Scientific Production in Cerebrospinal Fluid Leak (Rhinorrhea and Otorrhea) from 1945 to 2018

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Abstract

BACKGROUND: To analyze research activity on cerebrospinal fluid (CSF) leaks in general and CSF rhinorrhea and otorrhea in particular, and to identify the main topic clusters in these areas.

METHODS: We identified all documents using the medical subject heading "Cerebrospinal Fluid Leak" indexed in the MEDLINE database between 1945 and 2018. We performed a descriptive bibliometric analysis and analyses of networks and research clusters in order to identify the main topic areas of research.

RESULTS: From 1945 to 2018 a total of 4130 records were published with the term CSF, including 2821 documents (68.1%) with the term CSF rhinorrhea and 1040 documents (25.8%) with CSF otorrhea. The number of documents published increased from 10 in 1945-49 to 642 in 2010-14. Articles were the dominant document type (86.8% of the documents analyzed), while case reports were the main type of study (37.4%). In terms of geographic distribution, researchers from the United States of America (USA) led in the number of signatures (39.06%), followed by those from the United Kingdom (UK) (7.49%). The most active areas of research in the field were "Postoperative Complications," "Tomography, X-Ray Computed," and "Magnetic Resonance Imaging." The terms "Adults," "Young Adult," and "Middle Aged" were most common in CSF rhinorrhea research; and the terms "Infant," "Child, Preschool," "Child," and "Adolescent" were more common in CSF otorrhea.

CONCLUSIONS: Articles and case reports related with "Surgery" and "Postoperative Complications" associated with diagnosis are the main topic of study, highlighting the importance of this document type in advancing knowledge.

Background

Cerebrospinal fluid (CSF) leak is a discharge of cerebrospinal fluid through a hole in the skull bone, most commonly draining from the nose (CSF rhinorrhea) or from the ear (CSF otorrhea), occurring either through the external auditory meatus or through the eustachian tube into the nasopharynx) [21]. Common etiologies of CSF rhinorrhea include trauma, neoplasms, and prior surgery, while CSF otorrhea is usually associated with craniocerebral trauma, neurosurgical procedures or other conditions; however, both conditions may occur spontaneously [9]

The past few decades have seen an increase in research publications in the field of otorhinolaryngology [8] Bibliometrics, too, has consolidated as a discipline enabling the analysis of scientific activity in a particular field or area of knowledge through the quantification of the bibliographic characteristics of scientific publications [5] Several studies have analyzed the scientific production of otorhinolaryngology and head-neck surgery [3, 17, 18] and neurosurgery [1, 2, 7, 11, 15, 16, 23]. Moreover, there are several publications focusing specifically on the activity in different countries, including African countries [1]. Other manuscript analyze specific research topics neurosurgery, like central nervous system arteriovenous malformations [15], idiopathic intracranial hypertension [16], endoscopic third

ventriculostomy [23] carotid artery stenting [2] pituitary adenoma [7] o IDEAL framework in neurosurgery [11]

One of the areas that has seen significant development within bibliometrics is the generation of visual representations, networks and maps of scientific activity [5]. These have great analytic potential, helping to characterize the structures, groupings and interconnections between the elements under analysis, including the descriptors assigned to the documents, such as in the present study. Although bibliometric indicators have been used to approach the study of numerous diseases [5, 6], this methodology has not been applied to research on the well-known condition of CSF, which encompasses surgical, diagnostic, and therapeutic-radiological aspects, among others.

The aim of this study is to describe the scientific production on CSF leak through bibliometric indicators, using the documents indexed in the MEDLINE database between 1945 and 2018. We analyze the evolution in the number of publications, the publication types, the document categories of clinical interest, the journals of publication, the geographic distribution of the research and the topics addressed according to the different types of CSF leak (CSF rhinorrhea and CSF otorrhea) by means of co-word maps.

