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SCIENTIFIC ARTICLE

A bibliometric analysis of the field of anesthesia during 2009–2018

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Abstract
Objective: The limited number of bibliometric studies in the literature have generally focused on the top-cited studies in the field of anesthesia, however, there is a lack of studies that made a holistic bibliometric evaluation of these works. The purpose of this study is to make a contemporary summary of the articles published in the field of anesthesia within the last 10 years through detailed bibliometric methods.
Methods: The articles published between the years 2009 and 2018 were downloaded from the Web of Science (WoS) database and analyzed using bibliometric methods. The literature review was conducted using the keyword ''Anesthesiology'' in the ''Research Area'' category via the advanced search option available in WoS. The relation between the number of publications of the countries and the Gross Domestic Products and Human Development Index values were analyzed using Spearman's correlation coefficient. The number of articles between the years 2019 and 2021 was estimated through linear regression analysis.
Results: A review of the literature indicated 41,003 articles in the Web of Science database. Estimations included 4,910 (3,971–5,849) articles for the year 2019. There was a high-level, positive significant correlation between the number of publications and Gross Domestic Product ($r = 0.776$, $p < 0.001$).
Conclusion: The findings show that countries with high income are effective in the field of anesthesia, which indicates a strong association between research productivity and economic development. Undeveloped and developing countries should be encouraged to conduct research in the field of anesthesia.

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PALAVRAS-CHAVE
Anestesia;
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Cientometria

Análise bibliométrica no campo da anestesiologia no período de 2009–2018

Resumo
Objetivo: Existe um número limitado de estudos bibliométricos na literatura, que no campo da anestesiologia, concentram-se de forma geral nos estudos mais citados. Entretanto, existem poucos estudos de avaliação bibliométrica holística dessas publicações. O objetivo do presente estudo foi fazer um resumo contemporâneo dos artigos publicados no campo da anestesiologia nos últimos 10 anos usando métodos bibliométricos detalhados.
Método: Os artigos publicados entre 2009 e 2018 foram extraídos do banco de dados *Web of Science* (WoS) e analisados usando métodos bibliométricos. A revisão da literatura foi conduzida usando o unitermo ''*Anesthesiology*'' (Anestesiologia) na categoria ''Research Area'' (Área de Pesquisa) via a opção de busca avançada disponível no WoS. A relação entre o número de publicações de cada país e os valores do Produto Interno Bruto e Índice de Desenvolvimento Humano foi analisada usando o coeficiente de correlação de Spearman. O número de artigos para os anos de 2019 a 2021 foi estimado através de análise de regressão linear.
Resultados: A revisão da literatura encontrou 41.003 artigos no banco de dados *Web of Science*. As estimativas incluíram 4.910 (3.971–5.849) artigos para o ano de 2019. Houve correlação de alto grau, positiva, significante entre o número de publicações e Produto Interno Bruto ($r = 0{,}776$; $p < 0{,}001$).
Conclusões: Os achados mostram que países de alta renda são efetivos no campo da anestesiologia, indicando uma forte associação entre a produtividade em pesquisa e desenvolvimento econômico. Países não desenvolvidos ou em desenvolvimento devem ser estimulados a conduzir pesquisa no campo da anestesiologia.

Introduction

Evaluation of the knowledge in literature is becoming more and more difficult for researchers every day because there are an increasing number of scientific publications and the access to medical literature has become easier. Although the review of the literature has become easier with the development of internet-based search engines, making a holistic evaluation and accessing important publications about a topic or field is not always that easy in searches performed with keywords.[1,2] Bibliometric analyses enable the measurements of the quality and quantity of the publications conducted by individuals, institutions, and countries.[3,4] Such analysis reveals various types of information such as contemporary research, effective journals, the collaboration between countries, institutions, and authors and citation and co-citation networks.[5–7]

The science of Anesthesiology is a scientific field that considers patient safety before, during and after any surgical intervention and focuses on the whole care, including the elimination of pain. The first written document in the field of anesthesia was written in 1847 by John Snow.[8] Since that day, Anesthesia has become a rather wide discipline with its various research areas, which increases the number of studies every day. The limited number of bibliometric studies in the literature have generally focused on the top-cited studies in the field of anesthesia, clinical studies in anesthesia departments, anesthetic medicine and the contribution of some countries to anesthesia research.[9–13] However, there is a lack of studies that made a holistic bibliometric evaluation of the works in the field of anesthesia. The purpose of this study is to make a contemporary summary of the articles published in the field of anesthesia within the last 10 years through detailed bibliometric methods, identify the top-cited publications in the field, and to identify the most influential journals,especially trend topics.

