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Heredity Blood Disorders (HBD): A Scientometric Analysis of Publications Output from India during 2002-2011

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Abstract

This study analyses the heredity blood disorder research output carried out during 2002-11 on different parameters including the global publications share and citation quality of top 10 leading countries, India's growth, citation impact, share of international collaborative papers, contribution of major collaborative partner countries, contribution of various subject fields and by type of heredity blood disorder, pattern of research communication in most productive journals, productivity and citation profile of top Indian institutions and authors and characteristics of high cited papers. The SCOPUS Citation Database has been used to retrieve the data for 10 years (2002-11). Conclude that there is a need to create comprehensive care services, including diagnosis and management of the heredity blood disorders in Indian context. For this purpose, there is need to undertake more R&D, develop trained manpower at different levels and create sufficient infrastructure to handle the problems associated with heredity blood disorders.

Keywords: Heredity blood disorders; Thalassemia; Scopus citation database; Sickle cell anemia; Hemophilia; Thrombopenia; Von Willebrand disease

Introduction

The blood is living tissue made up of liquid and solids. The liquid part, called plasma, is made of water, salts and protein. Over half of your blood is plasma. The solid part of the blood contains red blood cells, white blood cells and platelets. Red blood cells deliver oxygen from lungs to your tissues and organs. White blood cells help fight infections and are part of body's defense system. Platelets help form clots to stop bleeding. Plasma, the liquid part of blood, contains many types of proteins. These include proteins that help the blood to clot and proteins that protect the body from viruses and infection. Plasma also contains substances such as dissolved salts, sugars, and hormones. Blood cells are produced by the soft tissue inside your bones, called bone marrow. Blood cells constantly die and your body makes new ones. Red blood cells live about 120 days, platelets 6 days and white cells less than a day. Blood is essential for life. It carries oxygen and nutrients to every part of the body. Blood also fights infections and heals injuries. Therefore, disorders of the blood can have a great effect on your health [1]. There are many different types of blood disorders. Some blood disorders are caused by excessive blood loss from injury, some are caused by other diseases and even still, some are caused by certain medications. Yet, there are some blood disorders that are hereditary. Heredity Blood Diseases or Disorders (HBD) are a group of diseases which are transmitted from parents to children and are caused by defects in the makeup of red blood cells resulting in blood cells that are unable to perform their natural functions. The most common hereditary blood disorders include hemophilia, von Willebrand disease, thrombophilia, thalassemia and sickle cell anemia [2].

Thalassemia is a blood related genetic disorder which involves the absence of or errors in genes responsible for production of hemoglobin, a protein present in the red blood cells. Each red blood cell can contain between 240 and 300 million molecules of hemoglobin. The severity of the disease depends on the mutations involved in the genes, and their interplay. A hemoglobin molecule has sub-units commonly referred to as alpha and beta. Both sub-units are necessary to bind oxygen in the lungs properly and deliver it to tissues in other parts of the body. Genes on chromosome 16 are responsible for alpha subunits, while genes on chromosome 11 control the production of beta subunits. A lack of a particular subunit determines the type of thalassemia (e.g. a lack of alpha subunits results in alpha-thalassemia). The lack of subunits thus corresponds to errors in the genes on the appropriate chromosomes. There can be various gradations of the disease depending on the gene and the type of mutations. The alpha and beta thalassemia are the most common inherited single-gene disorders in the world with the highest prevalence in areas where malaria was or still is endemic [3]. Thalassemia in India the prevalence shows the estimated number of thalassemics in India is 1,00,000. On an average 8 to 10 thousand thalassemia majors born in India every year [4].

Sickle-cell anemia is a blood related disorder that affects the hemoglobin molecule and causes the entire blood cell to change shape under stressed conditions. In sickle cell anemia, the hemoglobin molecule is defective. After hemoglobin molecules give up their oxygen, some may cluster together and form long, rod-like structures which become stiff and assume sickle shape. Unlike healthy red blood cells, which are usually smooth and donut-shaped, sickled red blood cells cannot squeeze through small blood vessels. Instead, they stack up and cause blockages that deprive organs and tissues of oxygen-carrying blood. This process produces periodic episodes of pain and ultimately can damage tissues and vital organs and lead to other serious medical problems. Normal red blood cells live about 120 days in the bloodstream, but sickled red cells die after about 10 to 20 days. Because they cannot be replaced fast enough, the blood is chronically short of red blood cells, leading to a condition commonly referred to as anemia [5]. According to ICMR survey sickle cell gene is found amongst

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different tribal groups mainly of central and southern parts of India, which varies from 5 to 34% of their population [6].

