A Bibliometric Analysis of Geographic Publication Variations in the *Journal of Cardiothoracic and Vascular Anesthesia* From 1990 to 2011

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Objective: **The bibliometrics of the anesthesiology literature has shifted substantially during the past 3 decades. The present authors analyzed the *Journal of Cardiothoracic and Vascular Anesthesia* (JCVA) at selected time intervals from 1990 to 2011 to quantify temporal variations in geographic publication patterns. The authors also determined whether previously described reductions in North American research productivity were accompanied by similar decreases in the number of other forms of publication in JCVA.**

Design: **An observational study.**

Setting: **Internet analysis.**

Interventions: **None.**

Measurements and Main Results: **The number of research articles, case reports and conferences, review articles, and letters in each issue of the journal were quantified in each of 4 time intervals consisting of consecutive 4-year periods (1990-1993, 1996-1999, 2002-2005, and 2008-2011). Forty-three countries published a total of 2,587 articles (ie, 1,141 research articles, 735 case reports, 175 review articles, and 536 letters) during the 4 time periods examined. Progressive decreases in the percentage of research articles, case reports, and letters, but not review articles, from North America were observed over time. Significant increases in the percentage of research articles and letters contributed by European authors in 2008 to 2011 were observed compared with 1990 to 1993. The percentage of all publications from the Middle East and Australasia increased significantly, whereas South America and Africa were relatively minor contributors to JCVA throughout the study period.**

Conclusions: **The present bibliometric analysis indicates that JCVA has changed from a journal that primarily published work from countries in North America and Europe to one in which the Middle East and Australasia now make a substantial number of contributions. These results suggest that JCVA has evolved into a truly international journal since its inception in 1987.**

KEY WORDS: ***anesthesia journals, bibliometrics, research, scholarship, scientific publication***

THE BIBLIOMETRICS OF THE anesthesiology literature has shifted substantially during the past 3 decades,[1] similar to that observed with other medical specialties.[2-4] An important study by Szokol et al[1] reported that the percentage of total basic science and clinical research articles published by American authors in the journals *Anesthesiology*, *Anesthesia and Analgesia*, and *Pain* decreased approximately 50% from 1980 to 2000 (from 80% to 40%).[1] This trend has continued during the past 10 years[5-7] in conjunction with a progressive increase in the quality of submissions from other countries.[1] For example, Feneck et al[5] documented a significant reduction in the research publication rate (−2.3% per year; 95% confidence interval, 3.4%–1.2%) from North America from 1997 to 2006.[5] The present authors[7] and others[6,8] established that US investigators now produce approximately 20% of the total research articles published in anesthesiology journals. The *Journal of Cardiothoracic and Vascular Anesthesia* (JCVA) appears to reflect this change in the publication of anesthesiology research.[9] Landoni et al[9] conducted a 10-year analysis of publication trends in JCVA, including editorials, clinical and basic science research articles, reviews, and correspondence. Their data suggested that a greater percentage of all JCVA publications, including research articles, were being submitted from countries outside of North America and Europe (termed the "rest of the world"), but the specific types of these publications were not quantified and their precise region of origin were not subjected to statistical analysis. The authors also did not evaluate publication data before 2000 to examine this phenomenon from a more long-term perspective. The present authors conducted a bibliometric analysis of JCVA at selected time intervals from 1990 to 2011 to quantify temporal variations in geographic publication patterns. The authors also determined whether previously described reductions in North American research productivity were accompanied by similar decreases in the number of other forms of publication in JCVA.

METHODS

All data were collected in June and July 2012. The number of research articles, case reports and conferences, review articles, and letters in each issue of the journal were quantified in each of 4 time intervals consisting of consecutive 4-year periods (1990-1993, 1996-1999, 2002-2005, and 2008-2011; the publication of JCVA began in 1987). Meta-analyses were included as research articles because these articles are becoming an increasingly important part of the literature despite the fact that they do not involve the collection and analysis of original data. New features that appeared in the journal were incorporated into an appropriate publication category. For example, diagnostic dilemmas were first published in the journal in 1993; these publications were categorized as case reports. Similarly, special articles and emerging technology reviews were incorporated into the review article category. Editorials and articles in the debate section ("Pro/Con") of the journal were not included because these submissions were solicited. Some letters were published exclusively in an electronic format in 2011; these letters also were included in the analysis. The corresponding author was used to determine each article's country of origin. The authors were able to reach an agreement on the article type and its country of origin for all publications included in the analysis without the need for consultation with a third-party intermediary. The world was divided into 6 major regions based primarily by continent (ie, North America, South America, Europe, Middle East, Australia-Asia, and Africa). The UK, Ireland, and Russian Federation were included in the European region. Australia and Asia were combined into a single region (Australasia) in which India and Sri Lanka were included.