Methods

Bibliometric analyses were performed using the VOSviewer (Version 1.6.10) package program.[14] The articles published between the years 2009 and 2018 were downloaded from the Web of Science database (Web of Science Core Collection database maintained by Clarivate Analytics. Access date: 29.3.2019) and were analyzed using bibliometric methods. The literature review was conducted using the keyword ''Anesthesiology'' in the ''Research Area'' category using the advanced search option available in WoS [code: SU = (Anesthesiology) Refined by: Document Types: (Article) Indexes = SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan = 2009–2018]. Statistical analyses were conducted with SPSS (Version 22.0, SPSS Inc., Chicago, IL, USA, License: Hitit University). The relation between the number of publications of the countries and the Gross Domestic Product (GDP), Gross Domestic Product per capita (at purchasing power parity; GDP PPP), and Human Development Index (HDI) values was analyzed using the Spearman's correlation coefficient. A correlation coefficient of 0.90 to 1.00 was considered very high, 0.70 to 0.89 was considered high, 0.50 to 0.69 was considerate moderate and 0.26 to

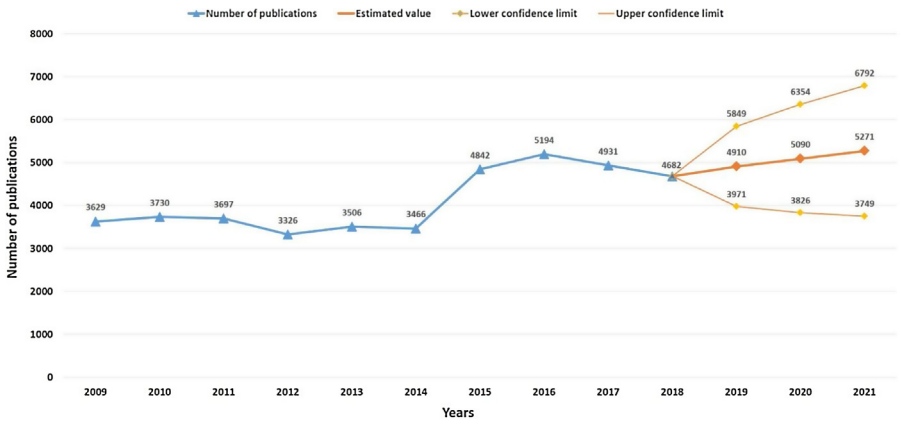

Figure 1 Number of publications by years in the field of anesthesia.

Figure 2 World map for the productivity of worldwide countries in the field of anesthesia.

0.49 was low. The number of articles to be published in the field of anesthesia between the years 2019 and 2021 was estimated through linear regression analysis. Statistical significance was taken $p < 0.05$.

Results

A review of the literature indicated 84,290 publications in the WoS (Web of Science) database, and those publications were retrieved for statistical analysis purposes. Distribution of these publications according to document type was found as article 41,003 (48.6%), letter 14,195 (16.8%), meeting abstract 12,121 (14.4%), editorial material 8,651 (10.3%), review 6,498 (7.7%), correction 995 (1.2%), proceedings paper 751 (0.9%), news item 208 (0.2%), biographical item 203 (0.2%), book review 60 (0.1%), book chapter 48 (0.1%) and other (retracted publication, retraction, reprint, bibliography: 48; 0.1%). Bibliometric analyses were performed with 41,003 publications in the article category. Of these publications, 36,799 (89.7%) were in English, which was followed by Czech 2697 (6.6%), French 981 (2.4%), Spanish 280 (0.7%), Portuguese 208 (0.5%), Turkish 25 (0.1%), and other (Slovak, Dutch, Italian, Polish) 10 (< 0.1%) languages.

Development of publications and citations

Fig. 1 demonstrates the distribution of the publications between 2009 and 2018. In addition, it displays publication estimations for the years between 2018 and 2021 with the confidence interval obtained through regression analysis. Estimations included 4,910 (3,971–5,849) articles for the year 2019, 5,090 (3,826–6,354) articles for the year 2020, and 5,271 (3,749–6,792) articles for the year 2021. Regression analysis results indicate that the number of articles in the field of anesthesia will exceed 5000 in 2021.

Active countries

Fig. 2 displays the publication distributions of the world countries in the field of anesthesia. The USA 11,835 (28.9%) was the country that made the top contribution to the field of anesthesia. The USA was followed by Germany 4,853 (11.8%), England 2745 (6.7%), Canada 2,652 (6.5%), France 2,568 (6.3%), Japan 2,176 (5.3%), Australia 1,984 (4.8%), China 1,875 (4.6%), India 1,782 (4.3%), Netherlands 1,436 (3.5%), South Korea 1,432 (3.5%), Italy 1,391 (3.4%), Denmark 1,086 (2.6%), Switzerland 1,048 (2.6%), Spain (1,021; 2.5%), Turkey (953; 2.3%), Sweden (877; 2.1%), Belgium (831;

