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Microbicides Development–Trends in Original Research Published Globally in *PubMed*-indexed Journals

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ABSTRACT

Microbicides are compounds currently under development that would be applied topically to the vagina or rectum and would have the ability to prevent the sexual transmission of human immunodeficiency virus (HIV) that causes acquired immuno-deficiency syndrome. The study aims to explore the progress and foresight in microbicides development using research papers' analysis. The 317 records were downloaded from the *PubMed* with the search strategy: (i) "Microbicide [ti]" and (ii) "HIV prevention[ti] + methods[ti] + women[ti]" till November 2010. Majority of the papers (280, 88.33 %) appeared during the recent decade (2001-2010). Of the 133 publishing journals, only four journals, *viz*., *Sexually Transmitted Diseases*, *Antimicrob Agents and Chemotherapy*, *Journal of Acquired Immune Deficiency Syndromes,* and *AIDS* contributed one-fourths (80 papers, 25.24 %) of the total papers published by researchers from 22 countries with US on the top of the tally. The recent decade has witnessed considerable growth in research output in this field while a successful microbicide still remains elusive. Leading countries in terms of research output like the USA, UK, South Africa, and India are those often directly affected by HIV. An international journal of microbicides R&D may emerge shortly to take care of the growing research in microbicides.

Keywords: Microbicides, human immunodeficiency virus, acquired immuno-deficiency syndrome, *PubMed*

1. INTRODUCTION

Microbicides are compounds currently under development that would be applied topically to the vagina or rectum and would have the ability to prevent the sexual transmission of human immunodeficiency virus (HIV) [that causes acquired immuno-deficiency syndrome (AIDS)] and possibly other sexually transmitted infections (STIs).

An HIV prevention strategy that women can initiate or control in the form of a microbicide was first proposed by Stein[1] almost two decades ago. Since then several candidate microbicides have entered effectiveness trials prevention to assess their impact on the prevention of HIV infection and it may take many years before a safe and effective product is ready for distribution. The excellent document of the US-based Alliance for Microbicide Development[2] entitled "*Mapping the Microbicide Effort*" provides an exhaustive report on microbicides development till 2006 by more than 30 leading microbicide research, development and advocacy organisations. In an editorial published recently, Abdool Karim & Baxter[3] discusses briefly the developments in microbicides development spanning of almost two decades.

Mapping of research papers from a premier biomedical database like the *PubMed* therefore offers an important scientometric tool to present the current trend in a growing area of biomedical field like the microbicides development. As the microbicides research is a relatively new field, the purpose of this pilot study is to explore the progress and foresight in microbicides development using research papers' analysis.

2. METHODOLOGY

Specifically, records were downloaded from the *PubMed*[4] with the search strategy, (i) "Microbicide [ti]" and (ii) "HIV prevention [ti] + methods [ti] + women[ti] ". Total 395 records were saved as *Medline* records in text (.txt) format on November 16, 2010. Of these, 317 records complete in all fields/respects were processed for analysis in the present analysis. Records with publication type as news, newspaper article, letter, interview, editorial, comment and addresses were excluded, leaving only journal articles and reviews for the present analysis. Broadly, the analysis included the publishing journals of the papers analysed, number of authors/paper as also

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corresponding author's affiliation with country, country of publishing journals, language of papers, and Thomson's Reuters impact factor of publishing journals from the *Journal Citation Reports* 2009[5].

3. RESULTS

Of the 317 papers, 293 (92.43 %) were journal articles and the remaining 24 (7.57 %) reviews, published during 1952–2010. Majority of the papers (280, 88.33 %) appeared during the recent decade only (2001-2010) (Table 1).

