A scientometric analysis for identifying major specialties of pharmacological research and geographical contributors

Today, care of patients revolves around medicines that have passed rigorous tests. This integrates the discoveries of basic and applied research in medicine, and pharmacology is an integral discipline of medicine. During the last century the role of research and development in pharmacology increased significantly. This was evidenced by the introduction of new drugs, organization of scientific meets, and emergence of scientific journals. The analysis of nation-wise contribution to scientific literature on biomedical research is a subject that creates expectations. “Scientometrics is the science of measuring and analyzing science. In practice, scientometrics is often done using bibliometrics that is measurement of (scientific) publications”.[10] In 1960, Vassily V. Nalimov had coined the term scientometrics.[10] Modern scientometrics is primarily based on the work of Derek J. de Solla Price and Eugene Garfield. The latter founded the Institute of Scientific Information (ISI), which carries out scientometric analysis.

Citations are available about scientometric studies in gastroenterology, nuclear medicine, anesthesia, and chronotherapy.[10,11] However, similar scientometric studies are not available to reveal the various facets of pharmacological research and the geographical contributors. Furthermore, it would be of interest for a novice pharmacologist to know about the leading specialties of pharmacological research and the nations that lead in conducting this research. One way to find this information is to survey the original research articles published in leading scientific journals. Therefore, we undertook a scientometric analysis of the original papers published in at least three leading pharmacology journals to find (1) the spectrum and the major specialties or divisions of pharmacological research and (2) the countries contributing the highest number of research articles in the field of pharmacology.

A library based retrospective search of paper or electronic version of pharmacology journals was done. This covered the original research papers published in three international journals with an impact factor greater than 2.40, viz., European Journal of Pharmacology (EJP) (www.sciencedirect.com/science/journal/00429999) 52 issues, British Journal of Pharmacology (BJP) (www.nature.com/bjp/archive/index.html) 24 issues, and Journal of Pharmacology and Experimental Therapeutics (JPET) (http://jpet.aspetjournals.org/contents) 12 issues, from January to December 2005. The research papers in these journals were screened for different specialties or divisions of pharmacology as indexed by them. In addition, country-wise contribution was identified by referring to authors’ affiliation. The z test of proportions was used to find out the significant difference between various specialties and different countries. Difference between specialties or countries with P<0.05 was considered statistically significant. In this study, we used the terms specialties, divisions, disciplines, and areas interchangeably, to mean the different branches of pharmacological research.

The three journals published 1,471 research papers. This constituted about ten specialties [Table 1], of which cellular and molecular pharmacology (19.98%), neuropharmacology and analgesia (19.85%), and cardiovascular pharmacology (19.71%) were found to be the three leading specialties. Less than 10% of total number of papers were published on inflammation and immunopharmacology, gastrointestinal, hepatic, pulmonary pharmacology, behavioural pharmacology, endocrine, reproductive and urogenital pharmacology, and pharmacokinetic specialties. The lowest numbers of papers were from toxicology, chemotherapy, antibiotics, and gene therapy areas.

Authors from 57 nations published 1,471 papers scoring (alone and in collaboration with any other country) 1,837 papers. The US emerged as the first nation with 30% score of the total publications. It was followed by Japan with 13% and

### Table 1

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<th>Specialties or Divisions</th>
<th>Total no. of papers (%) (n=1471)</th>
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<tr>
<td>Cellular and Molecular pharmacology</td>
<td>294 (19.98)</td>
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<tr>
<td>Neuropharmacology and Analgesia</td>
<td>292 (19.85)</td>
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<tr>
<td>Cardiovascular pharmacology</td>
<td>290 (19.71)**</td>
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<tr>
<td>Inflammation and Immunopharmacology</td>
<td>146 (9.92)</td>
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<tr>
<td>Gastrointestinal, Hepatic, Pulmonary pharmacology</td>
<td>118 (8.02)</td>
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<tr>
<td>Behavioural Pharmacology</td>
<td>115 (7.181)</td>
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<tr>
<td>Endocrine, Reproductive and Urogenital pharmacology</td>
<td>80 (5.43)</td>
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<tr>
<td>Pharmacokinetics</td>
<td>73 (4.96)</td>
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<tr>
<td>Toxicology</td>
<td>35 (2.37)</td>
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<tr>
<td>Chemotherapy, Antibiotics, and Gene therapy</td>
<td>28 (1.90)</td>
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**P<0.001 when compared with total number of papers in inflammation and immunopharmacology.**
the UK with 8.3%. The rest of the countries (47) contributed 22.5% score of the total papers. [Figure 1] One score of paper was reported from Algeria, Byelorussia, Estonia, Latvia, Lebanon, Montenegro, New Zealand, Oman, Pakistan, Puerto Rico, Slovakia, and UAE (data not shown in Figure 1). India contributed 0.32% of the total score of papers.