Hemophilia is a hereditary bleeding disorder, in which there is a partial or total lack of an essential blood clotting factor. It is a lifelong disorder, that results in excessive bleeding, and many times spontaneous bleeding, which, very often is internal. Hemophilia A is the most common form, referred to as classical hemophilia. It is the result of a deficiency in clotting factor 8, while Hemophilia B (Christmas disease) is a deficiency in clotting factor 9. This illness is a sex-linked recessive disorder. Due to the sex-linkage of the disorder, there is a greater prominence in males than in females [7]. With an estimated prevalence rate of 1:10,000, approximately 1,00,000 people are estimated to be haemophiliac in India, out of which 50,000 are likely to be severe. There are however, only about 13,000 registered patients [8].

Von Willebrand's disease is a hereditary deficiency or abnormality of the blood protein von Willebrand factor, which affects platelet function. The von Willebrand factor is found in plasma, platelets, and the walls of blood vessels. When the factor is missing or defective, platelets cannot adhere to the vessel wall at the site of an injury. As a result, bleeding does not stop as quickly as it should [9].

Thrombophilia is a disorder in which the blood clots easily or excessively. Inherited and acquired disorders can increase blood clotting. Clots cause legs or arms to swell. Blood levels of proteins that control clotting are measured. People may need anticoagulants. Most disorders that cause thrombophilia increase the risk of blood clot formation in veins; a few increase the risk of clot formation in both arteries and veins [10].

The Indian health ministry plan soon to roll out a national program to prevent and manage Hereditary Blood Disorders (HBDs) as per the report of the Planning Commission's Working Group on Health for the 12th Five Year Plan. A registry of hereditary blood disorders will be set up to collect actual data. For providing comprehensive care services, including diagnosis and management of HBDs, 120 medical colleges/hospitals across the country will be strengthened to have in it a hematologist/biochemist and a pathologist. Molecular genetics laboratory will also be set up at 20 Indian medical colleges that shall act as final referral centre for designated districts. These genetic laboratories will be developed in a phased manner with five new each year of the 12th Five Year Plan. In the first year of the plan, institutes like AIIMS, CMC Vellore, KEM Mumbai, PGI, Chandigarh, along with the one in Kolkata will be strengthened. These institutes will also train gynecologists/sonologists to conduct prenatal diagnostic procedures for prenatal diagnosis for hereditary disorders. The department of hematology at AIIMS will coordinate the quality control for the diagnosis of hemoglobinopathies. Each molecular genetics lab will be supported with Rs. 25 lakhs as a one-time grant and Rs 20 lakhs/year as recurring budget for human resource, drugs, reagents and other consumables. AIIMS and PGIMER, Chandigarh, and National Institute of Immunohaematology (NIIH), Mumbai, will serve as nodal training centers since these are already carrying out such comprehensive care. Counselors may be trained in the psychiatric department of different medical colleges (tertiary care centers). A fully-fledged DM (Clinical Genetics) program may be developed at one of the tertiary care centers. An amount of Rs 25 lakhs each year will be required for this scheme. According to the Commission, there are around 10,000-12,000 new thalassemia syndrome and 7,000-10,000 new sickle cell anemia patients added annually in India. Besides, there are around 1,20,000 hemophiliac patients of which 14,000 are registered [11].

There are no specific studies available in the literature dealing with scientometric analysis of publications in the area of heredity blood disorders. However, the author has carried out similar studies in Indian context on other diseases such as diabetes [12], tuberculosis [13], malaria [14], asthma [15] and AIDS/HIV [16].

Objectives

The main objectives of this is to analyze Indian publications output in heredity blood disorders during the last ten years from 2002-11. In particular, the study focuses on the following objectives: (i) to analyze the contribution and citation impact of top 10 most productive countries and identify the place of India among them, (ii) to analyze the growth, citation impact and international collaborative share of Indian research; (iii) to study the contribution, citation impact and international collaborative share of different types of heredity blood disorders in India and in global context, (iv) to study research output in context of different subjects, (v) to study the research profile of most productive Indian institutions and authors; and (vi) to study the media of communication of research output and identification of characteristics of highly cited papers.