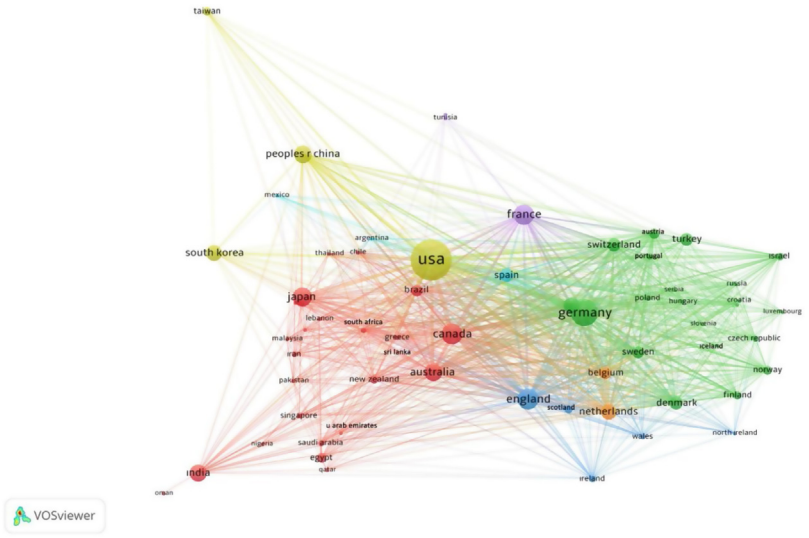

Figure 3 Network visualization map for international collaboration of worldwide countries in the field of anesthesia.

2%), Brazil (737; 1.8%), Austria (603; 1.5%), and Egypt (530; 1.3%).

A total of 159 countries produced publications in the field of Anesthesia. Fig. 3 displays the international collaboration analysis performed among the 79 countries that had at least 5 publications.

Active journals

There were 64 journals where these articles were published. Table 1 demonstrates the average number of citations calculated according to the proportion of number of citations and number of publications. Among these, 62 journals had at least 20 publications. The citations among these are given in the visualization map in Fig. 4.

Active organization

Table 2 demonstrates the top 15 Organizations and Organizations-Enhanced that produced the highest number of publications in the field of anesthesia. There were a total of 19,317 organizations that produced articles. Fig. 5 demonstrates the international collaboration cluster analysis of 66 organizations that had at least 150 publications.

Active authors

Table 3 demonstrates the authors that produced the highest number of articles in the field of anesthesia. Sessler DI, who published 231 articles, was the top author.

Citation analysis

Table 4 shows the top 15 documents according to the number of citations.

Trending topics

A total number of 38,790 words were used in the keywords sections of all articles. Table 5 demonstrates the frequency of these words use. In addition, a bibliometric analysis was performed with 134 keywords that were used at least 100 times, and Fig. 6 demonstrates the clusters and relations between these words. Fig. 7 shows the network visualization map of keywords by year. Fig. 8 displays the network visualization map of the keywords used in the top-cited articles.

Correlation analysis

There was a high-level, positive, and statistically significant correlation between the number of publications and GDP and GDP PPP ($r = 0.776$, $p < 0.001$; $r = 0.737$, $p < 0.001$, respectively). In addition, there was a moderate-level statistically significant correlation between the number of publications and HDI ($r = 0.649$, $p < 0.001$).

Discussion

This bibliometric analysis study has obtained important results that provide researchers in the field of anesthesia with a comprehensive analysis of the articles published in the field of anesthesia within the last decade.

As expected, the USA was the country that contributed to the field of anesthesia the most. The Fig. 2 demonstrating the publication productivity of the countries also indicates that the economic power of the countries is associated with their publication productivity. The correlation analysis also showed that there was a high correlation between the number of articles and GDP and GDP PPP, which confirmed this hypothesis. Thus, low income level of the countries has important effects on the low number of publications. Although the level of economic development is seen as an important factor in the number of publications, it was remarkable that countries such as China, India, Turkey,

Table 1 Active journals in the field of Anesthesia.

