World Rabies Research Output: A Scientometric Assessment of Publication Output during 2006-15

Ritu Gupta, Dhawan SM, Gupta BM

[1]*Sri Venkateshwara University, Tirupathi, India.*
[2]*Naional Physical Laboratory, New Delhi, India.*
[3]*1173 Sector 15, Panchkula 134 113, Haryana, India.*

ABSTRACT

The paper examines 7818 world publications on global rabies research, as indexed in Scopus database covering the period 1999-2014. The global rabies research increased by 5.87% per annum and its citation impact averaged to 14.27 citations per paper. Top 15 most productive countries continued to dominate world rabies research through 1999-2014 both in terms of quality and quantity of research. Together they accounted for as much as 83.82% share of world total output during 1999-2014. Twelve of these top countries scored relative citation index (RCI) above the world average of 1: USA (1.74), U.K. (1.70), France (1.66), Switzerland (1.62), Germany and Netherlands (1.50 each), Australia (1.44), Japan (1.39), Thailand (1.35), Canada (1.31), South Africa (1.24) and Italy (1.08) during 1999-2014. Being a multidisciplinary topic, world rabies research is widely scattered across several disciplines. Medicine contributed the largest share 54.80%, followed by 7 other disciplines. The top 20 most productive organizations and authors engaged on rabies research respectively accounted for 40.94% and 21.42% share of publications output and 39.62% and 34.90% share of world citations during 1999-14. The world rabies research output is highly scattered across journals. Top 20 most productive journals barely accounted for 24.06% share of global rabies research. Less than 2 per cent of global rabies research papers (148) received 100 plus citations, cumulated 29160 citations, with an average of 197.03 citations per paper. These 148 highly cited papers involved the participation of 1003 authors and 502 organizations and were published in 85 journals. The USA contributed the largest number of highly cited papers (89), followed by U.K. (32), France (20), Germany (11), Canada, Australia and Belgium (7 each), Thailand and Switzerland (6 each), Japan (5), Kenya (4), South Africa, Russia Federation and Tanzania (3 each), etc. For India, rabies research is not a top priority.

Key words: Rabies, Disease, Global publications, Biblio metrics, Scientometrics.

INTRODUCTION

Rabies pose a significant threat to humans in much of the developing world, kills tens of thousands of people each year and impacts the lives of as many as 5 billion people. Over 95% of human rabies deaths today occur in Africa and Asia as a result of being bitten by an infected dog and up to 60% of all dog bites and rabies deaths occur in children under 15 years of age. The cost of this in terms of global economic output is a staggering $124 billion: this disproportionately hits poorer parts of the world hardest.[1] The virus widely disseminates throughout the body at the time of clinical onset.[2] Interestingly, bats are primary or sole reservoir hosts for all lyssaviruses except MOKV (for which the reservoir species has not been clearly identified as of yet).[3] Rabies is inevitably fatal and death occurs during the first seven days of illness without intensive care due to respiratory failure.[4] Rabies being a zoonotic disease, the threat to humans is likely to continue for many more years as huge animal reservoirs exist in most parts of the world. But global elimination of rabies is a possibility through prevention, epidemiology and control. Vaccination for high-risk individuals, surveillance of human cases, post-exposure prophylaxis following animal bites, vaccination and/or culling of the canine

***Address for correspondence:**

B.M Gupta

1173 Sector 15, Panchkula 134 113, Haryana, INDIA.

Mobile 9888378275

E-Mail. Bmgupta1@gmail.com

Access this article online

Official Publication of

PhcogNet
Bringing Medicinal Plants Researchers Together

Website: www.jscires.org

DOI: 10.5530/jscires.5.3.5

population and other animal reservoirs are the key interventions for rabies control. WHO recommendations can prevent the onset of rabies in virtually all exposures. Globally, the most cost-effective strategy for preventing rabies in people is by eliminating rabies in dogs and wildlife animals through annual vaccinations.[1] Middle East and Eastern Europe Rabies Expert Bureau (MEEREB) has been active on rabies research particularly in Egypt, Turkey, Iran, and Ukraine where several human deaths have occurred due to canine rabies. Post exposure treatments are increasing in these countries. Iran alone is administering more than 200,000 PEPs to humans bitten by dogs. Intradermal rabies vaccination (IDRV) with modern cell culture rabies vaccines is widely used in many developing countries nowadays. However, research on minimum potency requirement for IDRV is still underway. Scientists are trying to understand the kinetics of immune response to varying antigenic content and dosage schedule of IDRV. Research is also underway on anamnestic response to booster doses of vaccine in children from rabies endemic countries who have already received 2 or 3 doses of preexposure primary vaccination in the past. Several national and international organizations including World Health Organization (WHO) and Global Alliance for Rabies Control (GARC) are though actively working out various strategies for getting international and national commitment to eliminate human rabies and reduce canine rabies, but given the fact that many new developments have taken place in rabies prevention in humans and canine rabies control, more and more efforts are needed at the global, national and community levels to defeat a disease which wreaks untold suffering on millions of people each year and to reduce the burden of rabies focusing particularly on the Asian and African countries. Most rabies research is done in the basic sciences but key questions remain unaddressed. Policy-makers need evidence for social, political and economic outcomes of control programmers'. Research–policy disconnect in rabies control is as important an issue of concern as is rabies research in basic sciences.