Methodology and Database Used

This study is based on the Indian publication data in heredity blood disorder retrieved from the Scopus Citation database http://www.scopus.com/search for the 10 years (2002-2011). The string used to retrieve the data in heredity blood disorder was developed using the following keywords: heredity blood disorders, thalassemia, sickle cell anemia, hemophilia, thrombopenia and von Willebrand disease along with India. The search using the above keywords becomes finally our main string. For citations data, three years, two year, one year and zero years citations window has been used for computing average citations per paper in heredity blood disorder research during 2002-08, 2009, 2010 and 2011. For searching and calculating the total international collaborative papers, a separate search strategy, which combines India's collaboration with 140 major countries, was prepared and this string was combined with the main string to generate India's total international collaborative output. For analyzing institutional, author and journals output, the separate search strategies for generating institutional, author and journal outputs were developed, which later combined with the main string to generate the desired output.

Analysis

Contribution and citation impact of leading countries

The world has published 29773 papers in heredity blood disorders during the last ten years from 2002-11, which has increased from 13107 papers during 2002-06 to 16666 papers during 2007-11, witnessing a growth rate of 27.15%. Among the twenty leading countries contributing to heredity blood disorders research, the largest output of 7544 papers (with 25.79% share) comes from United States during 2002-11, followed by United Kingdom (2762 papers, 9.48% share), Italy (2455 papers, 8.84% share), France (1693 papers, 5.77% share), Germany (1577 papers, 5.14% share), Netherlands (1176 papers, 3.97% share), Canada (1022 papers, 3.49% share), India (921 papers, 3.09% share), Spain (763 papers, 2.63% share), Turkey (699 papers, 2.39% share), Australia (682 papers, 2.29% share), Greece (675 papers, 2.27% share), Japan (617 papers, 2.07% share), Brazil (600 papers, 2.02% share), China (595 papers, 2.00% share), Iran (535 papers, 1.80% share), Israel (490 papers, 1.65% share), Thailand (482 papers, 1.62% share), Sweden (434 papers, 1.46% share) and Switzerland (433 papers, 1.45% share).

Among the top 10 publishing countries in heredity blood disorders, the publishing share has increased in United States (from 25.63% to 25.92%), Italy (from 7.85% to 8.84%), Netherlands (from 3.96% to 3.98%), Canada (from 3.27% to 3.66%), India (from 2.91% to 3.23%), Spain (from 2.43% to 2.78%) and Turkey (from 2.33% to 2.44%), as against decrease in United Kingdom (from 10.43% to 8.73%), France (from 5.90% to 5.68%) and Germany (from 5.69% to 5.14%) from 2002-06 to 2007-11. In terms of citation impact per paper during 2002-11, the highest among the top 10 countries was achieved by Netherlands (10.08), followed by UK (9.63), Canada (9.25), USA (8.82), Italy (7.96), Germany (7.40), France (6.57), Spain (5.89), Turkey (2.82) and India (2.43) (Table 1).

Indian contribution, citation impact and international collaboration

Indian contribution in heredity blood disorder has increased from 56 papers in 2002 to 111 papers during 2011, witnessing an annual average growth rate of 9.09%. Its cumulative contribution has increased from 382 papers during 2002-06 to 539 papers during 2007-11, witnessing a growth rate of 41.09%. The average citation per paper registered by India's research in heredity blood disorders during 2002-11 was 2.43, which has decreased from 3.35 during 2002-06 to 1.77 during 2007-11. India has contributed 10.31% international collaborative papers share in heredity blood disorder during 2002-11, which has decreased from 11.52% during 2002-06 to 9.46% during 2007-11 (Table 2).

