Publication Productivity of the Heart Transplantation, 1999 to 2014: A Scientometric Analysis

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Abstract

Purpose: The purpose of this study is to investigate the growth of Heart Transplantation literature between the time frame of 1999 and 2014. There are very less number of scientometric studies have been done on this area. This is to understand our motives and desires, as well as obstacles in the scientometric study of Heart Transplantation. *Methodology:* Statistical tools such as frequency distribution and percentage analysis and bibliometric techniques i.e. Relative Growth Rate (RGR), Doubling Time (Dt) are used for this study. *Findings:* An average RGR of articles $R_t(P)$ increased gradually from 0.68 to 2.63 (1999 to 2014) and sudden increase in the year 2008 (2.24). Correspondingly, the value of doubling time of the publication of the articles Dt(P) increased gradually from 2000(1.36 years) to 2014 (5.27 years). It indicates that the mean relative growth of Heart Transplantation literature has an increasing trend may be due to interdisciplinary and multidisciplinary nature of the research and communication pattern of the medical and surgical researchers.

Keywords: Scientometrics; Heart; Heart Transplantation; Relative Growth Rate (RGR); Doubling Time (Dt).

Introduction

Heart transplant is a surgical process in which a diseased heart is substituted with a healthy heart from a deceased person. Heart transplants are done as a life-saving measure for the end-stage of heart failure. The world's first heart transplant in human beings was done in South Africa on 3rd December, 1967 by Dr.Christian Barnard, but the patient only lived 18 days [1]. The number of patients with heart failure is getting epidemic proportions in the western world. In the UK there are approximately 100000 new cases per year, whereas in the USA five times more than that number. Patients at the end-stage of heart failure may have a 1 year survival of 50%, and the figure is as low as 10% by 2 years. It is primarily a disease of the elderly and in 95% of cases is due to ischemic heart disease. The most effective treatment, but with limited availability, is heart transplantation [2]. India's first heart transplant carried out by Dr. P K

Senat Parel back in 1968. Whereas,in India at present, there are 50000 cases have been reported for requiring heart transplant surgery in every year but Only 30 hearts have to done transplantation.

Scientometrics is used to analyze various quantitative or qualitative aspects of a publication in the field of Heart transplantation. It is a scientific field that studies the evolution of science through some quantitative measures of the scientific information, as the number of scientific articles published in a given period of time, their citation impact, etc. [3]. This study helps to library professional, Medical researcher to find exact statistics of the Heart Transplantation.

Review of Literature

The variations in the mass of literature over a specific period termed as growth literature. Gilbert (1978) has studied the existing literature on the indicators of growth of knowledge in scientific areas, and has enumerated many ways of measuring it, noting their strength and limitations and commenting, at same time, on their use. Gupta, B.M (1977) recommends two approaches that have normally been considered in understanding knowledge growth: (i) Qualitative and (ii) Quantitative. Qualitative methods

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recommended the structural or descriptive models of knowledge growth, while descriptive model use social phenomenon to explain diffusion and formation of knowledge. Quantitative approach is trusted on summarization of statistics to elaborate the observed behavior, whereas others apply growth and technology diffusion models and bibliometric/ Scientometric techniques.

More number of studies has been made on the growth of literature in the field of Medicine and Surgical literature but a less number of studies have been reported on growth of research literature on Heart Transplantation. Therefore an attempt has been made to study the growth and dynamics of Heart Transplantation research literature.

Objectives

- To define the growth rate of 'Heart Transplant' literature by calculating relative growth rate and doubling time for publications;

- To fit both modified linear curve and exponential curve for the original publications data studying actual growth pattern.

Scope

The Scientometric study is a statistical method of measuring to evaluate and enumerate the growth of a subject. The research trend during the said time span would be clearly understood from this study and a predictive projection may be made for an anticipatable future. There are several areas in science, social science and arts for which scientometric studies have been carried out. The data gathered on 'Heart Transplant' is between the year 199 to 2014 from the 'Pub Med' database only.

Methodology

The present study focused on the scientometric analysis of research publications in Heart transplantation. The literature is collected from PubMed database and applied search techniques to access the data and used key term as "Heart Transplant". A total of 31,665 records retrieved the field of Heart transplantation worldwide during the years 1999 to 2014 [4]. A spreadsheet application (MS Excel) was used to classify the collected data and the data were analyzed by statistical tools such as frequency distribution, percentage analysis and bibliometric techniques such as Relative Growth Rate (RGR) and Doubling Time (D_t) were used for this study.

Statistical Method

To investigate the nature and growth of articles, exponential, linear and logistic were tested. The exponential growth is defined as

$F(t) = a\, e^{bt}$

Where

a = the initial size of literature i.e. at time t=o and b, the continuous growth rate is related to the percentage by which the size increases each year.

The logistic has a lower limit and an upper limit or a ceiling beyond which the size cannot grow and can be represented mathematically as

$$U_t = \frac{K}{1+\mu}$$

Where,

U = expected size of literature

K and μ = constants and t= time.