2. Literature Review

Very few sciento metric studies have so far been conducted on rabies research both at global and country level. Amongst such studies, Takahashi-Omoe and Omoe.[5] based on the analysis of articles and patent applications reported current trends in research and development for rabies control in USA, the EU and Asia. Sithi Jagannara.[6] analyzed 11567 papers on global rabies research as indexed in CAB database covering the period 1964-2015 using indicators such as publication growth, language wise distribution, country-wise distribution, etc. Kakkar, Venkataramanan, Chauhan and Abbas.[7] reviewed Indian rabies research 93 articles published during 2001-2011. 61% of the total articles consisted of laboratory based studies on rabies virus and 8% studies on animals, the least studied group. One third of articles were published in three journals focusing on vaccines and infectious disease epidemiology. The top 4 institutions (2 each from the animal and human health sectors) collectively produced 49% of the national research output. Biomedical research on development of new interventions dominated the total output to improve existing interventions. Sachithanantham and Raja.[8] analyzed 495 records of Indian research output in rabies as indexed PubMed database covering the period 1950-2014 on indicators such as literature growth, world share, prolific authors profile, collaborative pattern, journal distribution, most productive institutions, and geographical distribution. The Bradford law of scattering did not apply to rabies research in India. Gupta, Sharma and Gupta.[9] analyzed 510 India's publications on rabies research - as indexed in Scopus International multidisciplinary database covering the period 1999-2014 - using indicators such as publication growth, citation impact, international collaboration, subject-wise distribution, distribution by Indian organizations and authors, medium of communication and characteristics of highly cited papers.

Methodology

The study retrieved and downloaded the rabies research publication data of the world and 12 most productive countries from the Scopus database (http://www.scopus.com) for 16 years during 1999-2014. The keyword "rabies disease" was used in "title, abstract and keyword" tag and restricting it to the period 1999-2014 in "date range tag" was used for searching the global publication data and this was considered as the main search string. The main search string was restricted to individual 12 most productive countries one by one in the "country tag" for obtaining publication data on each country, including India. When the main search string was further restricted to "subject area tag", "country tag", "source title tag", "journal title name" and "affiliation tag", information on distribution of publications by subject, collaborating countries, organization-wise and journal-wise, etc. was obtained For citation data, the open window is used and citations window for each article starts from date of publication till 15 November 2015. A number of quantitative and qualitative measures are used to measure the performance of global rabies disease research.

Table 1: Publication Growth of World Rabies Research and Citations during 1999-2014

Publication Year	TP	TC	ACPP
1999	318	5913	18.59
2000	280	5851	20.90
2001	323	6848	21.20
2002	372	7183	19.31
2003	423	8352	19.74
2004	404	8123	20.11
2005	510	11192	21.95
2006	469	8595	18.33
2007	492	9466	19.24
2008	583	7900	13.55
2009	552	8424	15.26
2010	505	7251	14.36
2011	591	6688	11.32
2012	615	5372	8.73
2013	697	3288	4.72
2014	684	1151	1.68
1999-06	3099	62057	20.02
2007-14	4719	49540	10.50
1999-2014	7818	111597	14.27

TP=Total Papers; TC=Total Citations; ACPP=Average Citations Per Paper

Data Analysis & Results

The global research output on rabies research cumulated to 7818 publications during the study period 1999-2014. The yearly research output in this field increased from 318 in the first year 1999 to 684 publications in the last year 2014 with 5.87% growth per annum. The global publications on rabies research received 14.27 citations per paper (Table 1). Bulk of the total publications output on rabies research 63.42% (4958) appeared as articles, followed by 16.99% (1328) as review papers, 4.31% (337) as conference papers, 3.48% (272) as notes, 2.60% (203) as short surveys, 2.23% (174) as book chapters, 2.05% (160) as editorials, and other erratum (0.52%), books (0.46%), articles in press (0.33%) and conference review (0.01%) during 1999-2014.