Journals	RC	C	AC	Journals	RC	C	AC
Anesthesiology	2106	61078	29.00	Korean Journal of Anesthesiology	290	655	2.26
Pain	2515	72586	28.86	Seminars in Cardiothoracic and Vascular Anesthesia	111	207	1.86
British Journal of Anaesthesia	1953	44637	22.86	Anaesthesiology Intensive Therapy	126	233	1.85
Chronic Pain and Addiction	8	176	22.00	Annals of Cardiac Anaesthesia	300	552	1.84
Current Opinion in Anesthesiology	342	7305	21.36	Anasthesiologie Intensivmedizin Notfallmedizin Schmerztherapie	739	1180	1.60
Anesthesia and Analgesia	3310	53972	16.31	Saudi Journal of Anaesthesia	347	538	1.55
Regional Anesthesia and Pain Medicine	819	13070	15.96	Indian Journal of Anaesthesia	460	713	1.55
Anaesthesia	1264	18915	14.96	A & A Case Reports	461	688	1.49
Clinical Journal of Pain	1118	16497	14.76	Journal of Pain & Palliative Care Pharmacotherapy	84	123	1.46
European Journal of Pain	1402	20590	14.69	Anasthesiologie & Intensivmedizin	341	481	1.41
European Journal of Anaesthesiology	886	11405	12.87	BJA Education	192	265	1.38
Pain Medicine	1792	21807	12.17	Anesthesiology Research and Practice	76	95	1.25
Journal of Neurosurgical Anesthesiology	402	4492	11.17	Revista Española de Anestesiología y Reanimación	289	321	1.11
Acta Anaesthesiologica Scandinavica	1382	15417	11.16	International Anesthesiology Clinics	56	57	1.02
Canadian Journal of Anesthesia/Journal canadien d'anesthesie	848	9350	11,02	Turkish Journal of Anaesthesiology and Reanimation	243	240	0.99
Pain Physician	856	9362	10.94	Trends in Anaesthesia and Critical Care	44	43	0.98
Minerva Anestesiologica	912	8322	9.13	Local and Regional Anesthesia	40	38	0.95
Pediatric Anesthesia	1255	11425	9.10	Acta Anaesthesiologica Belgica	74	59	0.80
Pain Practice	727	6308	8.68	Egyptian Journal of Anaesthesia	230	173	0.75
International Journal of Obstetric Anesthesia	501	4056	8.10	Douleur et analgesie	101	51	0.50
Anaesthesia and Intensive Care	960	6377	6.64	Anaesthesia and Intensive Care Medicine	276	123	0.45
Journal of Clinical Anesthesia	1032	6562	6.36	Southern African Journal of Anaesthesia and Analgesia	132	57	0.43

Table 1 (*Continued*)

Journals	RC	C	AC	Journals	RC	C	AC
Journal of Cardiothoracic and Vascular Anesthesia	1979	11889	6.01	Ja clinical reports	199	57	0.29
Journal of Clinical Monitoring and Computing	798	4354	5.46	Anaesthesia Pain & Intensive Care	302	82	0.27
Journal of anesthesia	1366	7439	5.45	Anesthesie & reanimation	226	58	0.26
BMC Anesthesiology	894	4232	4.73	A & A Practice	188	34	0.18
Schmerz	515	2380	4.62	Anesteziologie a Intenzivni Medicina	156	25	0.16
Anaesthesist	1040	4090	3.93	Pediatric Anesthesia and Critical Care Journal	73	10	0.14
Annales francaises d anesthesie et de reanimation	716	2626	3.67	Sri Lankan Journal of Anaesthesiology	95	8	0.08
Anaesthesia Critical Care & Pain Medicine	201	681	3.39	Indian anaesthetists forum	65	4	0.06
Best Practice & Research-Clinical Anaesthesiology	58	174	3.00	Ain Shams Journal of Anesthesiology	11	0	0.00
Brazilian Journal of Anesthesiology/Revista Brasileira de Anestesiologia	719	2156	3.00				

RC, Record Count; C, Number of Citation; AC, Average Citation.

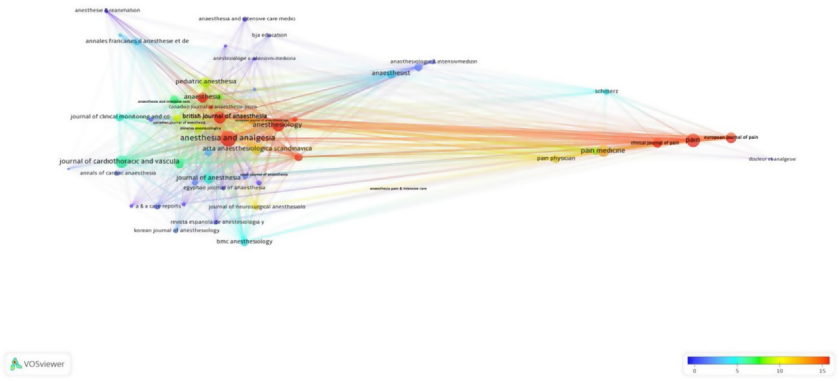

Figure 4 Network visualization map for citation analysis of active journals in the field of anesthesia.

Table 2 Active organizations and organizations-enhanced in the field of Anesthesia.

Organizations	RC	Organization-Enhanced	RC
University of Toronto	862	Harvard University	1415
Harvard University	683	University of Toronto	1026
University Washington	552	University of California System	997
Cleveland Clinic	505	Assistance Publique-Hôpitaux de Paris (AP-HP)	881
Stanford University	503	VA Boston Healthcare System	815
Mayo Clinic	474	Institut National de la Santé et de la Recherche Médicale	665
Massachusetts General Hospital	421	University of London	645
University of Pennsylvania	377	Cleveland Clinic Foundation	563
University of California, San Francisco	372	Massachusetts General Hospital	558
Duke University	368	University of Copenhagen	557
University of Pittsburgh	336	University of Washington	553
Mcgill University	331	University of Washington Seattle	553
Northwestern University	328	Stanford University	522
University of Copenhagen	325	Mayo Clinic	512
University of Melbourne	306	University Health Network Toronto	507

RC, Record Count.