Similarly, the linear growth is represented as

$U_e = a + b_t$

Relative Growth Rate (RGR) and Doubling Time (D_t) had been applied. RGR means the increase in the number of articles per unit of time. The mean RGR of articles over the exact period of interval is represented as

R_t = Relative Growth Rate of articles over the specific period of time.

$\log_e p(0)$ = Logarithm of initial number of articles

$\log_e p(t)$ = Logarithm of final number of articles

Similarly, RGR of subject's articles has increased in number of articles per unit of time. The mean RGR of subject articles Rt(SA) over the period the specific period of time is determined as

$$R_t(SA) = \frac{1}{t}\left[\log_e p(t) - \log_e p(0)\right]$$

R_t(SA) = Relative Growth Rate of articles over the specific period of time.

= Logarithm of initial number of articles

= Logarithm of final number of articles

Dt (Doubling Time) has been calculated using the following formula:

Doubling Time or D_t = 0.693/R

Dt (Doubling Time) is directly related to RGR and

is defined as the time required for the articles to become double of the existing amount. In case the number of articles in subject doubles during a given period, then the difference between logarithms of number at the beginning and at the end of this period must be the logarithm of the number 2. We used Napier logarithm and the taken value of is 0.693. Therefore, as per this (0.693) and an average growth rate we calculated by

what time interval does the Napier logarithm of numbers increase by 0.693. So the Doubling time is calculated as

$$D_t(SA) = \frac{\log_e 2}{R_t(SA)} = \frac{0.693}{R_t(SA)}$$

Here, $D_t(SA)$ = average doubling time of the articles [5].

Table 1: Relative Growth-rate (RGR) and Doubling time (D_t) of articles in Heart Transplantation, 1999 to 2014

Year	No. of Articles	Cumulative	Log$_e$1P	Log$_e$2P	R$_t$(P)	Mean Rt(P)	D$_t$(P)	Mean Dt(P)
1999	1671	1671	7.42	7.42	0		0	
2000	1722	3393	7.45	8.13	0.68		1.36	
2001	1729	5122	7.46	8.54	1.09		2.17	
2002	1645	6767	7.41	8.82	1.41		2.83	
2003	1773	8540	7.48	9.05	1.57		3.14	
2004	1882	10422	7.54	9.25	1.71		3.42	
2005	2132	12553	7066	9.44	1.77		3.55	
2006	2052	14605	7.63	9.59	1.96	1.27	3.93	2.55
2007	2018	16623	7.61	9.72	2.11		4.22	
2008	1976	18599	7.59	9.83	2.24		4.48	
2009	2045	20644	7.62	9.94	2.31		4.62	
2010	2185	22829	7.69	10.04	2.35		4.69	
2011	2107	24936	7.65	10.12	2.47		4.94	
2012	2184	27120	7.69	10.21	2.52		5.04	
2013	2271	29391	7.73	10.29	2.56		5.12	
2014	2274 31665	31665	7.73	10.36	2.63	2.4	5.27	4.8

R²(Linear trend for no. of articles)=0.863
R²(Exponential trend for no. of articles)=0.8559
R²(Exponential trend for cumulative no. of articles)=0.8955
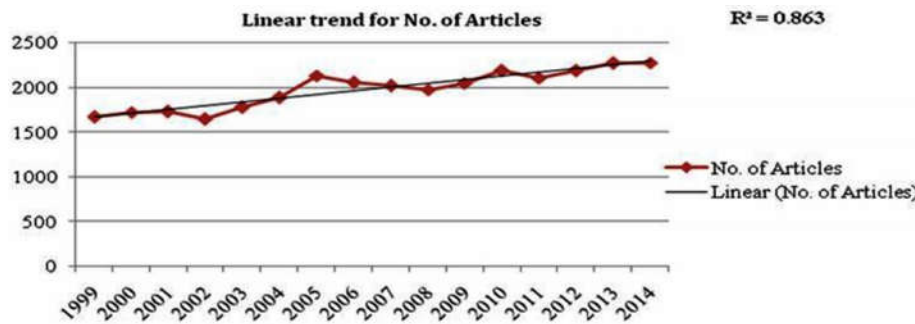
Table 1: Literature Growth of Heart Transplantation