Top 15 Most Productive Countries

The top 15 most productive countries on rabies research together published 6553 publications with 83.82% world share during 1999-2014. Country-wise, the USA contributed the largest to the world share (27.68%), followed by U.K. (9.45%), France (7.65%), India (6.52%), Germany, China, Brazil and Canada (from 5.0% to 5.55%), Japan, Australia, Thailand and Switzerland (from 2.46% to 3.47%), Italy, South Africa and Netherlands (from 1.38% to 1.73%) during 1999-2014. The world share did not remain static during the study period. It increased for most countries, with highest increase 7.39% in China, followed by Brazil (1.86%), USA (1.49%), India (1.24%), Australia (1.0%), Italy (0.99%), Germany (0.91%), Canada (0.85%), U.K. and Netherlands (0.74% each), Switzerland (0.54%), South Africa (0.43%) and Japan (0.08%), whereas it decreased by 1.53% in Thailand and France (0.80%) from 1999-06 to 2007-14 (Table 2).

The global citation share of top 15 most productive countries on rabies research varied from 1.92% to 48.06%, with largest citation share (48.06%) coming from USA, followed by U.K. (16.02%), France (12.07%), Germany (8.33%), Canada (6.54%), Japan (4.81%), Australia (4.41%), Switzerland, Thailand, Brazil and India (from 3.08% to 3.98%), Thailand, China, Netherlands, South Africa and Italy (from 1.87% to 3.58%) during 1999-2014. USA registered the highest citation impact per paper (24.79), followed by U.K. (24.20), France (23.70), Switzerland (23.15), Germany (21.43), Netherlands (21.36), Australia (20.59), Japan (19.80), Thailand (19.21), Canada (18.68), South Africa (17.69), Italy (15.46), etc. Twelve of 15 most productive countries registered relative citation index (RCI) above the world average of 1: USA (1.74), U.K. (1.70), France (1.66), Switzerland (1.62), Germany and Netherlands (1.50 each), Australia (1.44), Japan (1.39), Thailand (1.35), Canada (1.31), South Africa (1.24) and Italy (1.08) during 1999-2014 (Table 3). The study also showed the collaborative nature in rabies research. The international collaborative publication share of top 15 most productive countries varied from 5.93% to 62.96%, with highest share coming from Netherland (62.96%), Switzerland (59.38%), followed by South Africa (58.68%), U.K. (50.61%), Germany (47.47%), Australia (46.86%), France (43.31%), Canada (40.66%), Japan (40.59%), Thailand (33.65%), USA (29.48%), etc.

4.3 Rabies Research publication output in context of different subjects

The global publication output on rabies research was organized in context of different subjects as reflected in Scopus database. The highest publication share came from Medicine (4284 papers, 54.80%), followed immunology & microbiology (2433 papers, 31.12%), veterinary science (1608 papers, 20.57%), biochemistry, genetics & molecular biology (1198 papers, 13.56%), agricultural & biological science (712 papers, 9.11%), pharmacology, toxicology & pharmaceutics (679 papers, 8.69%) and neurosciences (270 publications, 3.45%) during 1999-

Table 2: World Output and Share of Top 15 Most Productive Countries on Rabies Research during 1999-2014

S.No	Name of the Country	Number of Publications			Global Share of Publications		
		1999-06	2007-14	1999-14	1999-06	2007-14	1999-14
1	USA	830	1334	2164	26.78	28.27	27.68
2	U.K.	279	460	739	9.00	9.75	9.45
3	France	252	346	598	8.13	7.33	7.65
4	India	179	331	510	5.78	7.01	6.52
5	Germany	155	279	434	5.00	5.91	5.55
6	China	22	382	404	0.71	8.09	5.17
7	Brazil	125	278	403	4.03	5.89	5.15
8	Canada	139	252	391	4.49	5.34	5.00
9	Japan	106	165	271	3.42	3.50	3.47
10	Australia	76	163	239	2.45	3.45	3.06
11	Thailand	111	97	208	3.58	2.06	2.66
12	Switzerland	66	126	192	2.13	2.67	2.46
13	Italy	35	100	135	1.13	2.12	1.73
14	South Africa	40	81	121	1.29	1.72	1.55
15	Netherlands	29	79	108	0.94	1.67	1.38
	Total of 15 countries	2340	4213	6553			
	Total of the World	3099	4719	7818			
	Share of 15 countries in world output	75.51	89.28	83.82			

Table 3: Scientometric Profile of Top 15 Most Productive Countries on Rabies Research, 1999-2014

