

Authorship Trends in Telemedicine Research

V. Viswanathan, B. Elango, S. Yugapriya



Abstract: *Telemedicine is the remote delivery of healthcare services, such as health assessments or consultations, over the telecommunications infrastructure. The aim of the study is to analyze the research output on telemedicine. The publications indexed in Scopus database have been used for this study for a period of twenty five years. Retrieved data has been analyzed with various bibliometric tools such as Co-Authorship Index, Multi Authorship Index, Citations per Paper, Relative Citation Index and Relative Uncitedness Index. Highly cited publications and frequently used words in titles are discussed. Analysis reveals that 36949 publications were published in the area of telemedicine with maximum number of publications in the year 2015. Nearly 80% of the total research output has been published with co-authors. Nearly one third of the publications (32.28%) have yet to receive citations.*

Keywords: *Telemedicine, Scopus Database, Multi-Authorship Index, Bibliometrics, Highly Cited Papers, Relative Uncitedness Index.*

I. INTRODUCTION

Telemedicine [1] is a type of service providing healthcare to a remote person with the advancements of telecommunication and information technology.

Although the term “Telemedicine” was coined in the 1970s, the history dates back to the 20th century. Literally it means “healing at a distance”. It is a combination of two words: a Greek word “Tele” meaning distance and a Latin word “medari” meaning to heal.

There is no standard definition for telemedicine. However, WHO defines as the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities. Similarly, the European Commission defines as the rapid access to share and remote medical expertise by means of telecommunication and information technologies, no matter where the patient or relevant information is located. In simple terms, the Time magazine called telemedicine as the “healing by wire”.

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Even though it is used interchangeably with telehealth, there is a difference between these two concepts. According to Health Resources and Services Administration, telemedicine can be described as remote clinical services while telehealth includes preventive, promotive and curative care delivery.

In the recent past, telemedicine has been tremendously used for the benefit of sick and disabled persons.

II. REVIEW OF LITERATURE

In the recent past, few bibliometric/scientometric studies have been carried out.

González et al. [2] conducted a bibliometric analysis of Latin America's scientific output in the field of Public Health.

Welsh [3] examined the publishing and citing patterns of telemedicine literature indexed in Telemedicine Information Exchange.

Fatehi and Wootten [4] found that *telemedicine* was the commonly used term among others like *telehealth* or *e-health*.

Armfield et al. [5] analyzed the literature on telemedicine and telehealth indexed in PubMed.

Groneberg et al. [6] conducted a bibliometric analysis on telemedicine covering the period 1900-2006.

Even though some bibliometric studies [3-7] on this subject area “telemedicine” has been carried out earlier, no one has studied in detail, the authorship pattern and citation analysis of published literature in this area.

III. OBJECTIVES OF THE STUDY

- To study the Authorship pattern on publications
- To study the Citation Analysis on publications like Citation per paper, Relative Citation Index (RCI)
- To find out the highly cited publications
- To study the yearly distribution of Uncited publications, Relative Uncitedness Index

IV. METHODOLOGY

Scopus database was used to download the data for a period of 25 years from 1992 to 2016. The Bibliometric/Scientometric Indicators like Multi-Authorship Index (MAI), Citation per Paper (CPP), Relative Citation Index (RCI), Highly Cited papers (HCP) and Relative Uncitedness Index (RUI) are used in the study. For analysis SPSS and Excel software are used. The following search string was used to extract the data from SCOPUS



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(TITLE-ABS-KEY (telemedicine or "tele medicine" or tele-medicine or telecare or "tele care" or tele-care or telehealth or "tele health" or tele-health or ehealth or "e health" or e-health) AND PUBYEAR > 1991 AND PUBYEAR < 2017).

V. RESULTS

A. Authorship Pattern

The above table represents the authorship pattern of publications during the study period. It is found that Single authored publications contribute 19.57% of the total publications whereas coauthored publications contribute nearly 80% of the total publications. Among the collaborative research works, five and above authors have contributed 30.34% of the total publications. From the table -1 it is clear that the researcher in the field of telemedicine prefers collaborative research works rather than the individual one.