Methods

Identification of documents on “Cerebrospinal Fluid Leak”

The first step of this study was to identify the documents about CSF leak in the MEDLINE database, the main database of reference for researchers and professionals in the health sciences. It is an open access resource that permits, through the use of the medical subject headings (MeSH) thesaurus, the precise identification of documents that address the concepts under analysis as well as the contents of those documents. The CSF leak descriptor was included in 2005. This term encompasses the specific terms “Cerebrospinal Fluid Rhinorrhea” and “Cerebrospinal Fluid Otorrhea,” both included in 1966. The searches of indexed documents with any of these three descriptors took place on the Clarivate Analytics Web of Science (WOS) platform, which includes the MEDLINE database, on January 21, 2019.

The Clarivate Analytics WOS platform provides information on the institutional affiliation of all authors. With this strategy, 4155 documents were retrieved, but we excluded 25 editorials, leaving 4130 documents to be analyzed. The analysis of the scientific production by country was limited to the 3019 documents (73.1%) included in WOS database.

Standardization of bibliographic information

Using the bibliographic information from the retrieved documents, we created a relational database to standardize the bibliographic data and calculate the study variables, with special attention to the following fields:

- **Publication type** (field: Publication Type). Based on the information collected from this field, we classified the records according to the document types (articles, reviews and letters) as well as the clinical approach (case reports, clinical trials, controlled clinical trials, evaluation studies, meta-analysis, observational studies, practice guidelines, randomized clinical trials, and validation studies).
- **Institutional affiliation of papers included in WOS** (field: Author Address). This field includes information relating to the institutional affiliation of the authors signing the documents. Although all institutional affiliations have been available for papers published in MEDLINE since 2014, we aimed to study and present the information using a standard approach, so we limited the analysis to the papers included in the WOS.
- **Descriptor**s (fields: MeSH Terms [MH] and MeSH Subheadings (also called qualifiers) [SH]). We differentiated the MeSH from the subheadings or topic qualifiers (82 auxiliary descriptors that specify the aspect being addressed in relation to the MeSH terms) and identified the descriptors assigned with respect to CSF leak, CSF rhinorrhea, and CSF otorrhea.

Calculation of indicators

A) Bibliometric indicators on scientific production

To analyze the scientific activity of the area, we determined the number of documents published each year, the journal of publication, the document types, the clinical approach to the study, and the countries of the authors signing the documents. This information generates a picture of the scientific activity, the media used (scientific journals), and the weight of countries leading the research—in general and according to the different types of CSF (rhinorrhea or otorrhea).

B) Topic analysis

To characterize the research in the area at a topic level, we determined the frequency with which the descriptors assigned to the documents appeared for each group: the generic CSF leak group and the specific document groups on CSF rhinorrhea and CSF otorrhea. We constructed topic maps to analyze the relationship between the descriptors and the research groups around them, that is, the existing research clusters, approaches, and specializations. This process had the following steps:

- Determination of the co-occurrence of the descriptors assigned to the documents and generation of a matrix of absolute values. The joint assignment of two descriptors in a single document implies a thematic affinity, as both aspects are addressed simultaneously in the same paper.
- Elimination of generic descriptors. We eliminated some excessively generic descriptors that did not describe relevant information on content or that presented a high density of relationships with the rest of the descriptors.

- Visual representation of the network. To establish the existing topic clusters in the area and represent them visually, we used a clustering algorithm in the VOSViewer program, which helps to detect the communities (clusters) within a network, made up of groups of homogeneous items that are strongly related to each other [21].

Statistical analysis

We compared the MeSH terms in CSF rhinorrhea and CSF otorrhea documents using the Chi-squared test. P values of less than 0.05 were considered statistically significant. We used statistical software SPSS version 22.0 for analysis.

Ethical considerations

Due to the nature of the study and dataset, it was not necessary to obtain informed consent or approval from an institutional ethics committee

Results

Bibliometric indicators

Evolution of production

From 1945 to 2018, 4130 articles were published with the CSF leak terms. The term CSF rhinorrhea was in 2821 documents (68.1%) and CSF otorrhea, in 1040 (25.8%). Both terms were present in 316 documents, while 269 documents used only the generic CSF leak descriptor. Figure 1 shows the evolution of the number of documents published on CSF leak.