Pearson chi-square tests (2×2) were used to sequentially compare categoric variables between each time interval. The null hypothesis was

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Table 1. Publications by Country

	Research Articles (%)	Case Reports (%)	Review Articles (%)	Letters (%)	All (%)
North America					
US	458 (40.1)	446 (60.7)	126 (72.0)	200 (37.3)	1230 (47.6)
Canada	58 (5.1)	25 (3.4)	6 (3.4)	15 (2.8)	104 (4.0)
South America					
Chile	5 (0.4)	0 (0)	0 (0)	7 (1.3)	12 (0.5)
Brazil	2 (0.2)	1 (0.1)	0 (0)	1 (0.2)	4 (0.2)
Argentina	2 (0.2)	0 (0)	0 (0)	1 (0.2)	3 (0.1)
Venezuela	1 (0.1)	0 (0)	0 (0)	0 (0)	1 (0.0)
Colombia	1 (0.1)	0 (0)	0 (0)	0 (0)	1 (0.0)
Europe					
Germany	96 (8.4)	24 (3.3)	5 (2.9)	13 (2.4)	138 (5.3)
Italy	64 (5.6)	22 (3.0)	3 (1.7)	24 (4.5)	113 (4.4)
UK	30 (2.6)	25 (3.4)	5 (2.9)	41 (7.7)	110 (4.3)
France	52 (4.6)	9 (1.2)	1 (0.6)	5 (1.0)	67 (2.6)
Netherlands	36 (3.2)	9 (1.2)	6 (3.4)	6 (1.1)	57 (2.2)
Belgium	27 (2.4)	17 (2.3)	1 (0.6)	10 (1.9)	55 (2.1)
Sweden	42 (3.7)	1 (0.1)	2 (1.1)	3 (0.6)	48 (1.9)
Spain	11 (1.0)	6 (0.8)	0 (0)	13 (2.4)	30 (1.2)
Switzerland	18 (1.6)	2 (0.3)	1 (0.6)	4 (0.8)	25 (1.0)
Finland	22 (1.9)	0 (0)	1 (0.6)	1 (0.2)	24 (0.9)
Greece	5 (0.4)	0 (0)	0 (0)	15 (2.8)	20 (0.8)
Denmark	10 (0.9)	2 (0.3)	2 (1.1)	0 (0)	14 (0.5)
Austria	5 (0.4)	7 (1.0)	0 (0)	1 (0.2)	13 (0.5)
Ireland	2 (0.2)	3 (0.4)	1 (0.6)	1 (0.2)	7 (0.3)
Poland	2 (0.2)	1 (0.1)	1 (0.6)	0 (0)	4 (0.2)
Norway	1 (0.1)	0 (0)	0 (0)	0 (0)	1 (0.0)
Russian Federation	1 (0.1)	0 (0)	0 (0)	0 (0)	1 (0.0)
Portugal	0 (0)	1 (0.1)	0 (0)	0 (0)	1 (0.0)
Hungary	0 (0)	0 (0)	1 (0.6)	0 (0)	1 (0.0)
Middle East					
Turkey	38 (3.3)	5 (0.7)	2 (1.1)	19 (3.5)	64 (2.5)
Israel	17 (1.5)	3 (0.4)	2 (1.1)	5 (1.0)	27 (1.0)
Lebanon	4 (0.4)	2 (0.3)	0 (0)	17 (3.2)	23 (0.9)
Saudi Arabia	1 (0.1)	1 (0.1)	0 (0)	3 (0.6)	6 (0.2)
Oman	1 (0.1)	3 (0.4)	0 (0)	1 (0.2)	5 (0.2)
Islamic Republic of Iran	1 (0.1)	0 (0)	0 (0)	0 (0)	1 (0.0)
Australasia					
India	24 (2.1)	63 (8.6)	1 (0.6)	74 (13.8)	162 (6.3%)
Japan	38 (3.3)	24 (3.3)	1 (0.6)	31 (5.8)	94 (3.6)
Australia	26 (2.3)	14 (1.9)	1 (0.6)	12 (2.2)	53 (2.1)
Korea	10 (0.9)	5 (0.7)	1 (0.6)	2 (0.4)	18 (0.7)
Singapore	6 (0.5)	7 (1.0)	0 (0)	3 (0.6)	16 (0.6)
China	7 (0.6)	0 (0)	0 (0)	5 (1.0)	12 (0.5)
Hong Kong	2 (0.2)	3 (0.4)	1 (0.6)	4 (0.8)	10 (0.4)
Taiwan	1 (0.1)	2 (0.3)	0 (0)	2 (0.4)	5 (0.2)
New Zealand	0	2 (0.3)	2 (1.1)	0 (0)	4 (0.2)
Sri Lanka	0	1 (0.1)	0 (0)	1 (0.2)	2 (0.1)
Africa					
South Africa	6 (0.5)	1 (0.1)	2 (1.1)	1 (0.2)	10 (0.4)
Total	1,141	735	175	536	2,587