In terms of three leading specialties of pharmacological research, about 37 nations published papers on cellular and molecular pharmacology. The major geographical contributors were the US (27.30%), Japan (9.81%), the UK (7.66%), Germany (6.13%), China (5.21%), Italy, S. Korea, Canada (4.29% each), Taiwan (3.68%), Spain (3.37%), and Australia (3.26%). About 44 nations published papers on neuropharmacology and analgesia. The major contributors were the US (49.35%), Japan (8.87%), the UK (7.02%), Germany (4.25%), Italy (4.06%), France (2.58%), Canada (2.40%), Australia, Spain (2.1% each), and Sweden (1.46%). Similarly, about 38 nations published papers on cardiovascular pharmacology, and the major contributors were the US (23.82%), Japan (12.75%), the UK (11.74%), Canada, Germany (6.04% each), France (5.70%), Spain (4.02%), Australia (3.69%), Brazil (3.02%), Italy (2.68%), China (2.34%), and Sweden (2.01%).

Scientometric studies broadly constitute quantitative analyses of scientific literature to reveal the latest developments in various fields and the patterns of geographical distribution of science and scientific productivity of individual nations.\(^{[9]10}\) Recently, these studies gained importance for identifying the global authorities in various fields of research.\(^{[9]11}\) It is well known that knowledge of pharmacology is essential for effective therapy of illness. Pharmacology has undergone rapid expansion over the years as a result of technology driven understanding of molecular action and knowledge to explore action of drugs or xenobiotics in humans or in animals. Increasing specialisation in pharmacological research has stimulated the publication of many new and specialty journals. Indeed, the journals selected in this study are known to publish reports from the less specialized areas of pharmacological research. Articles published in such journals indicate the trends in pharmacological research and the countries leading the research. In addition, the latest impact factor of these journals was higher than many other pharmacology journals (BJP:3.325, EJP:2.432, and JPET:4.335).

Our study attempted to identify the major specialties by mapping the spectrum of pharmacological research and geographical contributors as reported in three leading general pharmacology journals. Table 1 indicates that research activity was reported in at least ten divisions or specialties of pharmacology. We can infer that many researchers conduct research on cellular and molecular pharmacology, neuropharmacology and analgesia, and cardiovascular pharmacology. This makes these divisions the major or popular divisions of pharmacological research. Wagner and Groves\(^{[12]}\) recently reported that the highest percentage of the global population suffers from chronic degenerative diseases like cardiovascular, metabolic, and neurological disorders. Therefore, we were motivated to carry out this research to find therapeutic regimens for these chronic diseases. In addition, many government sponsored research schemes target the diseases prevalent in the respective countries.\(^{[8]}\)

Similar to a previous study\(^{[16]}\) our study also indicates a vast difference between developed and developing nations on contribution to scientific research. Developed countries contributed 90% of the papers, while developing countries contributed only 10% of the papers out of the score of 1843. Research requires the utilisation of scarce human, capital, social, educational, and other resources. A country can produce substantial amount of research output if it has large pools of resources, national affluence, and political ambition. The US, Japan, and the UK reported a majority of the publications. This accounted for 50% score of papers and was possibly due to national affluence. In addition, papers published from the US and the UK are known for their superior quality.\(^{[9]}\) These results further indicate that the number of papers published depends on a country’s expenditure on research and development. It also depends on trained personnel, who mainly belong to large industrialised nations.\(^{[18]}\) Furthermore, native English speaking countries (Anglo-American) have the advantage of publishing in their own language. However, it was surprising to find that Japanese scientists published the highest number of papers after American scientists, although their native language is not English. The US scored the highest number of papers in all the three major divisions. Developing countries suffer from lack of financial support and trained manpower. In addition, English is not their native language. Pragmatic policies, such as, increase in percentage of GNP (gross national product) invested in research, training facilities, and incentives for research should be adopted by developing countries to improve their contribution to research. The score over the number of published papers indicates collaborative research among various countries, which was about 25%.
Brazil published the highest number of papers (2.76% score) among developing countries. India contributed only 6 papers (IVRI, Izatnagar-2; CDRI, Lucknow-1 shared with Bundelkhand University, Jhansi; Hamdard University, New Delhi; Rajiv Gandhi centre for Biotechnology, Trivandrum; National Centre for Cell Sciences, Pune) contributing in specialties, such as neuropharmacology and analgesia, cellular and molecular, cardiovascular, pulmonary, gastrointestinal, urogenital, and cancer pharmacology.

Our study has not covered all the journals on pharmacology. However, the journals screened in this study report the highest level of research work carried out in pharmacology and are of international repute. Therefore, it may be concluded that at least three specialties or divisions, cellular and molecular pharmacology, neuropharmacology and analgesia, and cardiovascular pharmacology are surging ahead of others by the number of papers in leading pharmacology journals. We found that the US was leading in publishing papers on all the three major divisions of pharmacological research, followed by Japan and the UK.

Acknowledgments

We are thankful to Dr. S.A. Dkhar and Dr. D.G. Shewade for editing this manuscript.

References