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Trends in the growth of literature of telemedicine: A bibliometric analysis

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ABSTRACT

Over the past two decades, the use of telemedicine as a way to provide medical services has grown as communication technologies advance and patients seek more convenient ways to receive care. Because developments within this field are still rapidly evolving, identifying trends within telemedicine literature is an important task to help delineate future directions of telemedicine research. In this study, we analyzed 7960 telemedicine-related publication records found in the Science Citations Index – Expanded database between 1993 and 2012. Bibliometric analyses revealed that while the total growth in telemedicine literature has been significant in the last twenty years, the publication activity per country and over time has been variable. While the United States led the world in the cumulative number of telemedicine publications, Norway ranked highest when we ordered countries by publications per capita. We also saw that the growth in the number of publications per year has been inconsistent over the past two decades. Our results identified that neuroscience neurology and nursing as two fields of research in telemedicine that have seen considerable growth in interest in this field, and are poised to be the focus of research activity in the near future.

1. Introduction

Telemedicine is developed as a solution to provide health care to the underprivileged inaccessible regions, and aims to provide equal access to medical care irrespective of geographic location [1]. It has attracted increased interest in recent years. Health care organizations worldwide have increased interest in implementing telemedicine technology to improve care and services. The continued advancement of Internet-based

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audio and video communication technologies that enable more telemedicine applications, combined with the increased demands on the physician supply and the patients' desire for more convenient and efficient ways of receiving care, drive the growth of telemedicine. Over the past two decades, the functions of telemedicine have expanded significantly to include remote physician consultations, intensive care services, mental health monitoring, as well as chronic disease management, serving as a supplement or an alternative to traditional physician office visits [2]. This has proven particularly important to the improvement of rural health, as telemedicine effectively bridges the gap between inhabitants of rural areas and medical professionals located in city centers, providing specialist care, improving access, reducing long travels, and increasing the overall quality of care within these rural areas [3,4].

Since the field of telemedicine is still in a period of fast growth, keeping up-to-date of the latest developments and trends can be challenging; however, bibliometrics presents a useful quantitative tool to assess the large amount of literature within this field. Bibliometric methods have been effectively used to conduct citation analysis on an entire database of articles to identify the most influential journals and their publication characteristics [5]; within telemedicine, bibliometrics was most recently used to identify trends in key term usage within publications [6]. In this study, we focused on identifying telemedicine publication trends within the past two decades with regard to publication year, country, and language, as well as the relationship between these characteristics and factors such as population density, legislative influences, and the growth of specific research applications and areas.

2. Methods

2.1. Source of data

The Science Citation Index – Expanded (SCI-EXPANDED) was searched for articles relating to telemedicine using the Advanced Search feature of Web of Science (Thomson Reuters). This database was chosen since the journals within the index have been selected for inclusion based on high impact within their respective fields. Because the use and definition of the word "telemedicine" is not formally standardized within the literature, a query was developed to include variations in spelling as well as three other terms commonly used interchangeably with telemedicine [1]. "Telehealth", "e-health", and "telecare" were all searched in addition to "telemedicine" to ensure that the search results adequately reflects the literature in the field, following up on a recent bibliometric study that examined the usage of these terms [5]. By using these general search terms rather than terminology specific to any particular application, we hope to gain a cross-sectional perspective on the overall direction of development in the field of telemedicine. In the Web of Science, "Topic" (Tagged as 'TS') is one of the most common fields used for database searching and it searches for the entered term in Title, Abstract, Author keywords, and Keyword Plus fields of records in this database. The following query was used to search the "Topic" field of the Science Citation Index – Expanded for available articles:

TS = (telecare or "tele care" or tele-care) OR

TS = (telehealth or "tele health" or tele-health) OR

TS = (telemedicine or "tele medicine" or tele-medicine) OR

TS = (ehealth or "e health" or e-health).

The timeframe of the search was limited to 1993–2012 to analyze the characteristics of the publications within telemedicine for the most recent two decades. Articles published in 2013 were excluded to avoid incomplete results as this search was conducted in July 2013.

2.2. Analysis

Data analysis was conducted using the Results Analysis feature provided on Web of Science (Thomson Reuters) to first characterize the entire set of search results. Summary statistics regarding the publications, such as the publication year, countries of publication, and research areas were also gathered via this interface. Additional country information regarding population and land size were obtained from The World Bank: World Development Indicators [7], which includes current data from official sources, and used to obtain the population density by dividing a country's population by its land size. Countries were also ranked according to the total number of publications, publications per capita, and population density. Research areas, as classified and supplied by the Web of Science database based on the journal in which the article was published, were ranked by the total number of publications in each area during each of 4 sub-periods of 5 years over the past 20 years. These results were output to a text file and graphed using Excel (Microsoft, Redmond, USA) and map figures were drawn using the R 2.15.3 software [8] and the googleVis library [9].

3. Results

3.1. Results of query

A total of 7960 publications were located using the customized query in the Web of Science database, and the search results of each of the four terms searched individually as well as in conjunction are displayed in Table 1. We found that "telemedicine" (with its variants) was the most popular term with 6115 publications, followed by "telehealth" ($n = 1327$) and "e-health" ($n = 1246$). The term "telecare" returned the fewest, with only 392 results.

3.2. Publication languages, types, and by countries

Table 2 breaks down the 7960 publications by publication language, showing that the English language dominated with 7594 publications, which represented over 95% of total