Table1. Year-wise growth in number of publications in microbicides, 1952–2010

Year	No. of papers	Year	No. of papers	Year	No. of papers
1952	1	1994	02	2003	13
1957	1	1995	01	2004	20
1959	1	1996	01	2005	31
1960	1	1997	01	2006	32
1962	1	1998	02	2007	39
1966	1	1999	10	2008	45
1973	2	2000	08	2009	42
1983	2	2001	07	2010	42
1990*	2	2002	09	**Total**	**317**

**Microbicide was first proposed in 1990*

Table 2 lists 133 publishing journals used for 317 papers with research output during 1952-2010 in the descending order. Only four journals *viz*., *Sexually Transmitted Diseases* (32 papers, IF=2.579), *Antimicrob Agents and Chemotherapy* (19, IF=4.802), *Journal of Acquired Immune Deficiency Syndromes* (16, IF= 4.207) and *AIDS (*13, IF= 4.909) together contributed around one-fourths (80 papers, 25.24 %) of the total 317 papers, as also 24 publishing journals for 111 papers and another 105 journals for 126 papers. To put it simply, 20.05 % (28 journals) published 60.25 % (191 papers). Except, *AIDS*, the remaining top ranking journals are published from USA. Table 2 lists the top 28 journals publishing 3 or more papers on microbicides during 1952-2010.

In the literature output, the applicability of Bradford law[6] was also explored. According to Bradford law, the analysed journals can be placed into groups that account for about the same number of articles. The groups are called Bradford zones (Table 3) the most prolific journals are in the zone called the Bradford nucleus or the core. For example, after arranging the given journals from most to least productive (Table 4) one observes that the top 2 journals produce 50 articles; the next 5 journals produce 49 articles; the next 11 journals produce 67 articles; the next 30 journals produce 69 articles; and the next top 84 journals produce 84 articles. These five zones contain roughly the same number of articles. The number of journals in the five zones is in this proportion: 1:2:5:11:30:84, which is close to the proportion: $2.5^0 : 2.5^1 : 2.5^2 : 2.5^3 : 2.5^4$ or 1 : 2.5 : 12.50: 31.25: 78.12. Then n=2.5 in the general proportion is called the Bradford multiplier. Then, n=2.5 is the general proportion 1: n: n^2: n^3. The applicability of Bradford law is quite close to the expected results.

Table 2. List of top 28 journals publishing 3 or more papers on microbicides, 1952–2010

S. No.	Name of journal	No. of papers
1.	*Sexually Transmitted Diseases*	32
2.	*Antimicrob Agents and Chemotherapy*	19
3.	*Journal of Acquired Immune Deficiency Syndromes*	16
4.	*AIDS* (London, England)	13
5.	*Contraception*	08
6.	*AIDS and Behavior*	07
7.	*Culture, Health and Sexuality*	07
8.	*AIDS Research and Human Retroviruses*	06
9.	*American Journal of Public Health*	06
10.	*Antiviral Research*	06
11.	*PLoS One*	06
12.	*AIDS Education and Prevention*	05
13.	*Current Opinion in HIV and AIDS*	05
14.	*Journal of Women's Health*	05
15.	*Journal of Women's Health*	05
16.	*Proceedings of the National Academy of Sciences of the United States of America*	05
17.	*Sexually Transmitted Infections*	05
18.	*Biology of Reproduction*	04
19.	*Journal of Medical Primatology*	04
20.	*AIDS Care*	03
21.	*AIDS Patient Care and STDs*	03
22.	*BMC Medical Ethics*	03
23.	*International Journal of STD & AIDS*	03
24.	*Journal of Pharmaceutical Sciences*	03
25.	*Journal of Infectious Diseases*	03
26.	*Journal of Virology*	03
27.	*Retrovirology*	03
28.	*Sexual Health*	03

The data in Table 4 is plotted on a Bradford graph (Fig. 1) taking the cumulative number of journals (on a log scale) on the *X*-axis and cumulative number of articles on the *Y*-axis to test the Bradford law of scattering.

Table 3. Number of journals according to bradford zones, 1950-2010

Zones	Number of journals		Number of articles	
	Expected	Actual	Expected	Actual
0.	2.5^0x2=2	02	64	50
1.	2.5^1x2=5	05	64	49
2.	2.5^2x2=12.50	11	64	67
3.	2.5^3x2=31.25	30	64	69
4.	2.5^4x2=78.12	84	64	84
5.	128.87	132	320	319