In all 34 countries participated in international collaboration with India in heredity blood disorders during 2002-11, of which contribution of top 15 countries are listed in Table 3. The largest contribution to international collaborative papers of India in heredity blood disorder comes from United States (with 43 papers, 45.26% share), followed by UK (25 papers, 26.32% share), Italy (12 papers, 12.63% share), Japan and Canada (11 papers, 11.58% share each), Australia (8 papers, 8.42% share), France (7 papers, 7.375 share), Germany, Iran and Netherlands (6 papers, 6.32% share each), Pakistan and Sweden (5 papers, , 5.26% share each), Thailand (4 papers, 4.21% share) and Saudi Arabia and Taiwan (3 papers, 3.16% share each) (Table 3).

Types of heredity blood disorders

Under different type of heredity blood disorders, the maximum publication output (524) of India during 2002-11 was on thalassemia (with 56.89% share), followed by sickle cell anemia (193 papers, 20.96% share), haemophilia (105 papers, 11.40% share), von Willebrand disease (99 papers, 10.75% share) and thrombophilia (85 papers, and 9.23% share). In terms of citation impact per paper, the maximum citation impact (4.58) during 2002-11 was in von Willebrand disease, followed by haemophilia (2.81), thrombophilia (2.25), thalassemia (2.13) and sickle cell anemia (1.60). Compared to the world output, India's citation impact per paper was less in all types of heredity blood disorder. In terms of global share, the maximum (6.52%) was in thalassemia, followed by haemophilia (3.92% share), sickle cell anemia (2.58% share), von Willebrand disease (1.50% share) and thrombophilia (1.33% share) (Table 4 and 5).

Indian heredity blood disorders research output in context of different subjects

On analyzing the publication data, it was found that the Indian research output in heredity blood disorders during 2002-11 has been published in context of 6 subjects, with highest publications output coming from medicine (810 papers and 87.95% publications share), followed by biochemistry, genetics & molecular biology (175 papers and 19.00% publications share), pharmacology, toxicology & pharmaceutics (37 papers and 4.02% publications share), immunology and microbiology (20 papers and 2.17% publications share), agricultural & biological sciences (11 papers and 1.19% publications share) and neurosciences (9 papers and 0.98% publications share). On analyzing the quality and impact of Indian heredity blood disorders research under different subjects, it was found that agricultural & biological sciences had scored the highest impact (4.00 citations per paper), followed by neurosciences (3.89 citations per paper), pharmacology, toxicology & pharmaceutics (3.62 citations per paper), medicine (2.36 citations per paper biochemistry, genetics & molecular biology (2.30 citations per paper) and immunology and microbiology (2.20 citations per paper) during 2002-11 (Table 6).

Research profile of most productive Indian institutions in heredity blood disorders

The top 10 most productive Indian institutions involved in heredity blood disorders research have published 14 and more papers each during 2002-11. The publications profile of these 10 Indian institutions along with their research output, citations received and h-index values are presented in Table 7. These 10 Indian institutions involved in heredity blood disorders research together have contributed 60.69% share (with 559 papers) in the cumulative publications output of India in heredity blood disorders, with an average of 55.9 papers per institution. Only 4 Indian institutions have registered higher publications share than the group average. These are Institute of Immunohaematology, Mumbai with 145 papers, followed by All India Institute of Medical Sciences, New Delhi (107 papers), King Edward Memorial Hospital, Mumbai (86 papers) and Christian Medical College (CMC), Vellore (65 papers). The average citation per paper registered by the total papers

Country	Number of Papers			Share of Papers			Citations	ACPP
	02-06	07-11	02-11	02-06	07-11	02-11	02-11	02-11
USA	3359	4319	7678	25.63	25.92	25.79	67713	8.82
UK	1367	1455	2822	10.43	8.73	9.48	27179	9.63
Italy	1029	1473	2592	7.85	8.84	8.71	19910	7.96
France	773	946	1719	5.90	5.68	5.77	11289	6.57
Germany	746	857	1603	5.69	5.14	5.38	11878	7.40
Netherlands	519	664	1183	3.96	3.98	3.97	11924	10.08
Canada	429	610	1039	3.27	3.66	3.49	9614	9.25
India	382	539	921	2.91	3.23	3.09	2235	2.43
Spain	318	464	782	2.43	2.78	2.63	4607	5.89
Turkey	305	406	711	2.33	2.44	2.39	2014	2.82
World	13107	16666	29773	100.00	100.00	100.00		

Table 1: Contribution and Citation Impact of Top 10 Countries in Heredity Blood Disorders, 2002-11.