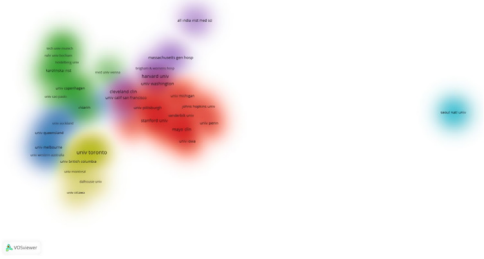

Figure 5 Cluster visualization map for the organizations in the field of anesthesia.

Brazil and Egypt had notable contributions to publication productivity.

A similar result was found in the study conducted by Swaminathan et al. (2007). In addition, similar to the results in the present study, the top three countries that made the biggest contribution to the literature were the USA, Germany, and Japan in this order.[10] According to the international collaboration analysis results between countries, Belgium-Netherlands, England-Ireland-Wales-North Ireland, Finland-Norway-Denmark-Sweden-Poland, for instance, were in the same cluster, which indicates that geographical location is one of the biggest factors for collaboration in the field of anesthesia.

Table 3 Active authors in the field of Anesthesia.

Authors	RC	Authors	RC
Sessler DI	231	Lee SH	88
Lee JH	158	Epstein RH	87
Dexter F	127	Jensen MP	84
Arendt-Nielsen L	108	Landoni G	84
Wulf H	106	Kranke P	80
Weiss M	105	Bauer M	78
Pagel PS	102	Roewer N	77
Kehlet H	96	Tobias JD	76
Kim SH	93	Turan A	76
Bein B	92	Gupta A	75
Rossaint R	91	Lee J	75
Kim HS	90	Maier C	75

RC, Record Count.

Table 4 The 15 most cited manuscripts in the field of Anesthesia.

N°	Article	Author	Journal	PY	TC	AC
1	Early exposure to anesthesia and learning disabilities in a population-based birth cohort	Wilder RT, Flick RP, Sprung J, et al.	Anesthesiology	2009	699	63.55
2	Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: Anaesthesia	Cook TM, Woodall N, Frerk C.	British Journal of Anaesthesia	2011	652	72.67
3	Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on management of the difficult airway	Group author(s): Amer Soc Anesthesiologists	Anesthesiology	2013	547	78.57
4	The evidence for pharmacological treatment of neuropathic pain	Finnerup NB, Sindrup SH, Jensen, TS	Pain	2010	543	54.40
5	Quantitative sensory testing in the German Research Network on Neuropathic Pain (DFNS): somatosensory abnormalities in 1,236 patients with different neuropathic pain syndromes	Maier C, Baron R, Toelle TR, et al.	Pain	2010	466	46.70
6	Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults	Frerk C, Mitchell VS, McNarry AF, et al.	British Journal of Anaesthesia	2015	443	88.80
7	Management of severe perioperative bleeding Guidelines from the European Society of Anaesthesiology	Kozek-Langenecker SA, Afshari A, Albaladejo P, et al.	European Journal of Anaesthesiol-ogy	2013	442	63.14
8	Sensitization in patients with painful knee osteoarthritis	Arendt-Nielsen L, Nie H, Laursen, MB, et al.	Pain	2010	434	43.60
9	Validity of four pain intensity rating scales	Ferreira-Valente, MA, Pais-Ribeiro, JL, Jensen MP.	Pain	2011	415	46.33
10	Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: intensive care and emergency departments	Cook TM, Woodall N, Harper J, et al.	British Journal of Anaesthesia	2011	385	42.89

Table 4 (*Continued*)

N°	Article	Author	Journal	PY	TC	AC
11	Consensus guidelines for the management of postoperative nausea and vomiting	Gan, TJ, Diemunsch, P, Habib, AS, et al.	Anesthesia and Analgesia	2014	384	64.00
12	Major complications of central neuraxial block: report on the Third National Audit Project of the Royal College of Anaesthetists	Cook TM, Counsell D, Wildsmith JAW. Group author(s): Royal Coll Anaesthetists Third Nat	British Journal of Anaesthesia	2009	383	34.82
13	Long-term consequences of postoperative cognitive dysfunction	Steinmetz J, Christensen, KB, Lund T, et al. Group author(s): ISPOCD Grp	Anesthesiology	2009	364	33.18
14	Practice guidelines for acute pain management in the perioperative setting: an updated report by the American Society of Anesthesiologists Task Force on acute pain management	Ashburn MA, Caplan RA, Carr, DB, et al.	Anesthesiology	2012	362	45.13
15	Relationship between intraoperative mean arterial pressure and clinical outcomes after noncardiac surgery: toward an empirical definition of hypotension	Walsh M, Devereaux PJ, Garg, AX, et al.	Anesthesiology	2013	362	51.86

PY, Publication Year; TC, Total Citation; AC, Average Citations per Year.

Table 5 The first 134 trend keywords in the field of Anesthesia.