Publication type distribution

The main publication type was article, which encompassed 86.8% (n = 3584) of the documents; followed at a considerable distance by review, which made up 9.4% (n = 390); and letter, at 3.8% (n = 156). With regard to the type of clinical research, 37.4% (n = 1544) of the documents were case reports; 1.7% (n = 74), clinical trials; 0.6% (n = 48), evaluation studies; and 0.5% (n = 19), meta-analyses. The rest of the study types presented only negligible values (10 observational studies, 8 validation studies, and 2 practice guidelines).

Journal distribution and thematic categories

The documents were published in 735 different journals. The main journals were *World Neurosurgery/Surgical Neurology* (n = 178), *Laryngoscope* (n = 176), *Journal of Neurosurgery* (n = 134), *Otology & Neurotology/American Journal of Otology* (n = 124), and *Otolaryngology-Head and Neck Surgery* (n = 101). These five journals published 16.8% of the documents. Moreover, there were 371 journals with just one document, which together represented 9.0% of the total. Table 1 presents details of the top 17 journals at least 1.0% of the total documents on CSF leak. About three-quarters of the

documents (n = 3019, 73.1%) were published in journals included in the WOS *Journal Citation Reports*. The three main WOS categories were Otorhinolaryngology (29.3%), Surgery (20.7%), and Clinical Neurology (19.8%), followed by Medicine, General & Internal (5.9%) and Radiology, Nuclear Medicine & Medical Imaging (5.2%).

Table 1
The 17 top-ranking journals (≥ 1% research production) in research production on cerebrospinal fluid leak

Top 15 journals	N docs	% docs	Impact factor 2018	Journal category (ranking, 2018)
*World Neurosurgery/Surgical Neurology**	178	4.3	1.723	Clinical Neurology (151/199) Surgery (111/203)
Laryngoscope	176	4.1	2.343	Medicine. Research & Experimental Medicine (78 of 136) Otorhinolaryngology (12 of 42)
Journal of Neurosurgery	134	3.1	4.204	Clinical Neurology (41/199)
*Otology & Neurotology / American Journal of Otology***	124	3.0	2.063	Clinical Neurology (134/199) Otorhinolaryngology (21/42)
Otolaryngology-Head and Neck Surgery	101	2.3	2.310	Otorhinolaryngology (13/42) Surgery (72/203)
Journal of Laryngology and Otology	88	2.0	1.261	Otorhinolaryngology (33/42)
Acta Neurochirurgica	86	2.0	1.834	Clinical Neurology (146/199) Surgery (106/203)
Neurosurgery	85	2.0	4.853	Clinical Neurology (31/199) Surgery (12/203)
Journal of Craniofacial Surgery	57	1.3	0.785	Surgery (181/203)
British Journal of Neurosurgery	53	1.2	1.481	Clinical Neurology (165/199) Surgery (130/203)
Otolaryngologic Clinics of North America	50	1.2	1.620	Otorhinolaryngology (20/42)
Annals of Otology, Rhinology, and Laryngology	49	1.1	1.458	Otorhinolaryngology (23/42)

* *World Neurosurgery* was called *Surgical Neurology* until 2010.

***Otology & Neurotology* was called *American Journal of Otology* 2012.

***Impact Factor from2009.

NI: not included in *Journal Citation Reports*

Top 15 journals	N docs	% docs	Impact factor 2018	Journal category (ranking, 2018)
International Journal of Pediatric Otorhinolaryngology	47	1.1	1.225	Otorhinolaryngology (34/42) Pediatrics (89/125)
No Shinkei Geka. Neurological Surgery	43	1.0	0.131***	Neuroscience (146/197) Surgery (106/203)
HNO	43	1.0	0.914	Otorhinolaryngology (37/42)
Ear, Nose & Throat Journal	43	1.0	1.375	Otorhinolaryngology (27/42)
Annales d'Oto-laryngologie et de Chirurgie Cervico-faciale	43	1.0	NI	
* *World Neurosurgery* was called *Surgical Neurology* until 2010.				
** *Otology & Neurotology* was called *American Journal of Otology* 2012.				
***Impact Factor from2009.				
NI: not included in *Journal Citation Reports*				