of these 10 Indian institutions is 2.88 during 2002-11. Only 2 Indian institutions have registered higher impact than the group average. The highest impact of 6.97 citations per paper was scored by the Christian Medical College (CMC), Vellore, followed by Sir Ganga Ram Hospital, New Delhi (3.29 citations per paper). The average h-index value of these 10 Indian most productive institutions was 8.2 during 2002-11. The five Indian institutions have scored higher h-index value than group's average of 8.2. The highest h-index value (14) was achieved by Christian Medical College (CMC), Vellore, followed by Institute of Immunohaematology, Mumbai and All India Institute of Medical Sciences, New Delhi (12 each), King Edward Memorial Hospital, Mumbai (11) and Sanjay Gandhi Postgraduate Institute of Medical Sciences Lucknow (9) (Table 7).

Contributions and citation impact of most productive authors in Indian heredity blood disorders

Based on the publication output, 10 most productive authors having been identified who have published 18 and above papers in heredity blood disorder. Of these 4 authors are affiliated to Institute of Immunohaematology, Mumbai, 3 to All India Institute of Medical Sciences, New Delhi, 2 to Christian Medical College, Vellore and 1 to Regional Medical Research Center, Bhubaneshwar. These 10 authors together contributed 459 papers with an average of 45.9 papers per author and account for 49.84% share in the cumulative publications output of India during 2002-11. Five authors have published higher number of papers than the group average (45.9). These are: K.Ghosh with 90 papers, followed by S. Shetty (63 papers), D. Mohanty (62 papers), R.Saxena (62 papers) and R.B.Colah (50 papers). Considering the quality/impact of papers, these most productive authors have received a total of 1447 citations for 459 papers with an average of 3.15 citations per paper. Two authors have registered higher impact than the average impact of papers of all authors (3.15). These are: A.Srivastava with 6.03 citations per paper and M. Chandy (5.14 citations per paper). Measuring the performance of these authors on the basis of h- index, five authors have achieved the higher h-index value than the group average of 9.5. These authors are A. Srivatava with h-index of 13, followed by K. Ghosh (12), S. Shetty (11), D. Mohanty (11) and R. Saxena (10) (Table 8).

Research Communication in High Productive Journals

The 20 most productive Indian and foreign journals publishing Indian research papers together contributed 415 papers in heredity blood disorder, which accounts for 45.06% share of the total output of India during 2002-11. The cumulative publications output share of these 20 most productive journals showed a decrease in India's publications output from 50.00% during 2002-06 to 41.56% during 2007-11 (Table 9).

Highly cited papers

The characteristics of top 13 most highly cited papers of India in heredity blood disorder are evaluated in this section. These 13 highly cited papers have received citations (since their publications till April 2012) from 30 to 266 during 2002-11. These 13 highly cited papers have received 926 citations, with an average of 71.23 citations per paper. Of these 13 highly cited papers, 7 appeared as reviews, 5 as articles and 1 as conference paper. Of these 13 papers, 8 involve international collaboration (3 bilateral and 5 multilateral), 1 involve national collaboration and 5 papers zero collaboration. Of the 13 highly cited papers, 3 papers are in citation range of 100-266, 3 papers in citations range of 50-99 and 7 papers in citations range of 30-49. The authors of these high cited papers are affiliated to 13 Indian institutions, including 5 papers from Christian Medical College, Vellore, 2 papers from All India Institute of Medical Sciences, New Delhi and 1 paper each from Bombay Hospital, Mumbai, Central Drug Research Institute, Lucknow, Christian Medical College, Ludhiana, GB Pant Hospital,

Period	TP	TC	ACPP	ICP	%ICP
2002	56	98	1.75	5	8.93
2003	77	178	2.31	7	9.09
2004	76	209	2.75	9	11.84
2005	91	379	4.16	11	12.09
2006	82	416	5.07	12	14.63
2007	104	365	3.51	7	6.73
2008	98	233	2.38	10	10.20
2009	103	200	1.94	4	3.88
2010	123	121	0.98	14	11.38
2011	111	36	0.32	16	14.41
2002-06	382	1280	3.35	44	11.52
2007-11	539	955	1.77	51	9.46
2002-11	921	2235	2.43	95	10.31

Table 2: India's Research Output, Citation Impact and International Collaborative Papers Share during 2002-11.

