

BIBLIOMETRIC ANALYSIS OF GENE THERAPY RESEARCH

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Abstract

Biomedical research proved that genetic disorders can be corrected only by means of Gene therapy. Gene therapy research, a top priority with a thumping progress till 2012, has slowed down due to ethical issues involved. This is a trend reporting bibliometric study of gene therapy research output covering a period of 10 years spanned between 2004 and 2013. Selective metric indicators were applied to the data. The study revealed that a sum total of 1,28,854 publications were authored altogether by 8,03,172 drawn from 78 countries publishing in 8443 journals. A sum total of 803172 authors participated in the publications of which collaborative publications outnumbered the single authored publications. The results of the study were not found to be in conformity to those of either the Pareto's 80x20 rule or Bradford's law. The publications, though maintained for all the nine years duration, suffered a depression in the 10th year i.e. 2013. Commercialisation of gene therapy has been lingering at the doorstep warranting for removing certain precision lacking procedures in administering the therapy. Separate bibliometric studies may reveal whether gene therapy suffers the general theory of technology life cycle which advocates that any technology suffers a downward trend after reaching a peach in research output.

Key words: *Bibliometric study; Gene therapy; Authorship pattern; Pareto's 80x20 rule; Bradford's law.*

Introduction

Gene Therapy research has been witnessing a proliferation of Publications over the last few decades yielding a potential of being analysed bibliometrically. Gene Therapy research adds to the Biomedical knowledge base leading to the welfare of human beings and this process is known by the term knowledge economy. According to an OECD (1996) report, "In order to incorporate more directly knowledge and technology in their theories and models and to understand the role of knowledge and technology in driving productivity and economic growth, economists introduced a new term – 'knowledge-based economy' as found discussed by Foray and Lundvall¹, (1996); Abramowitz and David², (1996), which is directly based on the production, distribution, and use of knowledge and information."

Gene therapy evolved from scientific endeavors to a clinically pertinent treatment for many of the human organ systems. In disease treatment, experiments continue to progress in the context of the selection of optimal target cells, development of sequential therapeutic methods, and identification of factors which may be detrimental to the

introduction of genes. Stem cell research has made a significant contribution to the study of basic mechanisms of cell proliferation and differentiation and has proven to be indispensable in the development of gene therapy.

Gene therapy, defined as the insertion of a gene into recipient cells, was initially considered only as a treatment option for patients with a congenital defect of a metabolic function or late-stage malignancy³. Academic Research is enlivened by Government and Corporate funding/Grants which is always subject to measurement and evaluation. To fulfill this policy of evaluation or assessment of research output, other than peer review process, the other alternative available is bibliometrics.

Bibliometrics

According to Alan Pritchard⁴ (1969), "The definition and purpose of bibliometrics is to shed light on the process of written communication and of the nature and course of a discipline (in so far as this is displayed through written communication) by means of counting and analysing the various facets of written communication." Bibliometrics does not measure the physical properties of documents but statistical patterns in variables such as authorship, sources, subjects, geographical origins, and citations. Bibliometrics was given a shape after a well founded debate when Pritchard came forward with a definition that was accepted by his contemporaries in 1969.

Review of Literature

Ledley, et al.,⁵ (2014) by means of bibliometric analysis, examine the commercialization of gene therapy in the context of innovation theories that posit a relationship between the maturation of a technology and successful product development. The authors show that the field of gene therapy has matured steadily since the 1980s, with the congruent accumulation of >35000 papers, >16000 US patents, >1800 clinical trials and >\$4.3 billion in capital investment in gene therapy companies. Gene therapy technologies comprise a series of dissimilar approaches for gene delivery, each of which has introduced distinct product architecture. Ruth Isserlin, et al.,⁶ (2011) in their bibliometric analysis, identified a seminal paper charting the human kinome was published in 2002. There were a total of 80,000 citations prior to 2002 and 120,000 citations after. This analysis revealed that 84% of the citations to protein kinases in 1950-2002 were focused on only 10% of the kinome (50 kinases). Interestingly, the very same kinases continued to garner most of the citations even long after the genome information became widely available (77% of citations between 2003 and 2008, and 74% of the citations in 2009). All the authors belong to different fields in medicine and no library professional was to be found among the coauthors.

Objectives of the Study

The major objective of this investigation is to measure gene therapy research output at the global level along with attempts to identify overall world scientific research output and spectrums analysis of related facets. This study aims to analyse the data to find out the frequency distribution of contributors, contributions and future course of projections in Gene Therapy Research Publications.

Methodology

This is a bibliometric study. The study is based on publications count in Gene Therapy between 2004 and 2013 as found registered in PubMed, an International online open source publication by the National Library Medicine (NLM), United States. The present study confines its scope to a single field namely Human Gene Therapy as found enumerated and indexed in PubMed. Based on the analysis, the study aims to arrive at future course of projections in authorship pattern, country of origin of contributions and country of publications. In addition, the study proposes to apply the empirical laws of Lotka; Bradford; and Price.

