Authorship Pattern – Scientometrics Study of Antimicrobial Agents and Chemotherapy Journal

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Abstract **- Purpose of present chapter is to measure productivity of scientists as well as productivity patterns of Antimicrobial Agents and Chemotherapy Journal. Evaluating the productivity of institutional research and developmental activities highlights the contribution of the institution and the individual scientists engaged in research. It also provides some insights into the complex dynamics of research activity and enables the science policy makers and science administrators to make available adequate facilities and direct the research activities in proper direction. A well known productivity indicator is the number of publications produced by scientists, institutions, or research groups. Over the years, Bibliometrics and Scientometrics techniques have became tools to evaluate the productivity of research institutes, individual researchers. Therefore, present chapter aims to measure productivity of scientists in Antimicrobial Agent and Chemotherapy Journal.**

Index Terms **- Author Productivity, Authorship Pattern, Scientometrics, Bibliometrics.**

INTRODUCTION

Nowadays the Scientometrics studies include mainly the quantitative aspects of science (in cognitive, as well as in social context), has strengthened its position as a significant component of the general science of science, and it appears to be a complete disciplinary field with clearly outlined subjects of research, specific set of well elaborated research methods and techniques, a significant size of research community, numerous research institutions, regularly held conferences, etc.

To measure productivity of scientists the collected data has been analyzed under following parameters, viz.

Author Productivity;

Authorship Pattern;

AUTHORSHIP PATTERN

The application of statistical techniques to the study of the subject literature has many dimensions. An example of these statistical techniques is the study of authorship patterns in a subject literature. This is of primary importance in understanding the structure of the subject field. In communication system, authors contributing to a subject field constitute a population. Within this population may emerge patterns such as single and multiple authorship. Studies in this area of statistical techniques (Bibliometrics) have made useful discoveries which shed more light in our knowledge of structure of subject literatures (Subramanyam, 1983). When two or more authors jointly produce a publication, the act is operationally termed as collaboration.

Authorship pattern is important for scientists and researchers to know the research work, hence, authorship pattern of scientific literature was analysed in order to determine the number of authors (both single and joint collaborative) contributing their work for analysis and statistical interpretation.

Authorship pattern was analysis to determine the percentage of corporate, single and multiple authors and the number of anonymous papers.

Following concepts have been used in this section in relation to authorship pattern viz.

1.Single author
2.Collaborator
3.Authorship credit
4.Principle author
5.Status of authorship
6.Most prolific author
7.Collaboration co-efficient
8.Salton index
9.Equivalence index.

The above terminology can be defined as under.

1. Single author

The word single author, single authorship is used synonymously. Single author is against multi author.

Single author means an author who writes an article in journals or periodicals or writes a book and expresses his own views is called single author.

2. Collaborator

Collaborative research is one of the characteristics of modern science. "It can apparently be measured adequately from multiple authorship of papers". There have been a number of studies which analysed and interpreted the trends in multiple authorship, thus indicating the trend towards collaborative research in different disciplines of Science and Technology.

3. Authorship credit

The credit given to each author of a collaborative paper. Normally each author figuring in a collaborative paper gets one credit regardless of the position as first or last in the byline.

4. Principle author

The common author among the authors forming a collaborative group. (Munnoli and Kalyane, 2003).

5. Status of authorship

The position of the author, i.e. first, second, third, etc. sequence in the byline of a paper. (Munnoli and Kalyane, 2003).

It is assumed that the first author plays a major role in a research project. Where international collaboration exists, Indian researchers shoulder different responsibilities in each case of collaboration, such as a team member or as a team leader. Mostly, a team leader holds the position of the first author in the research output and team members hold the subsequent position.

6. Most prolific Author

Most prolific author is a collaborator of a principal author, but he produces more publications than the other collaborators.

7. Collaboration co-efficient

The terms collaboration coefficient and degree of collaboration are used synonymously. The degree of collaboration was defined as the ratio of the number of collaborative research papers to the total number of research papers in the discipline during a certain period of time (Rana and Agarwal, 1994). The extent of degrees of collaboration in research is measured with the help of the formula derived by Subramanyam. According to this formula

$$C = \frac{N_m}{N_m + N_s}$$

Where

C= Degree of collaboration in a discipline.

N_m= Number of multiauthored research paper in the discipline published during a certain period.