Keyword	O	Keyword	O	Keyword	O	Keyword	O
Pain	1656	Fibromyalgia	248	Rocuronium	153	Headache	116
Chronic pain	1208	Hyperalgesia	243	Ventilation	149	Meta-analysis	116
Anesthesia	949	Sedation	243	Congenital heart disease	146	Spinal cord stimulation	116
Anaesthesia	682	Depression	227	Hemodynamics	143	Anesthesiology	115
Neuropathic pain	662	Critical care	218	Quantitative sensory testing	142	Pain assessment	115
Opioid	661	Bupivacaine	212	Sugammadex	142	Thoracic surgery	115
Cardiac surgery	652	Ultrasonography	209	Complex regional pain syndrome	136	Laryngoscopy	114
Analgesia	623	Fentanyl	207	Inflammation	135	Osteoarthritis	114
Propofol	579	Postoperative	206	Transfusion	135	Allodynia	113
Complication	571	Morphine	205	Analgesics	134	Bispectral index	113
Dexmedetomidine	566	Spinal anesthesia	204	Postoperative analgesia	133	Elderly	113
Pediatric	502	Postoperative complications	198	Epidemiology	132	Liver transplantation	113
Children	488	Acute pain	196	Migraine	131	Perioperative care	113
Postoperative pain	445	Airway	195	General anaesthesia	130	Resuscitation	112
Surgery	430	Anxiety	195	Intensive care unit	129	Assessment	111
Cardiopulmonary bypass	401	Sepsis	195	Randomized controlled trial	129	Back pain	111
Sevoflurane	388	Acute kidney injury	188	Pediatric anesthesia	128	Laryngeal mask airway	111
Ultrasound	373	Regional anesthesia	188	Spinal anaesthesia	127	Pain measurement	109
Intubation	368	Nerve block	187	Dexamethasone	126	Bleeding	108
General anesthesia	349	Caesarean section	186	Disability	125	Levobupivacaine	108
Airway management	340	Cesarean section	186	Infant	125	Nociception	107
Pain management	322	Echocardiography	185	Midazolam	125	Pregabalin	106
Intensive care	315	Lidocaine	183	Regional anaesthesia	125	Survey	106
Monitoring	312	Pharmacokinetics	181	Spinal cord	123	Spinal	105
Low back pain	294	Risk factors	178	Trauma	123	Blood pressure	104
Outcome	287	Education	169	Cancer pain	122	Blood transfusion	104
Mortality	286	Ropivacaine	165	Cardiac arrest	121	General	104
Transesophageal echocardiography	274	Safety	165	Epidural analgesia	121	Cancer	103
Cardiac output	272	Quality of life	162	One-lung ventilation	120	Central sensitization	103
Remifentanil	266	Difficult airway	161	Postoperative nausea and vomiting	120	Clonidine	103
Ketamine	263	Hypotension	160	Chronic low back pain	118	Regional	102
Child	262	Obesity	156	Delirium	118	Hypothermia	100
Pregnancy	256	Mechanical ventilation	155	Extracorporeal membrane oxygenation	118		
Epidural	248	Patient safety	154	Equipment	117		

O, Number of occurrences.

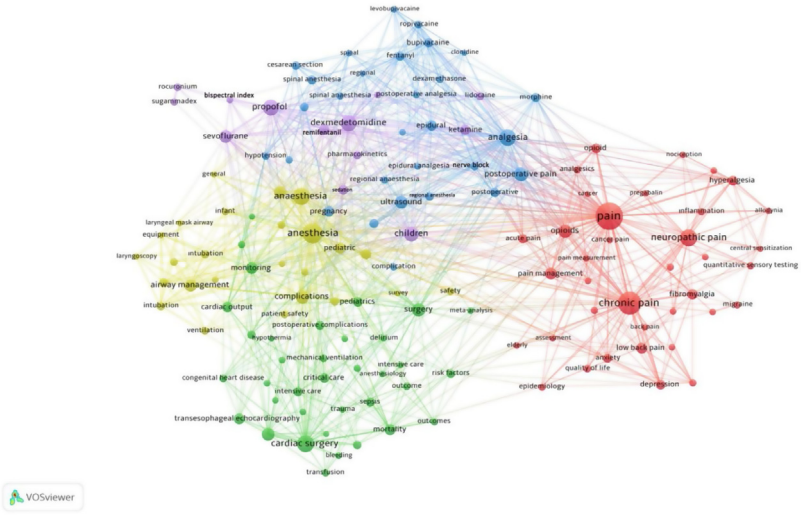

Figure 6 Cluster map for keyword analysis in the field of anesthesia.