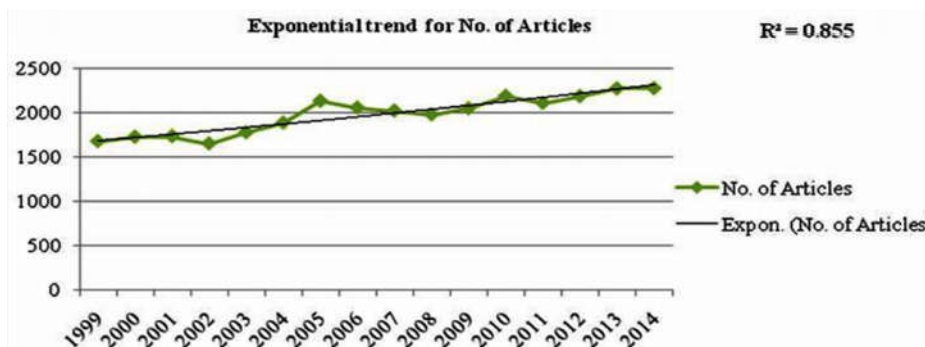

Fig. 1: Linear trend for No. of articles from 1999 -2014

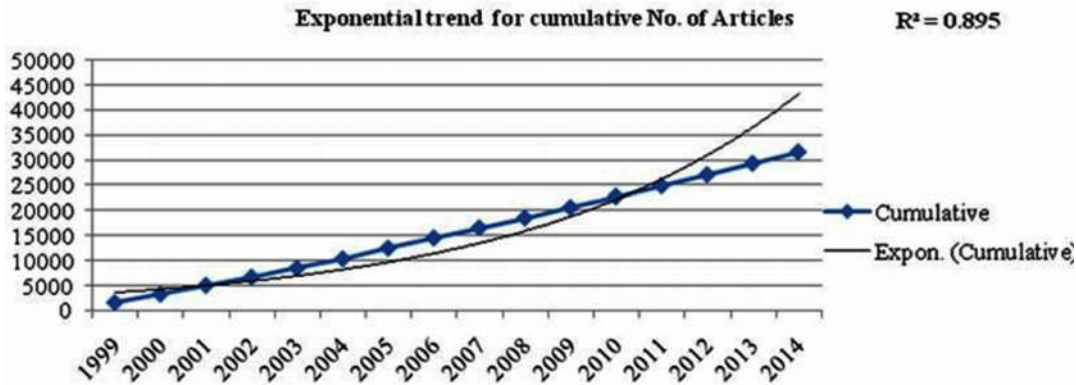**Fig. 2:** Exponential trend for No. of articles from 1999-2014

Fig. 3: Exponential trend for cumulative No. of articles from 1999-2014

Relative Growth Rate (RGR)

As the table clearly indicates, the value of an average RGR of articles $R_t(P)$ increased steadily from 0.68 to 2.63 (1999 to 2014) and there is tiny decrease in the year 2012 (2.33). Therefore during year 1999 to 2014 there were much research has been done. Consequently majority of the countries of the world have given more importance to research to improve the surgical techniques as well as to create the awareness among the donors of the heart, those who are in end stage of the life, hence the RGR has been increased. For the first eight years i.e. 1999 to 2006 the RGR was 1.27 and in the next eight years i.e. from 2007 to 2014, it was increased to 2.40. Interestingly it noted that, during the year 2008 (2.24) the $R_t(P)$ has been increased slightly, whereas in the year 2014 there has been $R_t(P)$ growth was raised up to (2.63). Because of variations in Cumulative articles. Cumulative values of Doubling time of the publication of articles $D_t(P)$ increased gradually from 1999 (1.36 years) to 2014 (5.27).

The mean relative growth $R_t(P)$ for the first 8 years (1999 - 2006) indicates a growth rate of 2.55 years, whereas for the next 8 years (2007 - 2014) it was increased 4.80 years. It indicates that the mean relative growth of Heart Transplant literature has shown an increasing trend. It may be due to interdisciplinary and multidisciplinary nature of research and the communication patterns of medical and surgical researchers. Therefore, it is inferred that majority of the countries have shown keen interest in research to precious Heart Transplant Surgery. The linear growth trend is fit to number of articles and exponential growth trend fit to number of articles and number of cumulative articles for the years 1999 to 2014. The Table and Figure 1, 2 & 3 reveals that the R^2 value for the linear trend (0.863) is more than that of exponential trend (0.8559), which indicates that the exponential trend is more suitably fit to as compared to linear trend.

Further, the exponential trend is fit to the cumulative number of articles from 1999 to 2014. The R^2 value for this trend is 0.8955, shows 96.04% variation observed from the cumulative number of articles.

Major Findings

The year-wise analysis of the growth of literature output shows that the growth was asymmetrical from the year 1999 to 2006, and it was high during 2007 to 2008. Between the years 2009 to 2014 there was an exponential growth of research literature on Heart Transplant worldwide. The high productivity during these years may be due to their significance of the studies on Heart Transplant Surgery, which may have got prominence in Research and subsequent literature as well. Therefore, it is evident from the study that there was an asymmetrical growth of literature on Heart Transplantation During a span of 16 year (1999 to 2014).

Conclusion

Many of the disciplines around the world would be aimed at informed decision making, critical assessments of the amount of new knowledge contributed by the research output and so on. Therefore valid measures of knowledge growth may be obtained. It helps to provide exact, useful descriptions and estimated growth of knowledge in the field of 'Heart Transplantation'. The year wise analysis of the growth of article output as shows that growth was peer in the year 1999 to 2014 and then there is a gradually increase in the output during the year 1999 to 2006 and 2007 to 2014. The high productivity during these years may be due to their significance in Heart Transplantation literature having got prominence in research.

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