Table 4. Distribution of journals in the decreasing order of productivity

Rank number	No. of papers	No. of journals	Cumulative number of papers	log of cumulative of journals	Cumulative number journals
1.	32	01	001	0.00	032
2.	19	01	002	0.30	051
3.	16	01	003	0.48	067
4.	13	01	004	0.60	080
5.	08	01	005	0.70	088
6.	07	02	007	0.85	102
7.	06	04	011	1.04	126
8.	05	05	016	1.20	151
9.	04	02	018	1.26	159
10.	03	09	027	1.43	186
11.	02	21	048	1.68	228
12.	01	84	132	2.12	312

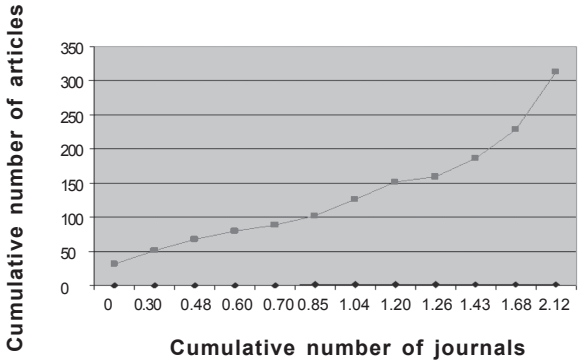

Figure 1. Bradford graph on article scattering in journals.

In terms of corresponding author's affiliation, 22 countries accounted for these papers. However, the country affiliation of the corresponding author was not available in 19 papers. Top ranking countries in terms of number of papers were USA (with198 papers), followed by UK (23 papers), South Africa (14 papers), India (12 papers), Belgium (7 papers), PR China (6 papers), Australia, Canada and France (5 papers each), Netherlands (4 papers), Spain and Thailand (3 papers each), Italy, Uganda and Tanzania (2 papers each) and Austria, England, Germany, Kenya, Switzerland, Zambia and Zimbabwe (1 paper each). Institution-wise break-up of the top ranking country's 198 papers from the USA showed that 72 institutions across the USA contributed these papers. Only USA with 12 institutions (96 papers, 48.86 %) have published five or more papers during the study period with University of Washington, Seatle, WA on the top of the tally with 15 papers (Table 5).

The collaboration pattern in 317 papers showed 30 (9.46 %) as single-authored papers and the rest by multi-authored (with 2 or more authors) with 2 papers having collaborative/editorial teams. However, there were no authors in four papers. Barring nine papers (German (4), French (3) and Italian (2)), all the papers analysed were published in the English language (307). However, one paper did not include the language used.

Table 5. List of USA institutions with five or more papers on microbicides, 1952–2010

Name of institution	No. of papers
University of Washington, Seatle, WA	15
New York State Psychiatric Institute and Columbia University, New York	11
The Population Council, New York	10
University of Texas Medical Branch, Galveston, Texas	09
Family Health International, North Carolina	08
Duke University Medical Center, North Carolina	07
Johns Hopkins University, Baltimore, MD	07
Parker Hughes Institute, MN	07
CONRAD Contraceptive Research and Development,Arlington, Virginia	06
The Miriam Hospital, Rhode Island	06
International Partnership for Microbicides, Maryland	05
University of North Carolina at Chapel Hill, North Carolina	05

4. CONCLUSIONS

Around 280 (88.33 %) papers appeared during the recent decade (2001-10) only are on expected lines as microbicides are currently under R&D. While a successful microbicide still remains elusive, more and more microbicides researchers, public health personnel, communities and advocacy organisations from number of countries are actively pursuing the global initiative in developing a safe, effective and accessible microbicide. In the present study, 133 publishing journals for 317 papers more or less follow Bradford's Law of scattering, describing how the literature of microbicides is scattered in these 133 journals.

The number of countries from the present 22 is certainly going to mount in the time to come as also the US-based institutions. Leading countries in terms of research output like the USA, UK, South Africa and India are often those directly affected by HIV. Even the impact

of 24 review articles is of maximum benefit to the scientific and biomedical community as suggested by Ketcham and Craford[7]. Beginning from 2006 at Cape Town, South Africa followed by 2008 meet in New Delhi, India and the recently the biannual international microbicides conference was held in Pittsburgh, Pennsylvania, USA during 22-25 May 2010.

The next in the series will be the Microbicides 2012 at Sydney, Australia. The authors predict by that time an international journal of microbicides R&D will emerge on the scene to take care of the growing number of research papers .

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