S.No	Name of the Country	TP	TC	ACPP	GPS	GCS	RCI	HI	ICP	%ICP	HCP	%HCP
1	USA	2164	53639	24.79	27.68	48.06	1.74	95	638	29.48	89	4.11
2	U.K.	739	17881	24.20	9.45	16.02	1.70	61	374	50.61	32	4.33
3	France	598	14171	23.70	7.65	12.7	1.66	61	259	43.31	20	3.34
4	India	510	3442	6.75	6.52	3.08	0.47	30	74	14.51	2	0.39
5	Germany	434	9300	21.43	5.55	8.33	1.50	48	206	47.47	11	2.53
6	China	404	2827	7.00	5.17	2.53	0.49	25	109	26.98	1	0.25
7	Brazil	403	3483	8.64	5.15	3.12	0.61	28	84	20.84	1	0.25
8	Canada	391	7302	18.68	5.00	6.54	1.31	44	159	40.66	7	1.79
9	Japan	271	5367	19.80	3.47	4.81	1.39	33	110	40.59	5	1.85
10	Australia	239	4921	20.59	3.06	4.41	1.44	37	112	46.86	7	2.93
11	Thailand	208	3995	19.21	2.66	3.58	1.35	32	70	33.65	6	2.88
12	Switzerland	192	4444	23.15	2.46	3.98	1.62	35	114	59.38	6	3.13
13	Italy	135	2087	15.46	1.73	1.87	1.08	27	8	5.93	2	1.48
14	South Africa	121	2140	17.69	1.55	1.92	1.24	28	71	58.68	3	2.48
15	Netherlands	108	2307	21.36	1.38	2.07	1.50	28	68	62.96	2	1.85
	World	7818	111597	14.27								

TP=Total Papers; TC=Total Citations; ACPP=Average Citations Per Paper; GPS=Global Publication Share; GCS=Global Citation Share; HI=h-index; ICP=International Collaborative Publications' HCP=High Cited Publications; RCI=Relative Citation Index

2014. The publication activity increased in medicine (from 47.85% to 59.36%), immunology & microbiology (from 28.40% to 32.91%), biochemistry, genetics & molecular biology (from 8.65% to 19.76%), agricultural & biological sciences (from 6.97% to 10.51%), pharmacology, toxicology & pharmaceutics (from 5.94% to 10.49%), neurosciences (from 2.74% to 3.92%), as against decrease in veterinary science (from 24.04% to 18.29%) from 1999-2006 to 2007-14. Neurosciences had scored the highest citation impact per paper of 29.43, followed by biochemistry, genetics & molecular biology (18.47), immunology & microbiology (18.11), agricultural & biological sciences (13.30), pharmacology, toxicology & pharmaceutics (12.55), medicine (12.07) and veterinary science (10.28) during 1999-2014 (Table 4).

4.7 Scientometric Profile of the Highly Productive Organizations on Rabies Research

The top 20 most productive organizations engaged on global rabies research individually published 64 to 328 publications and together published 3201 publications, received 44211 citations, accounting for 40.94% and 39.62% share of world publications and citations during the study period 1999-14. The scientometric profile of these 20 organizations along with their research output, citations received, and h-index values are presented in Table 5. Three organizations registered publication share above the group average productivity of 160.5 publications per organization: Center for Disease Control & Prevention, Atlanta, USA (328 publications), Veterinary Laboratory Agency, Surrey, U.K. (199 publications) and Institut Pasteur, Paris, France (184 publications) during 1999-2014.

Eleven organizations registered citation impact above the group average of 11.81 citations per paper: Ludwig-Maximilans-Universitat Munchen, Germany (55.14), University of Oxford, U.K. (46.54), The French National Centre for Scientific Research, France (37.8), Thomas Jefferson University, Philadelphia, USA (36.01), Center for Disease Control & Prevention, Atlanta, USA (27.64), Institut Pasteur, Paris, France (27.17), University of Georgia, Athens, USA (22.53), Veterinary Laboratory Agency, Surrey, U.K. (20.08), Chulalongkorn University, Thailand (18.89), Friedrich Loeffer Institute, Germany (16.56) and University of Pretoria, South Africa (16.42) during 1999-2014.

Ten organizations scored h – index value above the group average of 24.45: Center for Disease Control & Prevention, Atlanta, USA (49), Institut Pasteur, Paris, France (40), Thomas Jefferson University, Philadelphia, USA (39), Veterinary Laboratory Agency, Surrey, U.K. (34), The French National Centre for Scientific Research (CNRS), France (33), University of Oxford, U.K. (29), Ludwig-Maximilans-Universitat Munchen, Germany (28), University of Georgia, Athens, USA, Chulalongkorn University, Thailand and Friedrich Loeffer Institute, Germany (25 each) during 1999-2014

Thirteen organizations contributed ICP share above the group average of 26.93%: University of Pretoria, South Africa (63.64%), Veterinary Laboratory Agency, Surrey, U.K. (59.30%), Friedrich Loeffer Institute, Germany (57.26%), University of Georgia, Athens, USA (55.56%), Institut Pasteur, Paris, France (51.09%), University of Oxford, U.K. (50.0%), Ludwig-Maximilans-Universitat Munchen, Germany (43.75%), Kansas State University, USA (42.42%), The French National Centre for Scientific Research (CNRS), France (42.25%), Center for Disease Control & Prevention, Atlanta, USA (41.16%), Univer sidade de Sao Paulo, Brazil (36.44%), Thai Red Cross Agency, Thailand (28.75%) and Chula long korn University, Thailand (27.88%) during 1999-2014.