rejected when $p < 0.05$. Statistical calculations were performed using NCSS 2001 software (NCSS, Kaysville, UT).

RESULTS

Forty-three countries published a total of 2,587 articles (ie, 1,141 research articles, 735 case reports, 175 review articles, and 536 letters) during the 4 time periods examined (Table 1). The United States (47.6% of the total), Chile (0.5%), Germany (5.3%), Turkey (2.5%), India (6.3%), and South Africa (0.4%) were the leading contributors to JCVA from the North American, South American, European, Middle Eastern, Australasian, and African regions, respectively (Table 1). Progressive decreases in the percentage of research articles, case reports, and letters, but not review articles, from North America were observed over time (Table 2). For example, although North American investigators contributed 147 of 258 research articles

Table 2. Publications by Time Interval and Geographic Region

	Research Articles (%)	Case Reports (%)	Review Articles (%)	Letters (%)	All (%)
1990-1993					
North America	147 (57.0)	112 (80.6)	19 (73.1)	72 (66.1)	350 (65.8)
South America	3 (1.2)	1 (0.7)	0 (0)	3 (2.8)	7 (1.3)
Europe	93 (36.1)	18 (13.0)	7 (26.9)	16 (14.7)	134 (25.2)
Middle East	4 (1.6)	1 (0.7)	0 (0)	7 (6.4)	12 (2.3)
Australasia	8 (3.1)	7 (5.0)	0 (0)	10 (9.2)	25 (4.7)
Africa	3 (1.2)	0 (0)	0 (0)	1 (0.9)	4 (0.8)
Total	258	139	26	109	532
1996-1999					
North America	138 (47.8)*	109 (68.6)*	39 (86.7)	65 (52.0)*	351 (56.8)*
South America	1 (0.4)	0 (0)	0 (0)	0 (0)	1 (0.2)
Europe	108 (37.4)	30 (18.9)	6 (13.3)	22 (17.6)	166 (26.9)
Middle East	7 (2.4)	3 (1.9)	0 (0)	8 (6.4)	18 (2.9)
Australasia	26 (9.0)*	17 (10.7)	0 (0)	24 (19.2)*	67 (10.8)*
Africa	1 (0.4)	0 (0)	0 (0)	0 (0)	1 (0.2)
Total	289	159	45	125	618
2002-2005					
North America	124 (42.9)*	90 (47.6)*†	26 (78.8)	27 (28.7)*†	267 (43.6)*†
South America	4 (1.4)	0 (0)	0 (0)	0 (0)	4 (0.7)
Europe	97 (32.8)	44 (23.2)*	4 (12.1)	30 (31.9)*†	175 (28.6)
Middle East	32 (10.8)*†	7 (3.7)	0 (0)	13 (13.8)	52 (8.5)*†
Australasia	37 (12.5)*	49 (25.9)*†	3 (9.1)	24 (25.5)*	113 (18.5)*†
Africa	2 (0.7)	0 (0)	0 (0)	0 (0)	2 (0.3)
Total	296	189	33	94	612
2008-2011					
North America	107 (35.9)*†	160 (64.5)*	48 (67.6)	51 (24.5)*†	366 (44.4)*†
South America	3 (1.0)	0 (0)	0 (0)	5 (2.4)	8 (1.0)
Europe	127 (42.6)*	37 (14.9)*	13 (18.3)	63 (30.2)*†	240 (29.1)
Middle East	19 (6.4)*†‡	3 (1.2)	4 (5.6)	17 (8.2)	43 (5.2)*†‡
Australasia	43 (14.4)*†	48 (19.4)*†	4 (5.6)	74 (35.5)*†	169 (20.5)*†
Africa	0 (0)	1 (0.4)	2 (2.8)	0 (0)	3 (0.4)
Total	298	248	71	208	825

