A Bibliometric Analysis of Alert Override in Clinical Decision Support

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Abstract. The aim of this study was to understand the status and trend in alert override research over the past two decades (1999-2018). We used the Web of Science core collection (WoSCC) database to extract all papers of alert override in clinical decision support from 1999 to 2018. A total of 150 papers were identified, most (86.67%) being articles. This study presented the key bibliometric indicators such as annual publications, top 5 authors, institutions, countries, and co-occurrence of terms from the titles and abstracts. VOSviewer was used to visualize keywords knowledge maps. The results show that alert override research has a wide variety of research themes and a multidisciplinary character. This study provides a broad view of the current status and trends in alert override research. It may help researchers, clinicians and policymakers better understand alert override research field change and direction in the future.

Keywords. Bibliometric, visual analysis, override, alert, clinical decision support

1. Introduction

The introduction of the federal meaningful use incentive program in the USA, usage of clinical decision support (CDS) in the form of alerts has increased substantially [1]. As CDS became more widespread and sophisticated, alert overload has become an increasingly significant problem. Too many alerts may lead to “alert fatigue” for the user, which can cause providers to miss or override important alerts [2-4]. Alert override exists in a broader context as alert safety and a CDS problem. Despite intensive efforts to improve alert function and reduce alerts, override rates remain as high as reported over a decade ago [5]. The alert override has been the focus of much research in health informatics.

Global trends and characteristics of alert override research were analyzed from 1999 to 2018 so as to bring a panoramic understanding of override alerts in health care and to help identify a suitable research direction. The bibliometric research uses the Web of Science (WoS) as the source of all investigations for the said purpose. WoS is the largest scientific database collection worldwide and the most valued for purposes of valid and reliable desk research in many areas of scientific interests. Many research fields use...
bibliometrics to explore the impact of a group of researchers, or the impact of a particular paper. Therefore, the present bibliometric analysis aims to map alert research output and identifying the focus areas and factors involved. This analysis will help inform researchers, academicians, and the scientific community on the need and importance of further research in understanding alert override in health care.

2. Methods

A literature search was conducted by two reviewers independently in WoSCC for publications from January 1, 1999, to December 31, 2018, and used the following topic terms: “alert” and “override” to search. Two investigators independently screened these studies based on titles, abstracts, and full text. Moreover, a double-check technique was applied to exclude irrelevant publications and to ensure that all remaining publications were relevant to the scope of the research. A third reviewer reviewed by adjudication, in cases of disagreement. The non-English language articles were excluded.

Record contents including full record and cited references such as paper title, abstract, keywords, authors’ names, affiliations, and references were compiled for further analysis. Data extraction and analysis were performed using Microsoft Excel 2016 and the Web of Science analysis tool. In addition, VOSviewer v.1.6.8 (a software tool for constructing and visualizing networks, Leiden University, Netherlands) was used to construct a knowledge map.

3. Results

A search of the online WoSCC database resulted in 176 articles from WoSCC. From the initial title screenings, we rejected seven other document type articles (editorial material, letters, and correction), and 169 articles were identified. Two reviewers independently read and judged all articles according to the objectives of the research, resulting in our final list of 150 articles (rejected 19 irrelevant articles) to include in the analysis. Of there 150 papers retrieved, 127 (86.67%) of them were articles, 10 (6.67%) of them were meeting abstracts, and three (2.00%) of them were proceeding papers. They were all published in English.

3.1. Annual Distribution of Publications and Citations

For the past twenty years, the annual distribution of articles is shown in Table 1, consisting of 3316 articles without self-citation and with a ratio of 26.13 citations per paper. The h-index is 31.
3.2. Journals Publishing on Alert Override

In total, 150 articles were published in 56 different journals. Of the 56 journals, 37 journals (66.07%) published only one article on the topic of alert override in health care. Three journals (5.36%) published 10 articles or more on the topic. A list of the top five journals in the field of alert override research is shown in Table 2.

| Journal                          | Records | Percent | IF 2017 |
|----------------------------------|---------|---------|---------|
| J Am Med Inform Assoc            | 34      | 22.67%  | 4.27    |
| Int J Med Inform                 | 11      | 7.33%   | 2.95    |
| J Gen Intern Med                 | 10      | 6.67%   | 4.00    |
| Am J Health Syst Pharm           | 8       | 5.33%   | 1.87    |
| BMC Med Inform Decis Mak         | 7       | 4.67%   | 2.13    |

3.3. Institution and Country

Alert override in health care publications originates from 20 different countries/regions. The top five productive institutions and countries on alert override are shown in Table 3. 294 different research institutions participated in the 150 articles. Of all the institutions, only 72.79% (n=214) participated in one article. Seven institutions (2.38%) produced at least 10 articles on the topic of alert override research. The United States leads the ranks by obtaining the most significant results in the number of papers.