Analysis and Interpretation

Table 1: Annual output and growth rate

S. No	Year	Publication Counts	Growth Rate
1	2004	8493	
2	2005	9690	0.93
3	2006	10563	0.68
4	2007	11026	0.36
5	2008	12312	1.00
6	2009	12980	0.52
7	2010	14799	1.41
8	2011	16106	1.01
9	2012	17196	0.85
10	2013	15689	-1.17
		128854	Average = 0.62

Table 1 reveals the annual output of gene therapy research. A sum total of 128854 records were found published for the whole period of 10 years under study. Excepting that of the year 2013, the trend registered a positive growth with 0.62 as the average while it was found that the growth was not uniform.

Table 2: Authorship pattern

Authorship	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Single	1140	1250	1130	1179	1265	1165	1198	1094	1126	940
Joint	1308	1438	1595	1484	1684	1656	1826	1824	1910	1699
Collaborative	6045	7002	7838	8363	9363	10159	11775	13188	14160	13050
Total	8493	9690	10563	11026	12312	12980	14799	16106	17196	15689

Regarding the authorship pattern, publications suffered fluctuations with ups and downs quantitatively regarding all types of authorship. While comparing the figures for 2004 and 2012, collaborative authorship almost doubled while joint authored publications showed an increment gradually. Single authored publications almost maintained a steadiness though in many S & T fields, it is said to be on the decline.

Table 3: Frequency Distribution of Contributors and Contributions

Year	Contributions	Contributors	Growth Rate
2004	8493	44667	
2005	9690	52035	0.92
2006	10563	59342	0.91
2007	11026	63131	0.47
2008	12312	72569	1.18
2009	12980	79634	0.88
2010	14799	94980	1.91
2011	16106	107163	1.52
2012	17196	117909	1.34
2013	15689	111742	-0.77
	128854	803172	Average = 0.93

With 2004 as the base year, it is found that the number of contributions have grown to nearly two folds while the overall number of authors taken collectively contributing them have grown to nearly three folds. This shows that the velocity or pace of growth of publications in Gene Therapy registered a strong and positive growth. The correlation coefficient of number of contributions and the number of contributors work out to 0.9941 showing a positive correlation. That is, statistically speaking, as the number of publications increases, the number of authors contributing them also increases.

Table 4: Collaboration Index

Year	Journal Count (Joint and Collaboration)	Number of Authors (NA)	Collaboration Index (CI) = NA/C
2004	7353	43527	5.92
2005	8440	50785	6.02
2006	9433	58212	6.17
2007	9847	61952	6.29
2008	11047	71304	6.45
2009	11815	78469	6.64
2010	13601	93782	6.90
2011	15012	106069	7.07
2012	16070	116783	7.27
2013	14749	110802	7.51
	117367	791685	Average = 6.62

A dominating trend in the authorship pattern, that has come up is the Collaborative scientific effort in producing scientific papers. In 1980, Lawani⁷ introduced collaboration index (CI) as the average number of authors per article. In the present study, the collaboration index ranges from 5.92 to 7.51 showing that the average number of authors per paper is 7 thereby revealing a strong and positive trend in multiple authorship.

Pareto's 80 x 20 Rule

The Pareto⁸ 80 x 20 rule states that 80 percent of the effects in a system is generated by 20 percent of the variables in the system. The rule has proven true in all large systems including those in user interface design as well as economics, management, quality control, and engineering among others. This principle does not hold good in the present study since 75 per cent of the total research output in Gene Therapy has been contributed by .5 per cent of the total countries involved in this research.

Table 5: Application of Bradford's Law

Zones	Journals
Zone 1	94
Zone 2	459
Zone 3	3668

Table 5 displays the three zones of journals which have produced the publications covered under the study. The journals are arranged according to the specified order prescribed in Bradford's law grouping them into three zones of equal number of publication counts represented in the journals cluster. Publications count though divided into three

zones of equal in number, the number of journals which published the papers varies. Bradfords law is applied to the three zones. The three zones are in the ratio which is not in conformity to the Bradford's formula $1:n:n^2$

Conclusion

The study identified a sum total of 1,28,854 publications authored altogether by 8,03,172 drawn from 78 countries publishing in 8443 journals. A sum total of 803172 authors participated in the publications of which collaborative publications outnumbered the single authored publications. The results of the study were not found to be in conformity to those of either the Pareto's 80x20 rule or Bradford's law. The publications, though maintained for all the nine years duration, suffered a depression in 2013. Commercialisation of gene therapy has been lingering at the doorstep warranting for removing certain precision lacking procedures due in administering the therapy. Separate bibliometric studies may reveal whether gene therapy suffers the general theory of technology life cycle which advocates that any technology suffers a downward trend after reaching a peak in research output.

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