles in a search result set by inspecting only the first part of all retrieved.

In conclusion, while confronted by the threat from new and re-emerging infectious diseases, we do need and should use more competent method for managing ever-changing and large amount of medical information. As demonstrated by our

Anti-SARS Knowledge Management System, ontology-driven knowledge management is an alternative and favored methodology in managing medical information whenever there is a need for fast updating in contents, building knowledge base from multiple sources, or constructing an integrated knowledge management platform.