N_s = Number of single authored research papers in the discipline published during the same period.

Collaboration coefficient means the ratio of the number of collaborative papers to the total number of papers published (Munnoli and Kalyane, 2003).

The degree of collaboration varies from one discipline to another. It is generally high in the intensely collaborative scientific and technical fields, but low in humanities in which the lonely scholar, working without the trappings of "big science" still produces much of the scholarly literature (Garfield, 1979).

Collaboration in research is said to have taken place when two or more persons work together on a scientific problem or project and effort, both physical and intellectual. Depending upon the types of participants, their status and location, etc. following possible kinds of collaborations are identified by Subramanyam.

1) Teacher-pupil collaboration;
2) Collaboration among colleagues;
3) Supervisor-assistant collaboration;
4) Researcher-consultant collaboration;
5) Collaboration between or among organizations; and
6) International collaboration.

8. Salton Index

"A Statistical measure of the co-author strength in a cluster. This has been calculated using the formula

$$Sij = \frac{Cij}{\sqrt{Ci} * Cj}$$

9. Equivalence Index

A Statistical measure of the linkage/ association between two authors in a cluster. EI for a pair of authors (a key author and one co-author) has been calculated using the formula:

$$Eij = \frac{(Cij)^2}{Ci * Cj}$$

Where (Ci) and (Cj) are respectively the frequencies of occurrence of the author (i) and (j).

To measure the authorship pattern following parameters were considered, viz.

1 .Year wise authorship

2. Single Vs Multiple authorship

3. Department wise authorship
4. Institution wise authorship
5. Country wise authorship
6. Most prolific author
   - Salton Index
   - Equivalence Index
   - Collaboration co-efficient
7. Status of Authorship
8. Authorship position of key authors

MATERIALS AND METHODS

Author Productivity

The term author productivity, scientific productivity, publication productivity and trends of publications are used synonymously. A well known productivity indicator is the number of publications produced by scientists, institutions, or research groups. Regarding the author productivity one can say that, author productivity means "authors productiveness or author's efficiency in publication". In other words author productivity can be explained as the effectiveness of productive efforts to produce fruitful publication. Scientometric and Bibliometric techniques have become tools to evaluate the productivity of research institutes, individual researcher, as well as to map the growth of the research field.

To analyze author productivity following parameters were considered.

1. Rank list of authors
2. Rank list of authors: Author at any position
3. Rank list of authors: Author at first position
4. Bradford's Law
5. Lotka's Law
6. Price square root law of scientific productivity
7. Year wise productivity and growth of literature
8. Year wise productivity of Key authors
9. Gender wise productivity
10. Chi square test
11. Subject wise productivity
12. Department wise productivity
13. Institution wise productivity
14. Country wise productivity

1. Rank list of authors

In the age of science, there is competition. Every person has to prove himself physically, economically and intellectually fit. Intellectual mapping shows the rank of person.

An attempt was made to analyze the total publications of authors writing in Antimicrobial Agents and Chemotherapy Journal, to see who is the topper in publications. The collected data has been analysed under the headings.

Rank list of authors: Author at any position;

Rank list of authors: Author at first position.

Rank list of Authors: Author at any Position

In antimicrobial agents and chemotherapy journal in all 44119 authors have contributed 20114 papers, i.e. 2.19 authors per paper and 0.45 papers per author. Attempt has been further made to rank the authors in the decreasing order of productivity, which is shown in table no. 1.

Table No. 1. Rank list of Authors: Author at any position

Rank	Authors	Total	Percentage
1	Appelbaum, Peter.C	156	0.78
2	Courvalin, Patrice.M	133	0.66
3	Nordmann, Patrice	132	0.66
4	Jones, Ronald.N	131	0.65
5	Mitsuhashi, Susumu	123	0.61
6	Drusano, George.L	113	0.56
7	Jacobs, Michael R	112	0.56
8	Neu, Harold.C	106	0.53
9	Clercq, Erik.DE	101	0.5
10	Walsh, Thomas.J	97	0.48
11	Poirel, Laurent	96	0.48
12	Barry, Arthur.L	85	0.42
12	Moellering, Robert.C	85	0.42
13	Thornsberry,Clyde	81	0.4
14	Rybak, Michael J	80	0.4
15	Bergeron, Michel.G	79	0.39
16	Bodey, Gerald.P	77	0.38
16	Carbon, Claude	77	0.38
16	Eliopoulos, George M.	77	0.38
16	Wise, Richard	77	0.38
17	Schinazi, Raymond.F	73	0.36
18	Stevens, David.A	72	0.36
19	Bush, Karen	70	0.35
20	Inoue, Matsuhisa	68	0.34
21	Baquero, Fernando	67	0.33
21	Goldstein, Ellie.J.C	67	0.33
21	Graybill, John.Richard	67	0.33
22	Sanders, Christine.C	64	0.32
23	Rinaldi, Michael G	63	0.31
24	Citron, Diane M	62	0.31
24	Pfaller, Michael.A	62	0.31
24	Rossolini, Gian Maria	62	0.31