Productive Authors on Rabies Research

The top 20 most productive authors engaged on rabies research individually published 47 to 253 publications and together published 1675 publications and received 38947 citations, accounting for 21.42% and 34.90% share of world publications and citations during 1999-14. The scientometric profile of these 20 authors along with their research output, citations received, and h-index values are presented in Table 6. Six authors registered publication share above the group average productivity of 83.75 publications per author: C.E. Rupprecht (253 publications), A.R. Fooks (188 publications), T. Muller (108 publications), H. Wilde (92 publications), H. Johnson (86 publications) and H. Bourhy (85 publications) during 1999-2014.

Seven authors registered citation impact above the group average of 23.25 citations per paper: C.A. Hanlon (40.66), B. Dietz hold (39.58), S. Clevland (38.02), M.J. Schnell (37.31), C.E. Rupprecht (32.49), N. Tordo (31.73) and L.M. Ethinney (28.31) during 1999-2014.

Ten authors scored h – index above the group average of 24.70: C.E. Rupprecht (49), A.R. Fooks (34), B. Dietzschold (32), M.J. Schnell (29), C.A. HanlonL.M. Ethinney and L.M. Ethinney (27 each), H. Bourhy (26), N. Tordo, H. Johnson and H. Wilde (25 each) during 1999-2014.

Table 4: Subject-Wise Distribution of Global Publications on Rabies research, 2005-14.

S.No	Subject*	Number of Publications			Share of Publications			TC	ACPP	HI	HCP	%HCP
		1999-06	2007-14	1999-14	1999-06	2007-14	1999-14					
1	Medicine	1483	2801	4284	47.85	59.36	54.80	51705	12.07	82	56	1.31
2	Immunology & microbiology	880	1553	2433	28.40	32.91	31.12	44064	18.11	84	59	2.42
3	Veterinary science	745	863	1608	24.04	18.29	20.57	16538	10.28	51	8	0.50
4	Biochemistry, genetics & molecular biology	268	930	1198	8.65	19.71	15.32	22125	18.47	67	28	2.34
5	Agricultural & biological sciences	216	496	712	6.97	10.51	9.11	9467	13.30	43	9	1.26
6	Pharmacology, toxicology & pharmaceutics	184	495	679	5.94	10.49	8.69	8523	12.55	41	6	0.88
7	Neurosciences	85	185	270	2.74	3.92	3.45	7946	29.43	47	14	5.19
	Total of the world	3099	4719	7818								

TP=Total Papers; TC=Total Citations; ACPP=Average Citations Per Paper; HCP=High Cited Publications; HI=h-index
*There is a overlapping of papers under various subjects and as a result the sum of total output of subjects will be more than the global output

Table 5: Scientometric Profile of Top 20 Most Productive World Organizations on Rabies Research, 1999-2014

S.No	Name of the Organization	TP	TC	ACPP	HI	ICP	%ICP
1	Center for Disease Control & Prevention, Atlanta, USA	328	9066	27.64	49	135	41.16
2	Veterinary Laboratory Agency, Surrey, U.K.	199	3995	20.08	34	118	59.30
3	Institute Pasteur, Paris, France	184	4999	27.17	40	94	51.09
4	Friedrich Loeffer Institute, Germany	124	2053	16.56	25	71	57.26
5	Universidade de Sao Paulo, Brazil	118	1236	10.47	20	43	36.44
6	Thomas Jefferson University, Philadelphia, USA	104	3745	36.01	39	26	25.00
7	Chulalongkorn University, Thailand	104	1965	18.89	25	29	27.88
8	Canadian Food Inspection Agency, Ottawa, Canada 82	1192		0.00	21	39	3.27
9	University of Georgia, Athens, USA	81	1825	22.53	25	45	55.56
10	Thai Red Cross Agency, Thailand	80	922	11.53	19	23	28.75
11	University of Pretoria, South Africa	77	1264	16.42	22	49	63.64
12	Academy of Military Medical Sciences, Changchun, China	76	690	9.08	14	20	26.32
13	The *French* National Centre for Scientific Research (CNRS), France	71	2684	37.80	33	30	42.25
14	National Institute of Mental Health & Neurosciences, Bangalore, India	70	690	9.86	13	14	20.00
15	University of Oxford, U.K.	68	3165	46.54	29	34	50.00
16	Kansas State University, USA	66	798	12.09	15	28	42.42
17	Chinese Center for Disease Control & Prevention, Beijing, China	66	521	7.89	13	13	19.70
18	The Universidad Estadual Paulista (Unesp), Brazil	65	484	7.45	11	14	21.54
19	Ludwig-Maximilans-Universitat Munchen, Germany	64	3529	55.14	28	28	43.75
20	Instituto Pasteurde , Sao Paulo, Brazil	64	580	9.06	14	9	14.06
	Total of 20 organizations	3201	44211	13.81	24.45	862	26.93
	Total of the world	7818	111597				
	Share of 20 organizations in world total	40.94	39.62				