Geographical distribution

Of the 3019 included in WOS, 2578 showed the country of the institution writing the manuscript. Table 2 shows the number of documents published on CSF by the 15 most productive countries, both as a total and by type of CSF. Only 160 of the 2578 documents with country data (6.21%) show evidence of international collaboration. The leading country in total scientific production on CSF—as well as specific production on CSF rhinorrhea and CSF otorrhea—is the United States of America (USA), followed by the United Kingdom (UK). The other countries with the largest research contributions were Japan, Germany, Italy, and France, with little difference between CSF rhinorrhea and CSF otorrhea.

Table 2. Top 15 countries producing research on cerebrospinal fluid (CSF) leak, CSF rhinorrhea and CSF otorrhea (1945–2018), included in the Web of Science and providing institutional data

All documents* (n=2578)			CSF rhinorrhea (n=1619)			CSF otorrhea (n=585)		
Country	**N of docs**	**% of docs**	**Country**	**N of docs**	**% of docs**	**Country**	**N of docs**	**% of docs**
USA	1007	39,06	USA	612	37.8	USA	245	41.8
UK	193	7.49	UK	118	7.29	UK	61	10.43
Japan	166	6.44	Germany	113	6.98	Germany	46	7.86
Germany	142	5.51	Japan	86	5.31	Japan	28	4.79
Italy	128	4.96	Italy	83	5.13	France	26	4.44
France	110	4.27	France	79	4.88	Italy	18	3.08
China	101	3.92	Turkey	71	4.38	Canada	16	2.73
Turkey	99	3.84	India	64	3.95	South Korea	13	2.22
India	87	3.37	China	47	2.9	Switzerland	12	2.05
Canada	63	2.44	Switzerland	42	2.59	Turkey	12	2.05
South Korea	60	2.33	Canada	40	2.47	China	12	2.05
Spain	57	2.21	Spain	38	2.35	Spain	11	1.88
Switzerland	54	2.09	Australia	35	2.16	India	11	1.88
Australia	46	1.78	South Korea	32	1.98	Israel	11	1.88
Brazil	44	1.71	Brazil	29	1.79	Australia	10	1.71

UK: United Kingdom, USA: United States of America

* The totals in this column are smaller than those of CSF rhinorrhea and CSF otorrhea, because a one documents can be included in both MeSH

Topic analysi

MeSH distribution

The three principal MeSH terms in the field were “Postoperative Complications,” “Tomography, X-Ray Computed,” and “Magnetic Resonance Imaging.” MeSH terms that were significantly more common in documents relating to CSF rhinorrhea compared to CSF otorrhea were “Magnetic Resonance Imaging,” “Treatment Outcome,” “Endoscopy,” “Dura Mater,” “Neurosurgical, Procedures,” “Pituitary Neoplasms,” and “ Sphenoid Sinus.” The terms “Meningitis,” “Recurrence,” “Ear, Inner,” “Neuroma, Acoustic,” “Mastoid,” and “Otitis Media” appeared more frequently in relation to CSF otorrhea (Table 3).

Table 3
Top descriptors (medical subject headings, MeSH) and qualifiers assigned to papers on cerebrospinal fluid (CSF)leak, CSF rhinorrhea and CSF otorrhea (1945–2018)