The table no. 1.shows authors from amongst 44119 authors at any position. Authors only upto 24th rank have been presented. It was found that Appelbaum, Peter. C has published maximum, i.e. 156 publications, and is topper amongst all authors. Courvalin, Patrice.M 2nd in rank followed by Nordmann, Patrice, Jones Ronald. N, Mitsuhashi Susumu in 3rd, 4th and 5th rank respectively.

The table no. 1. represents authors belonging to Editorial Board in Bold letters. Eliopulos, George. M is chief editor of this journal. He has published 77 papers at any position. It was observed that from the year 1972 to 2010 the journal had 554 experts on the editorial board. Of 554 experts, 408 have published 7136 articles in the journal, and i.e. from amongst editorial board 73.65% have published their papers in the journal. It can be further noted from the table 4.2.1.1.1 that upto 15th rank, 12 are from the editorial board as well as first two ranked viz. Appelbaum, Peter. C, Courvalin, Patrice.M are from editorial board. This indicates that "Experts on editorial board write more papers in the journal" is valid.

Rank List of Authors: Author at first position

Attempt was made to arrange the authors appearing at first-position in decreasing order of productivity in the journal under study, In all there were 11764 authors with 31 ranks, however, the table 2 represents only first 16 ranks.

Table No. 2: Rank list of Authors: Author at first position

Rank	Name of the Authors	Total No. of Papers	Percentage	Cumulative Total of Paper
1	Goldstein, Ellie.J.C	55	0.27	55
2	Neu, Harold.C	54	0.27	109
3	Wise, Richard	47	0.23	156
4	Poirel, Laurent	39	0.19	195
5	Barry, Arthur.L	38	0.19	233
6	Jones, Ronald.N	37	0.18	270
7	Fass, Robert.J	35	0.17	305
8	Pankuch, Glenn A	30	0.15	335
9	Drusano, George L	28	0.14	363
10	Andes, David. R	23	0.11	386
10	Jorgensen, James.H	23	0.11	409
11	Clemons, Karl.V	22	0.11	431
12	Eliopoulos, George M	21	0.1	452
12	Kaatz, Glenn W	21	0.1	473
13	Bayer, Arnold.S	20	0.1	493
13	Fuchs, Peter.C	20	0.1	513
13	Roberts, Marilyn C	20	0.1	533
14	Bergeron, Michel.G	18	0.09	551
14	Graybill, John.R	18	0.09	569
14	Jacoby, George.A	18	0.09	587
14	Pfaller, Michael.A	18	0.09	605
14	Rastogi, Nalin	18	0.09	623
14	Rice, Louis B	18	0.09	641
14	Sanders, Christine.C	18	0.09	659
14	Schinazi, Raymond F	18	0.09	677
15	Barchiesi, Francesco	17	0.08	694
15	Giacometti , Andrea	17	0.08	711
15	Zhanel, George G	17	0.08	728
16	Bodey, Gerald.P	16	0.08	744
16	Clercq, Erik.De	16	0.08	760
16	Ji, Baohong	16	0.08	776
16	Wexler, Hannah M	16	0.08	792

It can be noted from the Table. 2 that from amongst 11764 authors appearing at first position. Goldstein, Ellie.J.C has published maximum, i.e. 55 publications, is topper amongst all Authors. Neu, Harold.C Stood 2nd in rank followed by Wise Richard, Poirel Laurent, Barry Arthur. L in 3rd, 4th and 5th rank repressively. The Table. 2 also shows the authors on editorial board in bold letters. Eliopulos, George. M is chief editor of this journal. He has published 21 papers at first position. It was observed that from the year 1972 to 2010 of the total 554 experts representing editorial

board of the journal, 307 having first position in authorship have published 1645 papers, i.e. 55.42% experts from editorial board have published their papers having first position in authorship. It can be further noted from the Table 2. that upto 15th rank, 19 authors are from editorial board. This indicates that "Experts on editorial board write more papers in the journals" is valid.