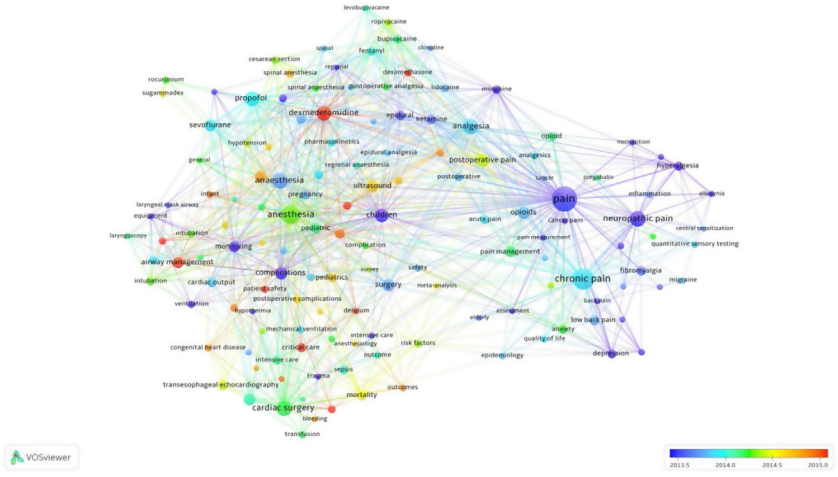

Figure 7 Network visualization map for trends based on keyword analysis in the field of anesthesia.

The top five journals that produced the highest number of publications in the field of anesthesia within the last decade were Anesthesia and Analgesia, Pain, Anesthesiology, Journal of Cardiothoracic, Vascular Anesthesia and British Journal of Anaesthesia respectively. The five top-cited journals according to the number of total citations were Pain, Anesthesiology, Anesthesia and Analgesia, British Journal of Anaesthesia and Pain Medicine. Anesthesiology, Pain, British Journal of Anaesthesia, Chronic Pain and Addiction, Current Opinion in Anesthesiology, Anesthesia and Analgesia, Regional Anesthesia and Pain Medicine, Anaesthesia, Clinical Journal of Pain and European Journal of Pain were found to be the most influential journals according to the number of citations per publication. Researches could consider these journals in order to receive more citations and increase the visibility of their studies.

The institutions that made the highest contributions to the literature were the University of Toronto, Harvard University, University of Washington, Cleveland Clinic, and Stanford University. Collaboration between universities also demonstrated the effect of geographical region. Sessler DI, Anonymous Lee JH, Dexter F, Arendt-Nielsen L, Wulf H, Weiss M, and Pagel PS were the authors who made more than 100 article contributions within the last decade.

The article entitled ''Early exposure to anesthesia and learning disabilities in a population-based birth cohort'', published in the Journal of Anesthesiology and written by Wilder et al. (2009) was most cited article.[15] It was followed by the study entitled ''Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: Anesthesia'', written by Cook et al. (2011) and published in the Journal of British Journal of Anesthesia.[16] According to the average number of citations per year, the top effective study was the article entitled ''Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults'' in the British Journal of Anesthesia, written by Frerk et al. (2015).[17]

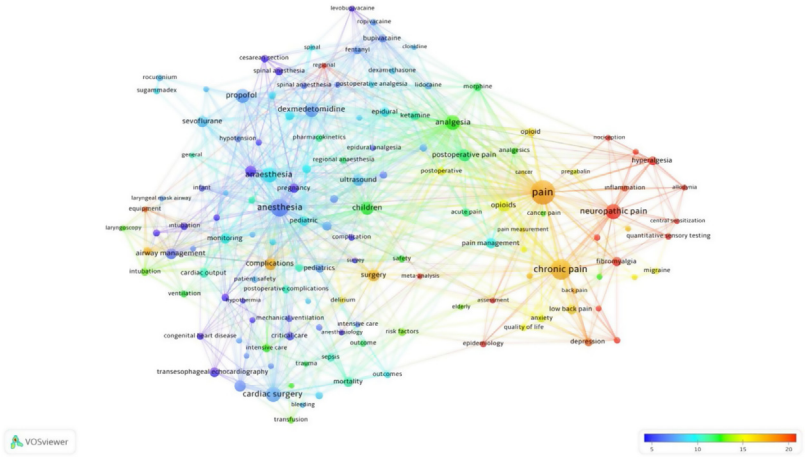

Figure 8 Network visualization map for the most cited keyword in the field of anesthesia.

According to the keyword analysis results, the trend keywords were found as dexmedetomidine, dexamethasone, ultrasonography, critical care, delirium, acute kidney injury, patient safety, airway management, and difficult airway. Dexmedetomidine, a relatively new medicine whose use has been increasing, is an α2-adrenergic receptor agonist and wide-spectrum sedative; the medicine is widely used in intensive care units and delirium treatment.[18] Through the trials using ischemic and inflammatory response models, dexmedetomidine was reported to have an anti-inflammatory effect with protective properties against ischemia/reperfusion injury.[19] With its increasing use in the field of anesthesia, there was an increase in the number of publications about dexmedetomidine what led it to take place among the keywords that were trends in critical care and delirium.

Due to its anti-inflammatory, anti-allergic, immunosuppressive functions and effects on almost every organ, dexamethasone is a frequently used medicine group. Corticosteroids have numerous known and proven effects on all systems.[20] The fact that they take an important place as the trend keywords in the field of anesthesia is considered a result from its wide effect mechanism as well as its wide use in regional anesthesia practices that became even more practical with Ultrasonography (USG).