*Significantly ($p < 0.05$) different from the corresponding value in 1990 to 1993.
†Significantly ($p < 0.05$) different from the corresponding value in 1996 to 1999.
‡Significantly ($p < 0.05$) different from the corresponding value in 2002 to 2005.

(57.0%) in 1990 to 1993, this total was significantly ($p < 0.05$) reduced in a time-dependent manner to 107 of 298 articles (35.9%) in 2008 to 2011. Similarly, the percentage of case reports from the United States and Canada decreased from 80.6% of the total in 1990 to 1993 to 47.6% in 2002 to 2005 before rebounding somewhat to 64.5% in 2008 to 2011. When combined with a decline in the percentage of letters contributed by North American authors (from 66.1% in 1990-1993 to 24.5% in 2008-2011), the percentage of the total number of JCVA publications from the United States and Canada declined from 65.8% in 1990 to 1993 to 44.4% in 2008 to 2011. In contrast to the North American data, European contributions to the journal were relatively constant. Modest but significant increases in the percentage of research articles and letters contributed by European authors in 2008 to 2011 were observed compared with 1990 to 1993. The percentage of all publications from the Middle East and Australasia increased significantly. Middle Eastern publications in JCVA increased from 2.3% of the total in 1990 to 1993 to 5.2% in 2008 to 2011 based primarily on an increase in research articles. Similarly, the percentage of total research articles (3.1%-14.4%), case reports (5.0%-19.4%), and letters (9.2%-35.5%) contributed by Australasian authors increased from 1990 to 1993 to 2008 to 2011. Countries in South America and Africa were relatively minor contributors to JCVA throughout the study period.

DISCUSSION

The current results from this JCVA bibliometric analysis show that the percentage of research articles contributed by North American investigators progressively declined from the early 1990s to date. These findings were anticipated because previous studies of the peer-reviewed anesthesia literature as a whole[1,5-7,10,11] indicated that the percentage of North American research articles has declined steadily during the past 3 decades. These observations alarmed many academic anesthesiology leaders and triggered pleas for new strategic approaches to revive research productivity[12-14] despite the fact that chronic personnel shortages, expanding services within and outside the operating room, reductions in nonclinical time, and the lack of grant funding continue to be identified as key factors hindering the research efforts of anesthesiology investigators.[15] Notably, the percentage of the total research articles contributed by North American authors in 2008 to 2011 (35.9%) remained greater than

reported in surveys of the entire anesthesiology literature. For example, Bould et al[6] reported that approximately 28% of all research articles originated from the United States and Canada in 2007 and 2008 in their survey of the 17 anesthesiology journals listed in the "anesthesiology" subject category of the Web of Knowledge Citation Reports (http://www.jcrweb.com) for 2008. Similarly, the present authors recently reported that US authors published approximately 22% of the world's anesthesia research articles in 2010.[7] These data suggest that JCVA may be a preferred venue for North American authors to publish their research findings despite the overall decline in the total percentage of research articles from the United States and Canada appearing in the *Journal*. The current results also show that North American contributions of case reports and letters to JCVA have declined over the past 20 years. Previous anesthesiology bibliometric analyses focused entirely on research productivity, and, as a result, whether similar trends in the publication of case reports, editorials, and correspondence have occurred in other journals currently is unknown. If subsequently shown in the anesthesia literature as a whole, such a trend may suggest evidence of a further erosion of scholarly activity in American and Canadian academic anesthesia departments beyond that already identified in basic science and clinical research.