Bradford's Law

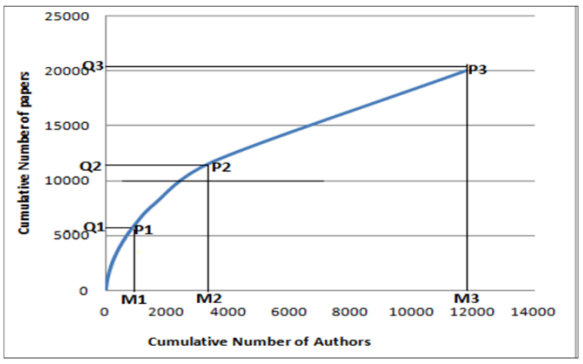
In 1934 Samuel Clement Bradford has formulated the law of Scattering to describe the distribution of articles on a particular subject in different periodicals. His article, "Sources of information on specific subject" was the first publication on observation on scattering. He explained his empirical law as:

"If scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of three zones and succeeding zones will be 1:n: n^2."

In the present set of data number of authors have been arranged in order of decreasing productivity of articles. They were divided in a nucleus of 3 equal zones. Which is shown in Table No. 4.2.2.1 Numbers of articles in each zone were more or less equal, while number authors were increasing in each zone. Which means the data verbally fits into the Bradford's law, however, the data does not fit into the Bradford's law mathematically, hence attempt has been made to represent the data graphically.

Bradford's Law of Scattering

Zones	No. of Papers	No. of Authors
I	6671	1178
II	6671	3916
III	6672	6670



Bradford's graph of cumulative number of papers versus cumulative number of authors is given here. The rising part of the graph represents the highly productive authors. The point's p_1, p_2, and p_3 on graph are the boundaries of three equiproductive zones in which the same number of articles are covered while number of authors in each zones are in increasing order.

The attempt was made to test applicability of Bradford's Law of scattering, as shown in figure no. 2.. The total numbers of 20014 publications of 11764 authors were divided into 3 equal zones, while number of authors writing similar numbers of papers in each zone are increasing which indicates that data does not fits into the Bradford's law of scattering.

The figure 2. is a graph showing on x axis cumulative number of authors while on y axis cumulative number of papers & a graph was plotted. From y axis a perpendicular was drawn on the graph showing three equal zones of papers i.e. Q_1P_1, Q_2P_2, Q_3P_3: Again from x-axis a perpendiculars were drawn intersecting the points M_1P_1, M_2P_2, M_3P_3. It can be observed that M_1P_1 first zone covers 1178 authors, M_2P_2 second zone covers the next 3916 authors and third zone M_3P_3 covers the rest of the 6670 authors.

According to Bradford, the relationship between the zones is 1: a: a^2 while the relationship in each ones of the present studies is 1178: 3916: 6670 which does not fit into the Bradford's distribution mathematically, but data fits into Bradford's Law verbally.

Table No. 3: Productivity of authors based on Lotka's Law

Total No. of Papers	Observed No. of Authors	Expected No. of Authors
1	8258	8258
2	1899	2064.5
3	727	917.55
4	337	516.125
5	186	330.32
6	97	229.38
7	61	168.53
8	49	129.03
9	33	101.95
10	22	82.58
11	20	68.24
12	19	57.34
13	8	48.86
14	3	42.13
15	13	36.7
16	4	32.25
17	3	28.57

18	8	25.48
19	0	22.87
20	3	20.64
21	2	18.72
22	1	17.06
23	2	15.61
24	0	14.33
25	0	13.12
26	0	12.21
27	0	11.32
28	1	10.53
29	0	9.81
30	1	9.17
31	0	8.59
32	0	8.06
33	0	7.58
34	0	7.14
35	1	6.74
36	0	6.37
37	1	6.03
38	1	5.71
39	1	5.42
40	0	5.16
41	0	4.91
42	0	4.68
43	0	4.46
44	0	4.26
45	0	4.07
46	0	3.9
47	1	3.73
48	0	3.58
49	0	3.43
50	0	3.3
51	0	3.17
52	0	3.05
53	0	2.93
54	1	2.83
55	1	2.72