Decreasing the loss in health sector caused by medical errors to minimum and monitoring and recording the cases that threaten patient and worker safety and enhancing patient safety is an issue that recently became increasingly important. This case has also been approved by the number of articles published. Patient safety will always maintain its popularity, as long as medicine and patient exist.

The keywords found in the top-cited articles were: neuropathic pain, fibromyalgia, hyperalgesia, allodynia, complex regional pain syndrome and regional. The majority of the cited topics were about pain. It is important to have good knowledge about pain mechanisms so that it could be possible to manage pain, which has a wide definition and affects a large section of the community. Although the wide use of USG accelerated the studies about regional anesthesia and pain, what is known about the pain and its physiopathology is still less than what is not known. Therefore, studies on pain seem to increase.

Conclusion

The findings show that countries with high income are effective in the field of anesthesia, which indicates a strong association between research productivity and economic development. In other words, strong economy seems to increase scientific outcomes in the field of anesthesia. Undeveloped and developing countries should be encouraged to conduct research in the field of anesthesia. Parallel to the increasing importance of anesthesia, this study is the first one to investigate the scientific productivity performance and make a holistic evaluation in the field of anesthesia. We believe that such studies conducted at certain intervals are beneficial in terms of improving expertise and identifying the goals. This study provides doctors, academics and students in the field of anesthesia with important information about the last decade of anesthesia.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent

For this type of study formal consent is not required.

Conflicts of interest

The authors declare no conflicts of interest.

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References

1. Muslu Ü, Demir E. Development of rhinoplasty: yesterday and today. Med Sci. 2019;23:294–301.
2. Demir E. The evolution of spirituality, religion and health publications: yesterday, today and tomorrow. J Relig Health. 2018;58:1–13.
3. Doğan G, İpek H. The development of necrotizing enterocolitis publications: a holistic evolution of global literature with bibliometric analysis. Eur J Pediatr Surg. 2019, http://dx.doi.org/10.1055/s-0039-3400514 [Online ahead of print].
4. Ozsoy Z, Demir E. The evolution of bariatric surgery publications and global productivity: a bibliometric analysis. Obesity Surg. 2018;28:1117–29.
5. Yıldırım E, Demir E. Comparative bibliometric analysis of fertility preservation. Ann Med Res. 2019;26:1622–8.
6. Doğan G, Kayır S. Global scientific outputs of brain death publications and evaluation according to the religions of countries. J Relig Health. 2019, http://dx.doi.org/10.1007/s10943-019-00886-8 [Online ahead of print].
7. Demir E, Comba A. The evolution of celiac disease publications: a holistic approach with bibliometric analysis. Irish J Med Sci. 2019, http://dx.doi.org/10.1007/s11845-019-02080-x [Online ahead of print].
8. Snow J. On the inhalation of the vapour of ether in surgical operations. Br J Anaesth. 1953;25:53–4.
9. Tripathi RS, Blum JM, Papadimos TJ, et al. bibliometric search of citation classics in anesthesiology. BMC Anesthesiol. 2011;11:24.
10. Swaminathan M, Phillips-Bute BG, Grichnik KP. A bibliometric analysis of global clinical research by anesthesia departments. Anesth Analg. 2007;105:1741–6.
11. Bould MD, Boet S, Riem N, et al. National representation in the anaesthesia literature: a bibliometric analysis of highly cited anaesthesia journals. Anaesthesia. 2010;65:799–804.
12. Vlassakov KV, Kissin I. Scientometrics of anesthetic drugs and their techniques of administration, 1984–2013. Drug Des Devel Ther. 2014;8:2463.
13. Moppett IK, Hardman JG. Bibliometrics of anaesthesia researchers in the UK. Br J Anaesth. 2011;107:351–6.
14. Van-Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics. 2010;84:523–38.
15. Wilder RT, Flick RP, Sprung J, et al. Early exposure to anesthesia and learning disabilities in a population-based birth cohort. Anesthesiology. 2009;110:796–804.
16. Cook TM, Woodall N, Frerk C. Fourth National audit project. Major complications of airway management in the UK: results of the fourth national audit project of the royal college of anaesthetists and the difficult airway society. Part 1: anaesthesia. Br J Anaesth. 2011:106617–31.
17. Frerk C, Mitchell VS, McNarry AF, et al. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. Br J Anaesth. 2015;115:827–48.
18. Gertler R, Brown HC, Mitchell DH, et al. Dexmedetomidine: a novel sedative-analgesic agent. Proc (Bayl Univ Med Cent). 2001;14:13–21.
19. Taniguchi T, Kidani Y, Kanakura H, et al. Effects of dexmedetomidine on mortality rate and inflammatory responses to endotoxin-induced shock in rats. Crit Care Med. 2004;32:1322–6.
20. Samancı N, Balcı N. Corticosteroids and their use in clinical practice. Turkiye Klinikleri J Med Sci. 2001;21:131–40.