Country	ICP	% Share	Country	ICP	% Share
USA	43	45.26	Iran	6	6.32
UK	25	26.32	Netherlands	6	6.32
Italy	12	12.63	Pakistan	5	5.26
Japan	11	11.58	Sweden	5	5.26
Canada	11	11.58	Thailand	4	4.21
Australia	8	8.42	Saudi Arabia	3	3.16
France	7	7.37	Taiwan	3	3.16
Germany	6	6.32	Total	95	

Table 3: Share of Top 15 Countries in International Collaborative Papers of India during 2002-11.

Types of Heredity Blood Disorder	India			World			India's Share in World
	TP	TC	ACPP	TP	TC	ACPP	
Thalassemia	524	1116	2.13	8035	36846	4.59	6.52
Sickle Cell Anemia	193	309	1.60	7487	38142	5.09	2.58
Haemophilia	105	295	2.81	2680	11675	4.36	3.92
Von Willebrand Disease	99	453	4.58	6620	48455	7.32	1.50
Thrombophilia	85	191	2.25	6370	34150	5.36	1.33

Table 4: India and World Publication Output & Citation Quality in Different Types of Heredity Blood Disorder, 2002-11.

Types of Heredity Blood Disorders	TP	ICP	%ICP	H-Index	Share in India's Output
Thalassemia	524	47	8.97	16	56.89
Sickle Cell Anemia	193	13	6.74	12	20.96
Haemophilia	105	15	14.29	9	11.40
Von Willebrand Disease	99	19	19.19	13	10.75
Thrombophilia	85	6	7.06	9	9.23

Note. There is also some overlapping in the coverage of literature under different type of heredity blood disorder.

Table 5: India Publication Output & International Collaborative Publications Share in Different Types of Heredity Blood Disorder, 2002-11.

Subject	No. of Papers	No. of Citations	ACPP	% Share of Papers
Medicine	810	1914	2.36	87.95
Biochemistry, Genetics & Molecular Biology	175	403	2.30	19.00
Pharmacology, Toxicology & Pharmaceutics	37	134	3.62	4.02
Immunology & Microbiology	20	44	2.20	2.17
Agri. & Biol Sciences	11	44	4.00	1.19
Neurosciences	9	35	3.89	0.98
Total Indian Papers	921			

Table 6: Subject-Wise Break-up of Indian Heredity Blood Disorders Publications during 2002-11.

S.No.	Name	TP	TC	ACPP	H-Index
1	Institute of Immunohaematology, Mumbai	145	335	2.31	12
2	All India Institute of Medical Sciences, New Delhi	107	271	2.53	12
3	King Edward Memorial Hospital, Mumbai	86	224	2.60	11
4	Christian Medical College, Vellore	65	453	6.97	14
5	Postgraduate Institute of Medical Education and Research, Chandigarh	54	81	1.50	7
6	Sanjay Gandhi Postgraduate Institute of Medical Sciences Lucknow	41	96	2.34	9
7	Regional Medical Research Center, Bhubaneshwar	19	51	2.68	6
8	Armed Forces Medical College of India, Pune	14	34	2.43	4
9	Sir Ganga Ram Hospital, New Delhi	14	46	3.29	4
10	Institute of Medical Sciences, BHU, Varanasi	14	17	1.21	3
		559	1608	2.88	8.2

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

Table 7: Productivity & Citation Impact of Top 10 Indian Institutions in Heredity Blood Disorders, 2002-11.

Delhi, Industrial Toxicology Research Centre, Lucknow, Lalitha Super Specialty Hospital, Guntur, Mahatma Gandhi Institute of Medical Sciences, Wardha, Ranbaxy Research Laboratories, Gurgaon, Sir Ganga Ram Hospital, New Delhi, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram and The Institute of Neurological Sciences, Care Hospital, Hyderabad. The 13 highly cited papers in heredity blood disorder have appeared in 11 journals, including 2 papers each in Blood Cells, Molecules and Diseases and