Determination of Estimated Proportion of Authors

Having found the value of α, Lotka'a fraction $1/n^{\alpha}$ was summed up for all the values of N= α applying Euler-Maclauring formula of summation. Then the sum was used as diviser for 1/n to determine the proportion of the total number of authors who should be expected to produce n papers (in the case of present study, (n=1, 2, 3, 4…55). Following formula was used to find the proportions, first the value of S was calculated by using the formula;

$S= \Sigma 1/n^{\alpha} = \Sigma 1/n^{3.65} = 1.111007146$

$n=1 \quad n=1$

For present study where S=sum of Lotka's modified ratio for the value of α =3.65 which is equal to 1.111007146.

The expected number of authors (An) was calculated for present set of data by using the formula:

$$An = \frac{1/n^{\alpha}}{S} \times T$$

Where α is the productivity constant T is total number of authors An is the total number of expected authors producing n papers.

Where n=1, 2, 3, 4, 5…..55 the values for An are shown in table no. 4.2.3.2

Application of Statistical Tests

After the values of α, S and proportions of authors (An) were determined, observed and estimated values of the proportions were statistically tested by applying chi-square test and K.S. Test as shown in table no. 3.

Table No. 4 Productivity Trend: Proportion of Authors

No. of Contributions	No. of authors observed	Observed	Sn(X)	No. of authors expected (An)	Expected	Fo (X)	{Fo(x) - Sn(x)}	Maximum
1	8258	0.702151178	0.70215	10595.4955	0.900901	0.900901	0.198751	
2	1899	0.161465862	0.86362	844.037587	0.071766	0.9726668	0.109050939	
3	727	0.061814472	0.92543	192.144825	0.016337	0.9890043	0.063573924	
4	337	0.028654026	0.95408	67.2360672	0.005717	0.9947211	0.040636765	
5	186	0.015814982	0.9699	29.7769873	0.002532	0.997253	0.027353624	
6	97	0.008247598	0.97815	15.3062643	0.001301	0.9985544	0.020407469	
7	61	0.005186634	0.98333	8.71993856	0.000741	0.9992958	0.015962263	
8	49	0.004166312	0.9875	5.35600278	0.000455	0.9997512	0.012251355	
9	33	0.002805884	0.99031	3.48446504	0.000296	1.0000475	0.009741744	
10	22	0.001870589	0.99218	2.37203597	0.000202	1.0002492	0.008072841	
11	20	0.001700536	0.99388	1.67508932	0.000142	1.0003916	0.006514733	
12	19	0.001615509	0.99549	1.21929761	0.000104	1.0004953	0.005002897	