Table 5: Profile of Top 20 Most Productive World Authors on Rabies Research, 1999-2014

S.No	Name of the Author	Affiliation of the Author	TP	TC	ACPP	HI	ICP	%ICP
1	C.E. Rupprecht	Center for Disease Control & Prevention, Atlanta, USA	253	8220	32.49	49	118	46.64
2	A.R. Fooks	Veterinary Laboratory Agency, Surrey, U.K.	188	3898	20.73	34	114	60.64
3	T. Muller	Veterinary Laboratory Agency, Surrey, U.K.	108	1585	14.68	24	66	61.11
4	H. Wilde	Chulalongkorn University, Thailand	92	1431	15.55	25	22	23.91
5	H. Johnson	Veterinary Laboratory Agency, Surrey, U.K.	86	1843	21.43	25	48	55.81
6	H. Bourhy	Institut Pasteur, Paris, France	85	1922	22.61	26	56	65.88
7	Q. Tang	Chinese Center for Disease Control & Prevention, Beijing, China	83	446	5.37	12	9	10.84
8	A.C. Jackson	Institut Pasteur, Paris, France	78	1307	16.76	22	23	29.49
9	T. Hemachudha	Chulalongkorn University, Thailand	73	1591	21.79	24	28	38.36
10	F. Cliquet	*French* Agency for Food, Environmental and Occupational Health & Safety, France	72	909	12.63	18	38	52.78
11	B. Dietzschold	Thomas Jefferson University, Philadelphia, USA	66	2612	39.58	32	15	22.73
12	M.J. Schnell	Thomas Jefferson University, Philadelphia, USA	58	2164	37.31	29	9	15.52
13	S.N.Madhusudana	National Institute of Mental Health & Neurosciences, Bangalore, India	60	663	11.05	13	11	18.33
14	N. Tordo	Institut Pasteur, Paris, France	51	1618	31.73	25	27	52.94
15	P.Khawplod	Thai Red Cross Agency, Thailand	51	900	17.65	21	16	31.37
16	Z.F.Fu	University of Georgia, Athens, USA	49	1095	22.35	20	28	57.14
17	C.A. Hanlon	Center for Disease Control & Prevention, Atlanta, USA	56	2277	40.66	27	12	21.43
18	L.H. Nel	Global Alliance for Rabies Control, Pretoria, South Africa	57	924	16.21	21	35	61.40
19	L.M. Ethinney	Veterinary Laboratory Agency, Surrey, U.K.	62	1755	28.31	27	24	38.71
20	S. Clevland	University of Edinburg, U.K.	47	1787	38.02	20	39	82.98
		Total of 20 authors	1675	38947	23.25	24.7	738	44.06
		Total of the world	7818	111597				
		Share of 20 authors in world total	21.42	34.9				

Ten authors contributed to ICP share above the group average of 44.06%: S. Clevland (82.98%), H. Bourhy (65.88%), L.H. Nel (61.40%), T. Muller (61.11%), A.R. Fooks (60.64%), Z.F.Fu (57.14%), H. Johnson (55.81%), N. Tordo (52.94%), F. Cliquet (52.78%) and C.E. Rupprecht (46.64%) during 1999-2014.

Research communication in journals

Of the total global publications on rabies research, 7388 appeared in journals, 212 in book series, 190 in books, 15 as trade publications, 10 in conference proceedings and 3 undefined during 1999-2014. The top twenty most productive journals on rabies research individually published 47 to 307 papers and together contributed 1881 publications with 24.06% world share (Table 10). *Vaccine* was the most productive journal with 307 papers, followed by *Veterinary Record* (177 papers), *Emerging Infectious Diseases* (141 papers), *Journal of Virology* (128 papers), *Journal of American Veterinary Medical Association* (108 papers), *Virus Research* (104 papers), etc during 2005-14 (Table 10)