S.No	Name	Address	TP	TC	ACPP	H-Index
1	K.Ghosh	Institute of Immuno-haematology, Mumbai	90	248	2.76	12
2	S. Shetty	Institute of Immuno-haematology, Mumbai	63	165	2.62	11
3	D. Mohanty	Institute of Immuno-haematology, Mumbai	62	163	2.63	11
4	R.Saxena	All India Institute of Medical Sciences, New Delhi	62	175	2.82	10
5	R.B.Colah	Institute of Immuno-haematology, Mumbai	50	122	2.44	9
6	A. Srivastava	Christian Medical College, Vellore	38	229	6.03	13
7	V.P. Choudhry	All India Institute of Medical Sciences, New Delhi	29	91	3.14	9
8	M.Chandy	Christian Medical College, Vellore	28	144	5.14	9
9	M.Kannan	All India Institute of Medical Sciences, New Delhi	19	55	2.89	6
10	R.S.Balgir	Regional Medical Research Center, Bhubaneshwar	18	55	3.06	5
	Total		459	1447	3.15	9.5

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

Table 8: Productivity & Citation Impact of Twenty Most Productive Indian Authors in Heredity Blood Disorders, 2002-11.

S.No	Name of the Journal	Number of Papers		
		2002-06	2007-11	2002-11
1	Hemophilia	25	28	53
2	Indian Journal of Pediatrics	19	28	47
3	Indian Pediatrics	22	11	33
4	Indian Journal of Pathology & Microbiology	13	19	32
5	Journal of Association of Physicians of India	16	10	26
6	Hemoglobin	15	9	24
7	Hematology	10	14	24
8	Annals of Hematology	9	10	19
9	Indian Journal of Medical Research	5	14	19
10	Indian Journal of Hematology & Blood Transfusion	6	12	18
11	European Journal of Hematology	6	10	16
12	British Journal of Hematology	6	8	14
13	American Journal of Hematology	8	5	13
14	Clinica Chimica Acta	2	11	13
15	Indian Journal of Human Genetics	5	8	13
16	Indian Journal of Clinical Biochemistry	5	6	11
17	Clinical & Applied Thrombosis & Hemostasis	2	10	12
18	Journal of the Indian Medical Association	7	3	10
19	Blood Cells Molecules & Diseases	5	4	9
20	National Medical Journal of India	5	4	9
	Total	191	224	415
	Total of India	382	539	921
	Share of Top 20 Journals in Indian Output	50.00	41.56	45.06

Table 9: List of Most Productive Journals Publishing Indian Papers in Heredity Blood Disorder, 2002-11.

Journal of Thrombosis and Haemostasis and one paper each in Annals of Hematology, Blood, Environmental Toxicology and Pharmacology, Expert Opinion on Drug Safety, Haemophilia, International Journal of Stroke, Journal of Gastroenterology and Hepatology, National Medical Journal of India and Toxicology Letters. A list of top 13 highly cited papers are given in Table 10.

Summary

India has published 921 papers in heredity blood disorder during 2002-11, accounting for 3.09% share in global publications output. India's global publication share in heredity blood disorder has increased from 2.91% during 2002-06 to 3.23% during 2007-11. India's publications output in heredity blood disorder has increased from 56 papers in 2002 to 111 papers in 2011, witnessing an annual average growth rate of 9.09%. The average citation impact per paper registered by Indian papers in heredity blood disorder was 2.43 during 2002-11, which has decreased from 3.35 during 2002-06 to 1.77 during 2007-11. Among the 10 most productive countries in heredity blood disorder, India registered the lowest citation impact per paper during 2002-11. The share of international collaborative papers in India's total publication output in heredity blood disorder was 10.31% during