| No   | Organization/Institution         | Records | Country | Records |
|------|----------------------------------|---------|---------|---------|
| 1    | Harvard University (USA)         | 47/ 31.33% | USA     | 102/68.00% |
| 2    | Partners Healthcare System (USA) | 34/22.67% | UK      | 25/16.67%  |
| 3    | VA Boston Healthcare System (USA)| 19/ 12.67% | Netherland | 15/10.00% |
| 4    | Durham University (UK)           | 82/ 1.28% | Switzerland | 12/8.00% |
| 5    | Massachusetts General Hospital (USA)| 79/ 1.23% | South Korea | 11/7.33% |

3.4. Contributing Author and Highly Cited Article

In this study, 622 authors contributed to the 150 papers. Table 4 shows the top five most prolific author in the field of alert override research. Bates DW obtains the first position.
with 35 articles (23.33%). The article by Van der Sijs H, et al., titled “Overriding of drug safety alerts in computerized physician order entry” [6] achieved the highest number of citations (n=517).

Table 4. Top 5 of most productive author.

| Author       | No. | Institution                                                                 |
|--------------|-----|-----------------------------------------------------------------------------|
| Bates DW     | 35  | 1. Brigham & Women’s Hosp, Div Gen Internal Med & Primary Care, Harvard Med Sch. 2. Partners HealthCare, Informat Syst |
| Seger DL     | 28  | 1. Brigham & Women’s Hosp, Div Gen Internal Med & Primary Care, Harvard Med Sch. 2. Partners HealthCare, Informat Syst |
| Slight SP    | 21  | 1. Brigham & Women’s Hosp, Ctr Patient Safety, Harvard Med Sch. 2. Newcastle Univ, Sch Pharm, Newcastle Upon Tyne, UK |
| Dykes PC     | 15  | Brigham & Women’s Hosp, Ctr Patient Safety Res & Practice, Harvard Med Sch. |
| Beeler PE    | 12  | 1. Massachusett’s Gen Hosp, Dept Anesthesia Crit Care & Pain Med, Harvard Med Sch. 2. Partners Healthcare Syst |
| NanJi KC     | 12  | 1. Brigham & Women’s Hosp, Div Gen Internal Med & Primary Care, Harvard Med Sch. 2. Partners HealthCare, Informat Syst |

3.5. Co-occurrence of All Terms Analysis

The terms were extracted from the title and abstract fields by VOSviewer. In the terms analysis, only terms mentioned together more than five times were analyzed. The minimum number of occurrences of terms were five, and of the 4968 terms, 232 terms met the threshold. For each of the 139 terms (60% default choice), the total strength of the co-occurrence links with other terms was calculated. 139 terms with the greatest total link strength were selected. The most common terms are “drug interaction”, “safety”, “fatigue”, “event” and “alert override”. The analysis results suggest the research themes include three clusters (Figure 1). The size of the visual representation of terms is related to the frequency they appear in the retrieved papers. Figure 2 shows the evolution of the various terms over time.

4. Discussion

The number of articles annually has a large growth over the period of 2014-2018. The number of publications is considered to be a measure of scientific productivity and
interest in alert override in CDS. The number of articles published annually and times cited has increased significantly over this period. 150 papers were distributed among 56 journals. The top 5 journals published 46.67% (n=70) of the papers. The key journals in the field are Journal of the American Medical Informatics Association (n=34, 22.67%), International Journal of Medical Informatics (n=11, 7.33%), and Journal of General Internal Medicine (n=10, 6.67%). There is a high number of different journals publishing on the alert override, which indicates a wide variety of research themes and the multidisciplinary character of alert override research in CDS.

The co-occurrence analysis of terms from title and abstract of alert override articles can provide insight into the main topics and research trends in the domain of alert override. In the co-occurrence, repetitive relations are determined based on the number of articles in which two terms occur together. The result of the terms analysis is presented in Figure 1. The size of the circles represents the occurrence of a term (the bigger the circle, the higher the occurrence of a term in the articles). The overall distance between terms offers information on their relatedness. The shorter the distance between two terms, the stronger their relation. The relatedness of terms is determined by counting the number of times that terms occur together in the title and abstract [7]. The colors are used to distinguish between different clusters. The overlay visualization is the timeline view of the network (Figure 2). The color of a term indicates the term’s average publication year (the terms with yellow show more recent publications). This helps in chronologically recognizing the most applied terms (e.g. “appropriateness,” “alert type,” “fatigue,” “alert burden,” and “CDS”). Nonetheless, this does not demean another research theme to be obsolete.

This study was restricted to the use of only one database as a source of data collection (WoSCC). Although it is the most recognized [8], it includes only a part of the total data available. Some journals are not represented in the database which leads to a lack of full coverage of articles related to alert override. In addition, we limited our literature search to English language publications. There is a possibility that the non-English articles reflecting alert override may have been missed.

5. Conclusions

These outcomes help us perceive the evolution of the research in the field of alert override in CDS over a twenty-year period. The study indicates a wide variety of research themes and the multidisciplinary character of alert override research. From an overall perspective, the results show that there has been a significant increase in alert override research in recent years. The United States and its institutions play a leading role in alert override research. This bibliometric analysis can offer a comprehensive approach regarding the research theme, state of the art, and trend.

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