Highly Cited Papers

Of the total world output on rabies research, 148 papers received 100+ citations per paper in 15 years. These highly cited papers – (109 papers with citations range from 100 to 199, 29 papers with citation range 200 to 399, 7 papers with citation range 400-599, 1 paper with citation range 600-699 and 2 papers with citation range 1100-1199) – together received 29160 citations, averaging to 197.03 citations per paper. These 148 highly cited papers came from several countries, with largest number of papers (89) coming from USA, followed by U.K. (32), France (20), Germany (11), Canada, Australia and Belgium (7 each), Thailand and Switzerland (6 each), Japan (5), Kenya (4), South Africa, Russia Federation and Tanzania (3 each), India, Netherlands, Spain, South Korea , Sweden and Denmark (2 each), China, Brazil, Poland, Israel, Turkey, Austria, Columbia, Argentina, Finland, Philippines and New Zealand (1 each). These 148 highly cited papers consisted of 91 articles, 52 reviews, 4 short surveys and 1 conference paper. Single institution authorship characterized 53 papers and multiple institution authorship in

Table 10: Most Productive Journals on Rabi Research, 1999-2014

S.No	Name of the Journal	Number of Papers		
		1999-06	2007-14	1999-2014
1	Vaccine	119	188	307
2	Veterinary Record	97	80	177
3	Emerging Infectious Diseases	58	83	141
4	Journal of Virology	60	68	128
5	Journal of American Veterinary Medical Association	76	32	108
6	Journal of Wildlife Diseases	42	66	108
7	Virus Research	39	65	104
8	Chinese Journal of Biologicals	27	61	88
9	Journal of Travel Medicine	32	48	80
10	PLOS Neglected Tropical Diseases	13	67	80
11	PLOS One	3	66	69
12	Clinical Infectious Diseases	41	24	65
13	Journal of Virological Methods	24	38	62
14	Travel Medicine & Infectious Diseases	12	44	56
15	Journal of General Virology	34	22	56
16	Epidemiology & Infection	19	34	53
17	Preventive Veterinary Medicine	18	34	52
18	Morbidity & Mortality Weekly Reports	19	31	50
19	Archives of Virology	11	39	50
20	Zoonoses & Public Health	0	47	47
	Total of 20 journals	744	1137	1881
	Total of the world	3099	4719	7818
	Share of 20 journals in world total	24.01	24.09	24.06

95 papers (49 national collaborative and 46 international collaborative). These 148 highly cited papers involved the participation of 1003 authors and 502 organizations.

The contribution to highly cited papers (14) was the largest by Center for Disease Control & Prevention, Atlanta, USA, followed by University of Oxford, U.K. (9 papers), Institut Pasteur, Paris, France (8 papers), London School of Tropical Hygiene & Tropical Medicine, U.K. (7 papers), Health Ludwig-Maximilans-Universitat Munchen, Germany (6 papers), Thomas Jefferson University, Philadelphia, USA and University of Edinburg, U.K., Massachusetts General Hospital, USA and University of Pennsylvania, USA, (5 papers each), University of Georgia, Athens, USA, GlaxoSmithKline, USA, University of Pennsylvania, School of Veterinary Medicine, USA and Pittsburg Veterinary Affairs Medical Center, USA (4 papers each), Chulalongkorn University, Thailand and The French National Centre for Scientific Research (CNRS), France, Colorado State University, USA, National Center for Infectious Disease, Atlanta, USA, Harvard Medical School, USA, Salk Institute of Biological Sciences, USA and Walter Reed Army Institute of Research, USA (3 papers each), Veterinary Laboratory Agency, Surrey, U.K., . Friedrich Loeffer Institute, Germany, University of Cambridge, U.K., Queens University, Kingston, Canada, University of Toronto, Canada, Yale University School of Medicine, USA, John E Forgarty International Center for Advanced Study in the Health Sciences, USA and, University of California, San Diego, USA (2 papers each), etc. The average number of organizations participating per paper was 3.39.

As authors, the contribution of highly cited papers was largest by C.E. Rupprecht (13), followed by C.A. Hanlon (5 papers), N. Tordo, Orclcir and B. Dietzschold (4 papers each), H. Kaprpwski (3 papers), Michael Niezgoda, D.C.Hobper, A.R. Fooks, H. Johnson, H. Bourhy, T. Hemachudha, M.J. Schnell, Z.F.Fu, L.M. Ethinney and S. Clevland (2 papers each), etc. The average number of authors per paper was 6.78.