In contrast to the declines noted in North American contributions to JCVA, European authors were steady and consistent contributors to the *Journal*; the data indicated that the percentage of total publications from European countries ranged from 25.2% in 1990 to 1993 to 29.1% in 2008 to 2011. These observations support those of Landoni et al,[9] who reported that approximately 27% of JCVA publications originated from Europe between 2000 and 2009. The current and previous[9] surveys showed that Germany, Italy, and the UK were the most frequent European contributors to JCVA. Of note, a modest but nevertheless significant increase in the percentage of total European research publications was observed in 2008 to 2011 (42.6%) compared with 2002 to 2005 (32.8%). The *Journal* became affiliated officially with the European Association of Cardiothoracic Anesthesiologists in 2008,[16] and this new affiliation may have prompted European investigators to submit more of their research efforts to JCVA as a result.

The authors' findings confirm and extend previous suggestions that JCVA has evolved into a truly international journal since its inception in 1987. Landoni et al[9] previously reported that contributions from the "rest of the world" (outside of the United States and Europe) appeared to increase steadily between 2000 and 2009. Specifically, the current data indicated that the percentage of total research articles from the Middle East (1.6%-6.4%) and Australasia (3.1%-14.4%) increased significantly in a time-dependent manner from 1990 to 1993 to 2008 to 2011 (Table 2). Turkey and Israel were the major research contributors from the Middle East, whereas India, Australia, and Japan produced the most research articles from this region of the world. The numbers of case reports and letters from Australasia also dramatically increased. Indeed, Australasia accounted for more than 20% of all JCVA publications in 2008 to 2011. Whether this trend will continue is unknown, but the *Journal*'s recent official affiliation with the Chinese Society of Cardiovascular and Thoracic Anesthesiologists[17] may serve to facilitate additional contributions from this large part of Australasia in future years.

The current results must be interpreted within the constraints of several potential limitations. The authors simply counted the number of research articles, case reports, review articles, and letters published in JCVA, but they did not conduct a formal assessment of the relative "quality" of these publication types[18,19] nor did they quantify how often these articles were cited in the peer-reviewed literature. Editorials and debate section opinions were not included in the present survey because such articles were most often solicited by the *Journal*'s editorial board, which, until recently, consisted primarily of US anesthesiologists. Indeed, the authors observed that North American authors contributed >93% of all editorials and "Pro/Con" articles published in JCVA during the study period (data not shown). Thus, inclusion of the editorial and debate article data may have inappropriately skewed the results. The authors did not conduct a formal analysis of economic considerations in geographic publication variations in JCVA. Bould et al[6] used economic data from the World Bank Data Development Group to identify high-, middle-, and low-income countries in their analysis of national representation in the anesthesia literature. For example, the authors[6] showed that middle-income countries, including India, Turkey, and China, contributed approximately 10% of the world's total number of articles published in 17 anesthesia journals during 2007 and 2008. The present results appear to support these findings because these middle-income countries contributed 9.1% of all articles published in JVCA in the present sample. The authors identified the country of origin of each publication using the corresponding author's location. Nevertheless, authors from more than 1 country may be contributors to a single article, and these additional countries were not included in the analysis. The authors did not differentiate between articles published by PhD researchers without clinical obligations affiliated with anesthesia departments and those by their physician colleagues. Not all articles published in JCVA originate from anesthesiology departments. The authors did not discriminate between articles submitted by anesthesiologists from those in other academic disciplines (eg, cardiac surgeons and cardiologists). JCVA is published in English and as such may discourage authors who are not fluent in this language from submitting their work to the *Journal*. Nevertheless, the present authors do not believe that this factor substantially affected JCVA publication trends because approximately 45% of all JCVA articles included in the analysis originated from countries in which English is not the primary language. Whether the results of this JCVA analysis are individually applicable to other anesthesiology journals is unknown and will require further study to ascertain.

In summary, the present results indicate that JCVA has changed from a journal that, in its early years, primarily published work from countries in North America and Europe to one in which the Middle East and Australasia currently

also make a substantial number of contributions. Although European publications in the *Journal* have remained stable, overall decreases in North American contributions to JCVA not only reflected previously described reductions in the number of basic science and clinical research articles appearing in the anesthesiology literature,[1,5-7,10,11] but also involved the publication of fewer case reports and letters. The changing geographic profile of publication during its 25-year history suggests that JCVA has become a global journal.

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