Table 1. Authorship Pattern on Publications

S. No	Number of Authors	Total Publications	Share on Total Publications (%)
1	Anonymous	987	2.60
2	Single Author	7423	19.57
3	Two Authors	6541	17.24
4	Three Authors	6354	16.75
5	Four Authors	5120	13.50
6	Five & above Authors	11511	30.34
	Total	37936	100

B. Multi-Authorship Index

A new index called Multi- Authorship Index (MAI) suggested by Elango [8] which is a variant of

Co-Authorship Index (CAI) suggested by Garg and Padhi [9]. The mathematical formula of the new index is given below:

$$MAI = \frac{MAP_i / \sum MAP}{TP_i / \sum TP}$$

Where,

MAI = Multi Authorship Index

MAP_i = Number of Multi authored papers in the ith year

∑MAP = Total number of multi authored papers for all the years

TP_i = Total number of papers in the ith year

∑TP = Total number of papers for all the years

If MAI ≥ 1, the size of single authored publications is not significant in the total publications and MAI < 1, the size of the single authored publications is significant in the total publications.

It is observed from the table-2 that the maximum numbers of publications was reported in the year 2015 with 3861 publications. Overall the research productivity in this field shows positive trends. The study further reveals that there are considerable number of single authored publications in the beginning of the study period and however it seems decreasing in recent years which shows the researchers in the field preferred collaborative works. Multi-Authorship Index ranged between 0.53 and 1.10 during the study period. MAI between 1996 and 2008 shows that the single authored publications are significant in the total publications whereas from the year 2009 to 2016 shows that the single authored publications are not significant in the total publications.

Table 2. Yearly Distribution of Publications

S. No.	Year	Anonymus	Single Author	Coauthored Publications					TP (SAP+CAP)	MAI
				Two	Three	Four	≥Five	Total		
1	1992	2	28	11	3	8	6	28	56	0.63
2	1993	6	42	14	8	6	14	42	84	0.63
3	1994	4	81	21	10	8	21	60	141	0.53
4	1995	14	137	66	33	28	48	175	312	0.70
5	1996	21	178	73	54	43	70	240	418	0.72
6	1997	73	245	106	70	48	102	326	571	0.71
7	1998	93	285	91	80	59	146	376	661	0.71
8	1999	27	278	135	109	67	158	469	747	0.79
9	2000	29	329	157	141	112	196	606	935	0.81
10	2001	24	268	151	139	125	202	617	885	0.87
11	2002	22	219	149	135	92	196	572	791	0.90

12	2003	27	231	172	133	119	251	675	906	0.93
13	2004	30	250	166	169	108	302	745	995	0.94
14	2005	21	300	220	216	172	324	932	1232	0.95
15	2006	27	323	297	261	195	431	1184	1507	0.98
16	2007	34	369	296	312	206	492	1306	1675	0.98
17	2008	41	388	338	318	302	521	1479	1867	0.99
18	2009	47	353	396	348	317	624	1685	2038	1.03
19	2010	53	391	390	388	318	684	1780	2171	1.03
20	2011	62	390	445	432	364	811	2052	2442	1.05
21	2012	70	450	470	488	416	904	2278	2728	1.05
22	2013	78	486	589	579	467	1107	2742	3228	1.06
23	2014	43	463	593	597	490	1250	2930	3393	1.08
24	2015	69	541	625	698	572	1425	3320	3861	1.08
25	2016	70	398	570	633	478	1226	2907	3305	1.10
	Total	987	7423	6541	6354	5120	11511	29526	36949	

(TP: Total Publications; SP- Single Authored Publications; CAP: Coauthored Publications; MAI: Multiauthorship Index)

VI. CITATION ANALYSIS

Citation is an important factor for any research output, which is being used to measure its quality. The Citation per Paper (CPP) is the ratio between total numbers of citations received/total number of publications in a specific period of time. Relative Citation Index (RCI) suggested by Kumari [10], is an indicator of influence and visibility of research in global perspective, is defined as the proportion of an entity's share of World citations to that entity's share of World publications ($RCI = C\%/P\%$). An entity's citation rate is equal to the World's citation rate if, RCI value is equal to one. If, $RCI > 1$ indicates that an entity's citation rate is higher than the World's citation rate and $RCI < 1$ indicates that that

entity's citation rate is less than the World's citation rate. In this study, we have applied the same on single and coauthored publications.

The table-3 shows that 25689 publications out of 37936 have received 342616 citations with an average of 9.03 citations per paper. Among these publications, the published literatures in the year 2011 have received 25295 citations with 7.38 Citations per paper, which is the maximum during the study period. The Relative Citation Index (RCI) ranged between 0.09 and 1.80 across the study period. The table further reveals that more number of publications received significant number of citations during the study period, except for the publications in the recent years.