The 148 highly cited papers were published in 85 journals, with most papers (16) appearing in Journal of Virology, followed by New England Journal of Medicine (10 apers), Proceedings of the National Academy of Sciences of the United States of America (6 papers), Clinical Infectious Diseases (5 papers), Molecular Therapy, Nature Reviews Immunology, Science and, Vaccine (4 papers each), Clinical Microbiology Reviews, Journal of Allergy and Clinical Immunology, Journal of General Virology,The Lancet and Virus Research (3 papers each), Bulletin of the World Health Organization, Emerging Infectious Diseases, Gene Therapy, Journal of Neuroscience, Journal of Pharmaceutical Sciences, Lancet, Nature Biotechnology, Nature, Neuron and Reviews in Medical Virology (2 papers) and 1 paper each in rest of the 60 journals.

Summary & Conclusion

The global rabies research base is small (comprising 7818 publications) increasing at a slow pace of 5.87% per annum. Top 15 countries dominate global rabies research with as much as 83.82% world share. The USA is world leader in rabies research with 27.68% world share, followed by U.K. (9.45%), France (7.65%), India (6.52%), Germany, China, Brazil and Canada (from 5.0% to 5.55%), Japan, Australia, Thailand and Switzerland (from 2.46% to 3.47%), Italy, South Africa and Netherlands (from 1.38% to 1.73%) during 1999-2014. The top 12 countries registered relative citation index (RCI) above the world average of 1: USA (1.74), followed by U.K. (1.70), France (1.66), Switzerland (1.62), Germany and Netherlands (1.50 each), Australia (1.44), Japan (1.39), Thailand (1.35), Canada (1.31), South Africa (1.24) and Italy (1.08) during 1999-2014. Rabies research is highly collaborative in nature. The share of international collaborative publications by Netherland (62.96%) was the largest, followed by Switzerland (59.38%), followed by South Africa (58.68%), U.K. (50.61%), Germany (47.47%), Australia (46.86%), France (43.31%), Canada (40.66%), Japan (40.59%), Thailand (33.65%), USA (29.48%), etc during 1999-2014. Medicine registered the largest publication share of 54.80%, followed immunology & microbiology (31.12%), veterinary science (20.57%), biochemistry, genetics & molecular biology (13.56%), agricultural & biological sciences (15.32%), agricultural & biological science (9.11%), pharmacology, toxicology & pharmaceutics (8.69%) and neurosciences (3.45%) during 1999-2014. The contribution of top 20 most productive organizations and authors rabies research accounted for 40.94% and 21.42% share of publications output and 39.62% and 34.90% share of world citations during 1999-14. The top 20 most productive journals account for 24.06% share of global rabies research, which increased from 24.01% to 24.09% from 1999-2006 to 2007-14.

The share of highly cited papers in global rabies research is still very small even less than 2 per cent of total world output. These 148 highly cited together received 29160 citations, averaging to 197.03 citations per paper. The USA as usual contributed the largest number (89) of highly cited papers followed by U.K. (32), France (20), Germany (11), with contributions from 27 other countries. Center

for Disease Control & Prevention, Atlanta, USA contributed the largest number (14) of high cited papers followed by University of Oxford, U.K. (9 papers), Institut Pasteur, Paris, France (8 papers), London School of Tropical Hygiene & Tropical Medicine, U.K. (7 papers), Health Ludwig-Maximilans-Universitat Munchen, Germany (6 papers), Thomas Jefferson University, Philadelphia, USA and University of Edinburg, U.K., Massachusetts General Hospital, USA and University of Pennsylvania, USA, (5 papers each), etc. C.E. Rupprecht contributed the highest number (13) of high cited papers, followed by C.A. Hanlon (5 papers), N. Tordo, Orclcir and B. Dietzschold (4 papers each), H. Kaprpwski (3 papers), etc. The 148 high cited papers were published in 85 journals, with largest number of papers (16) in Journal of Virology, followed by New England Journal of Medicine (10 papers), Proceedings of the National Academy of Sciences of the United States of America (6 papers), etc.

India stands nowhere among top countries in rabies research given its weak performance on indicators such as publication activity, publication impact, share of international collaborative papers, and highly cited papers. National Institute of Mental Health & Neurosciences, Bangalore, India is the only organization that has come to international level in world rabies research. Given the highly collaborative nature of rabies research, it is imperative that India should build links with key hubs in international collaboration in this field under discussion. Suggest the need to develop training programme, which should include training health professionals to deal with animal bites, awareness creation and minimizing animal bites. On the veterinary side, there is a need to focus on sterilization and vaccination of dogs, with a larger involvement of civil society and municipal bodies. Advocating the need for greater awareness of the disease, the World Health Organization (WHO) says children and poor people are particularly vulnerable.

CONFLICT OF INTEREST

The author declare none.

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How to cite this article: Gupta R, Dhawan SM, Gupta BM. World Rabies Research Output: A Scientometric Assessment of Publication Output during 2006-15 J Scientometric Res. 2016;5(3):220-229. Full text available at http://www.jscires.org/v5/i1