13	8	0.000680214	0.99617	0.91103912	7.75E-05	1.0005728	0.004400145	
14	3	0.00025508	0.99643	0.69463065	5.91E-05	1.0006318	0.004204127	
15	13	0.001105348	0.99753	0.53999306	4.59E-05	1.0006777	0.003144693	
16	4	0.000340107	0.99787	0.42666138	3.63E-05	1.000714	0.002840863	
17	3	0.00025508	0.99813	0.34196583	2.91E-05	1.0007431	0.002614859	
18	8	0.000680214	0.99881	0.27757262	2.36E-05	1.0007667	0.001958246	
19	0	0	0.99881	0.22786133	1.94E-05	1.0007861	0.00197762	
20	3	0.00025508	0.99906	0.18895648	1.61E-05	1.0008021	0.001738606	
21	2	0.000170054	0.99923	0.15813239	1.34E-05	1.0008156	0.001581998	
22	1	8.50268E-05	0.99932	0.13343768	1.13E-05	1.0008269	0.001508317	
23	2	0.000170054	0.99949	0.11345266	9.65E-06	1.0008366	0.00134791	
24	0	0	0.99949	0.0971293	8.26E-06	1.0008448	0.001356169	
25	0	0	0.99949	0.08368358	7.12E-06	1.0008519	0.001363284	
26	0	0	0.99949	0.0725218	6.17E-06	1.0008581	0.001369451	
27	0	0	0.99949	0.0631893	5.37E-06	1.0008635	0.001374823	
28	1	8.50268E-05	0.99957	0.05533431	4.7E-06	1.0008682	0.001294501	
29	0	0	0.99957	0.04868202	4.14E-06	1.0008723	0.001298641	
30	1	8.50268E-05	0.99966	0.04301587	3.66E-06	1.000876	0.001217271	
31	0	0	0.99966	0.03816375	3.24E-06	1.0008792	0.001220516	
32	0	0	0.99966	0.03398786	2.89E-06	1.0008821	0.001223406	
33	0	0	0.99966	0.03037704	2.58E-06	1.0008847	0.001225989	
34	0	0	0.99966	0.02724101	2.32E-06	1.000887	0.001228305	
35	1	8.50268E-05	0.99974	0.02450603	2.08E-06	1.0008891	0.001145362	
36	0	0	0.99974	0.02211145	1.88E-06	1.000891	0.001147242	
37	1	8.50268E-05	0.99983	0.02000714	1.7E-06	1.0008927	0.001063917	
38	1	8.50268E-05	0.99991	0.01815144	1.54E-06	1.0008942	0.000980433	
39	1	8.50268E-05	1	0.01650956	1.4E-06	1.0008956	0.00089681	
40	0	0	1	0.01505228	1.28E-06	1.0008969	0.00089809	
41	0	0	1	0.01375499	1.17E-06	1.0008981	0.00089926	
42	0	0	1	0.01259683	1.07E-06	1.0008992	0.000900331	
43	0	0	1	0.0115601	9.83E-07	1.0009001	0.000901314	
44	0	0	1	0.01062965	9.04E-07	1.000901	0.000902217	
45	0	0	1	0.00979255	8.33E-07	1.0009019	0.00090305	
46	0	0	1	0.00903764	7.68E-07	1.0009026	0.000903818	
47	1	8.50268E-05	1.00008	0.00835534	7.1E-07	1.0009034	0.000819502	
48	0	0	1.00008	0.00773732	6.58E-07	1.000904	0.00082016	
49	0	0	1.00008	0.00717638	6.1E-07	1.0009046	0.00082077	
50	0	0	1.00008	0.00666624	5.67E-07	1.0009052	0.000821337	
51	0	0	1.00008	0.00620141	5.27E-07	1.0009057	0.000821864	
52	0	0	1.00008	0.00577709	4.91E-07	1.0009062	0.000822355	
53	0	0	1.00008	0.00538908	4.58E-07	1.0009067	0.000822814	
54	1	8.50268E-05	1.00017	0.00503366	4.28E-07	1.0009071	0.000738215	
55	1	8.50268E-05	1.00025	0.00470758	4E-07	1.0009075	0.000653588	
	11764	1.000255081		11771.67184	1.000906257			

The table depicts productivity trend with trend in proportion of authors where only first authors were considered with exponent value of $\alpha = 3.65$

Dmax =0.198751

Dmax = $\left| Fo(x) - Sn(x) \right| = 0.198751$

At 0.01 level of significance K-S. static = 1.63 / sqrt (11764) = 0.01503022 Dmax=0.198751>0.01503022

Therefore data does not fit into generalised form of lotka's law with exponent value of α=3.65.

RESULTS AND DISCUSSION

Of the total number of authors (authors at any position) it was found that Appelbaum, Peter.C has published maximum, i.e. 156 publications, and is topper amongst all authors. Second highest is Courvalin, Patrice.M followed by Nordman Patrice, Jones Ronald.N, Mitsuhashi Susuu in 3rd, 4th and 5th rank respectively.
From the year 1972 to 2010 the journal had 554 experts on the editorial board. Of 554 experts, 408 have published 7136 articles in the journal, i.e. from amongst editorial board 73.65% have published their papers in the journal. It was further noted that upto 15th rank, 12 are from the editorial board as well as first two ranked viz. Appelbaum, Peter.C, Courvalin, Patrice.M are from editorial board.
The rank of authors at first position based on the total number of publications, it was found that Goldstein, Ellie.J.C has published maximum, i.e. 55 publications, and is topper amongst all authors at first position. Second highest is Neu, Harold.C followed by Wise, Richard, Poirel Laurent, Barry Arthur,L in 3rd, 4th and 5th rank repressively.

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