Table 3. Citation Analysis on Yearly Publications

S.No.	Year	$Y_n - Y_i$	TP	TP (%)	CP	TC	TC (%)	CPP	RCI
1	1992	24	58	0.15	51	800	0.23	13.79	1.52
2	1993	23	90	0.24	75	1180	0.34	13.11	1.45
3	1994	22	145	0.38	83	625	0.18	4.31	0.48
4	1995	21	326	0.86	235	4311	1.26	13.22	1.46
5	1996	20	439	1.16	299	3773	1.10	8.59	0.95
6	1997	19	644	1.70	408	6840	2.00	10.62	1.17
7	1998	18	754	1.99	493	7452	2.18	9.88	1.09
8	1999	17	774	2.04	560	8425	2.46	10.89	1.20
9	2000	16	964	2.54	697	12799	3.74	13.28	1.47
10	2001	15	909	2.40	673	12828	3.74	14.11	1.56
11	2002	14	813	2.14	631	12404	3.62	15.26	1.69
12	2003	13	933	2.46	727	14819	4.33	15.88	1.76
13	2004	12	1025	2.70	802	14999	4.38	14.63	1.62

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14	2005	11	1253	3.30	945	20421	5.96	12.30	1.80
15	2006	10	1534	4.04	1144	21588	6.30	14.07	1.56
16	2007	9	1709	4.51	1240	20541	5.99	12.02	1.33
17	2008	8	1908	5.03	1394	24299	7.09	12.74	1.41
18	2009	7	2085	5.50	1525	23706	6.92	11.37	1.26
19	2010	6	2224	5.86	1648	25113	7.33	11.29	1.25
20	2011	5	2504	6.60	1852	25295	7.38	10.10	1.12
21	2012	4	2798	7.38	2065	24544	7.16	8.77	0.97
22	2013	3	3306	8.72	2335	24321	7.10	7.36	0.82
23	2014	2	3436	9.06	2330	17206	5.02	5.01	0.55
24	2015	1	3930	10.36	2288	11460	3.35	2.92	0.32
25	2016	0	3375	8.90	1189	2867	0.84	0.85	0.09
	Total	300	37936	100	25689	342616	100	9.03	1

(TP- Total Publications; CP-Cited Publications; TC-Total Citations; CPP-Citations per Paper; RCI: Relative Citation Index)

A. Highly Cited Papers

Recently, Elango [11] proposed an innovative method to determine highly cited papers and the following formula has been employed here:

$$MC \text{ in HCP} = \frac{TC}{TP} \times \frac{\sum Y_n - Y_i}{N}$$

Where, MC = Minimum Citations

HCP = Highly Cited Papers

TC = Total citations received by the papers (i.e. 342616)

TP = Total papers (i.e. 37936)

Y_n = Date of database access for citations (Date of access 9th October 2017 and taken as 2016)

Y_i = One of the year of publications in a data set (1992, 1993, 1994, ..., 2016)

N = Number of years 25

By substituting the appropriate values for the telemedicine research productivity in the above formula, the minimum number of citations needed for a publication to be called as a highly cited paper is 108. In this study 356 publications met this criterion and among them, the top 20 highly cited publication has been listed below:

Table 4. Highly Cited Publications

Authors	Title	Year	Source title	NoC	Document
Ringleb, P.A., et al.,	Guidelines for management of ischaemic stroke and transient ischaemic attack 2008	2008	Cerebrovascular Diseases	1485	Review
Lombard, M., Ditton, T	At the heart of it all: The concept of presence	1997	Journal of Computer-Mediated Communication	1160	Review
Martinez, A.W., et al.,	Diagnostics for the developing world: Microfluidic paper-based analytical devices	2010	Analytical Chemistry	1095	Article
Hansen, J.-P., McDonald, I.R.	Theory of Simple Liquids	2006	Theory of Simple Liquids	912	Book
Hu, P.J., et al.,	Examining the Technology Acceptance Model Using Physician Acceptance of Telemedicine Technology	1999	Journal of Management Information Systems	796	Article
Martinez, A.W., et al.,	Simple telemedicine for developing regions: Camera phones and paper-based microfluidic devices for real-time, off-site diagnosis	2008	Analytical Chemistry	734	Article
Eysenbach, G.	The law of attrition	2005	Journal of Medical Internet Research	705	Review