Authors	Title of the Paper	Source	Number of Citations
Sadler J.E., Budde U., Srivastava A., et al	Update on the pathophysiology and classification of von Willebrand disease: A report of the Subcommittee on von Willebrand factor	Journal of Thrombosis and Haemostasis 2006, 4(10), 2103-2114	266
Kumar S., Bandyopadhyay U.	Free heme toxicity and its detoxification systems in human	Toxicology Letters 2005, 157(3), 175-188	136
Rodeghiero F., Castaman G., Srivastava A. et al	The discriminant power of bleeding history for the diagnosis of type 1 von Willebrand disease: An international, multicenter study	Journal of Thrombosis and Haemostasis 2005, 3(12), 2619-2626	100
McCaughan G.W., Amarapurkar D., Chutaputti A., et al	Asian Pacific Association for the Study of the Liver consensus statements on the diagnosis, management and treatment of hepatitis C virus infection	Journal of Gastroenterology and Hepatology 2007, 22(5), 615-633	58
Premawardhena A., Verma I.C et al	The global distribution of length polymorphisms of the promoters of the glucuronosyltransferase 1 gene (UGT1A1): Hematologic and evolutionary implications	Blood Cells, Molecules, and Diseases 2003, 31(1), 98-101	57
Srivastava A., Poonkuzhali B., Shaji R.V. et al	Glutathione S-transferase M1 polymorphism: A risk factor for hepatic venoocclusive disease in bone marrow transplantation	Blood 2004, 104(5), 1574-77	53
Baronciani L., Cozzi G., Srivastava A. et al	Molecular defects in type 3 von Willebrand disease: Updated results from 40 multiethnic patients	Blood Cells, Molecules, and Diseases 2003, 30(3), 264-270	48
Peyvandi F., Jayandharan G., Chandy M., Srivastava A. et al	Genetic diagnosis of haemophilia and other inherited bleeding disorders	Haemophilia 2006, 12 (Suppl 3), 82-89	37
Dixit A., Chatterjee T.C., Mishra P. et al	Hydroxyurea in thalassemia intermedia - A promising therapy	Annals of Hematology 2005, 84(7), 441-46	37
Tiwari A., Bansal V., Chugh A., et al	Statins and myotoxicity: A therapeutic limitation	Expert Opinion on Drug Safety 2006, 5(5), 651-66	36
Kakkar P., Jaffery F.N.	Biological markers for metal toxicity	Environmental Toxicology and Pharmacology 2005, 19(2), 335-39	36
Pandian J.D., Padma V., Vijaya P. et al	Stroke and thrombolysis in developing countries	International Journal of Stroke 2007, 2(1), 17-26	32h
Kalantri S.P., Joshi R., Riley L.W.	Chikungunya epidemic: An Indian perspective	National Medical Journal of India 2006, 19(6), 315-22	30

Table 10: List of Top 13 Highly Cited Papers in Heredity Blood Disorders, 2002-11.

2002-11, which has decreased from 11.51% during 2002-06 to 9.46% during 2007-11. Thirty four countries participated in international collaboration with India in heredity blood disorder during 2002-11, with largest publication share (45.26%) from USA, followed by UK (26.32%), Italy (12.63%), Japan and Canada (11.58% each), Australia (8.42%). In terms of different types of heredity blood disorders, the largest contribution (56.89% share) in India was in thalassemia, followed by sickle cell anemia (20.96% share), hemophilia (11.40% share), von Willebrand disease (10.75% share) and thrombophilia (9.23% share) during 2002-11. In terms of sub-fields, the largest contribution of Indian heredity blood disorder research came from medicine (with 87.95% share), followed by biochemistry, genetics & molecular biology (19.00%), pharmacology, toxicology & pharmaceutics (4.02%), immunology & microbiology (2.17%), agricultural & biological sciences (1.19%) and neurosciences (0.98%) during 2002-11. The 10 most productive Indian institutions involved in heredity blood disorder research together contributed 60.69% share in India's total output with an average of 55.9 papers per institution during 2002-11. The average citation impact per paper and h-index of these 10 top Indian institutions was 2.88 and 8.2 during 2002-11. The 10 most productive Indian authors involved in heredity blood disorder research together contributed 49.84% share in India's total output with an average of 45.9 papers per author during 2002-11.The average citation impact per paper and h-index of these 10 top Indian authors was 3.15 and 9.5 during 2002-11 The top 20 most productive journals together contributed 415 papers, accounting for 45.06% share in Indian output during 2002-11, which has decreased from 50.00% during 2002-06 to 41.56% during 2007-11.

Conclude that there is a need to create comprehensive care services, including diagnosis and management of the heredity blood disorders in Indian context. For this purpose, there is need to undertake more R&D, develop trained manpower at different levels and create sufficient infrastructure to handle the problems associated with heredity blood disorders. Although, the Indian government has already taken some steps in this direction, but they are not totally sufficient to take care of all patients associated with heredity blood disorders in India.

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