Hesse, B.W., et al.,	Trust and sources of health information. The impact of the internet and its implications for health care providers: Findings from the first health information national trends survey	2005	Archives of Internal Medicine	657	Article
Karantonis, D.M., et al.,	Implementation of a real-time human movement classifier using a triaxial accelerometer for ambulatory monitoring	2006	IEEE Transactions on Information Technology in Biomedicine	632	Article
Yetisen, A.K., Akram, M.S., Lowe, C.R.	Paper-based microfluidic point-of-care diagnostic devices	2013	Lab on a Chip - Miniaturisation for Chemistry and Biology	582	Review
Chau, P.Y.K., Hu, P.J.-H.	Information technology acceptance by individual professionals: A model comparison approach	2001	Decision Sciences	552	Article
Spruit, M.A., et al.,	An official American thoracic society/European respiratory society statement: Key concepts and advances in pulmonary rehabilitation	2013	American Journal of Respiratory and Critical Care Medicine	531	Article
Jovanov, E., et al.,	A wireless body area network of intelligent motion sensors for computer assisted physical rehabilitation	2005	Journal of NeuroEngineering and Rehabilitation	515	Article
Chaudhry, S.I., Et al.,	Telemonitoring in patients with heart failure	2010	New England Journal of Medicine	513	Article
Marescaux, J., et al.,	Transatlantic robot-assisted telesurgery	2001	Nature	495	Article
Eysenbach, G.	Medicine 2.0: Social networking, collaboration, participation, apomediation, and openness	2008	Journal of Medical Internet Research	487	Review
Parati, G., et al.,	European society of hypertension guidelines for blood pressure monitoring at home: A summary report of the second international consensus conference on home blood pressure monitoring	2008	Journal of Hypertension	480	Review
Black, A.D., et al.,	The impact of ehealth on the quality and safety of health care: A systematic overview	2011	PLoS Medicine	470	Article
Perednia, D.A., Allen, A.	Telemedicine Technology and Clinical Applications	1995	JAMA: The Journal of the American Medical Association	467	Article
Goldsmith, A.	Wireless communications	2005	Wireless Communications	447	Book

B. Uncitedness and Relative Uncitedness Index

The Relative Uncitedness Index (RUI) suggested by Garg & Kumar [12] is to measure the Uncitedness of publications. The indicator has been applied on single and coauthored publications during the study period. RUI is the ratio of the share of uncited articles to the share of total articles. The value of RUI can be zero or more. Higher RUI value indicates less citation impact and zero RUI value

indicates that there is no uncited article for the calculating unit.

Table-5 shows that there are 12247 (32.28%) uncited publications out of the total 37936 publications during the study period. The study reveals that the amount of uncited publications increases over the period of time. The Relative Uncitedness Index ranged between 0.37 and 2.01.

Article titles contain information about the whole paper which can express the authors' attitude to the readers and previously researchers analyzed the single words in article titles [13, 14]. A word cloud is a beautiful informative image that communicates much in a single glance [14]. In this study, word cloud has been generated from the following website www.wordart.com by providing the article titles extracted from publication records of telemedicine research. Fig. 1 provides the information about the frequency of single word in titles of research

publications in the fields of telemedicine. The font size of the text indicates how often the word is used by the scientists in the article. It can be observed that *Health, Care, Patient and System* are high frequency words along with *Telemedicine*.

VII. FINDINGS AND CONCLUSION

This study enumerates the research output on Telemedicine for 25 years from 1992 to 2016 based on the Scopus database. It is observed from the study that the research output has increased gradually over the period of time from 56 in the year 1992 to 3861 in the year 2015 with a fluctuation trend. In the earliest years of the study period also seen some ups and downs in the number of publication. Nearly 80% of the total research output was collaborative in nature. Almost two-third of the total publications has yielded 342616 citations with an average of 9.03 citations per paper. The study further reveals that more number of publications has received significant number of citations during the study period. According to the calculations used in this study for the highly cited papers, 356 publications among them were met the minimum criteria of 108 citations for categorize as highly cited papers. Guidelines for Management of ischaemic stroke and transient ischaemic attack 2008 by Ringleb, P.A., et al., is the highly cited paper with 1485 citations during the study period. Nearly one third of the publications (32.28%) have not received its citations yet. It is observed from the Relative Uncitedness Index, the productivity in the recent years have received less number of citations when compared to the published literatures in the beginning years of the study period. The concept of Telemedicine is a boon for the patients in the remote areas to get proper healthcare for the minor healthcare needs. Using this technology the patients can save lot of time and energy in meeting the medical professionals as well as can get consultations at the least cost.

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