	All documents*		CSF rhinorrhea		CSF otorrhea		P value
	N docs	% docs	N docs	% docs	N docs	% docs	
MeSH Term							
Postoperative Complications	1008	24.41	645	22.86	220	21.15	0.28
Tomography, X-Ray Computed	912	22.08	637	22.58	226	21.73	0.62
Magnetic Resonance Imaging	585	14.16	377	13.36	107	10.29	0.012
Treatment Outcome	582	14.09	369	13.08	99	9.52	0.003
Endoscopy	572	13,85	486	17.23	22	2.12	< 0.001
Skull Fractures	414	10.02	343	12.16	131	12.60	0.87
Meningitis	401	9.71	293	10.39	142	13.65	0.001
Skull Base	368	8.91	267	9.46	131	12.60	0.005
Fistula	351	8.50	269	9.54	92	8.85	0.55
Dura Mater	292	7.07	208	7.37	32	3.08	< 0.001
Neurosurgical Procedures	290	7.02	192	6.81	17	1.63	< 0.001
Pituitary Neoplasms	280	6.78	233	8.26	12	1.15	< 0.001
Sphenoid Sinus	248	6.00	233	8.26	6	0.58	< 0.001
Encephalocele	240	5.81	169	5.99	64	6.15	0.76
Craniocerebral Trauma	226	5.47	184	6.52	77	7.40	0.37
Recurrence	215	5.21	137	4.86	79	7.60	0.001
Ear. Inner	157	3.80	35	1.24	127	12.21	< 0.001
Neuroma. Acoustic	149	3.61	97	3.44	69	6.63	< 0.001
Mastoid	106	2.57	24	0.85	83	7.98	< 0.001
Otitis Media	86	2.08	7	0.25	80	7.69	0.001

* The totals in this column are smaller than those of CSF rhinorrhea and CSF otorrhea, because a one documents can be included in both MeSH

	All documents*		CSF rhinorrhea		CSF otorrhea		P value
	N docs	% docs	N docs	% docs	N docs	% docs	
Qualifiers							
Surgery	2540	61.5	1758	62.32	566	54.42	< 0.001
Etiology	2444	59.18	1622	57.5	631	60.67	0.082
Complications	1502	36.37	1035	36.69	410	39.42	0.13
Diagnosis	1226	29.68	858	30.41	358	34.42	0.019
Methods	1195	28.93	809	28.68	189	18.17	< 0.001
Diagnostic imaging	954	23.1	645	22.86	220	21.15	0.52
Adverse effects	727	17.6	441	15.63	136	13.08	0.21
Pathology	683	16.54	437	15.49	162	15.58	0.89
Injuries	504	12.2	377	13.36	120	11.54	0.43
Therapy	432	10.46	251	8.9	103	9.9	0.89
Prevention & control	385	9.32	254	9	102	9.81	0.97
Therapeutic use	347	8.4	225	7.98	100	9.62	0.62
Epidemiology	293	7.09	148	5.25	68	6.54	0.14
Abnormalities	292	7.07	142	5.03	149	14.33	< 0.001

* The totals in this column are smaller than those of CSF rhinorrhea and CSF otorrhea, because a one documents can be included in both MeSH

Qualifiers

The most common qualifiers were “Surgery” and “Etiology.” The qualifiers “Surgery” and “Methods” were significantly more common in CSF rhinorrhea, whereas “Abnormalities” was significantly more common in CSF otorrhea (Table 3).

Generic MeSH Terms

Table 4 shows the frequency of MeSH terms referring to human/animal research, female/male, age groups and type of study, in all CSF documents and by type of CSF. Most research was in humans. The proportion of documents relating to males and females is similar in CSF rhinorrhea and CSF otorrhea. By age, the terms “Infant,” “Newborn,” “Adults,” “Young Adult,” and “Middle Aged” are more common in CSF

rhinorrhea; and the terms “Infant,” “Child, Preschool,” “Child,” and “Adolescent” were significantly more common in CSF otorrhea. The most common MeSH terms describing the type of study was “Retrospective Studies” and “Follow-Up Studies,” with similar results in both types of CSF.

Table 4
Distribution of medical subject headings (MeSH) referring to type of research, gender, age group and type of study on cerebrospinal fluid (CSF) leak, CSF rhinorrhea and CSF otorrhea (1945–2018)

MeSH terms	All documents *		CSF rhinorrhea		CSF otorrhea		P value
	N docs	% docs	N docs	% docs	N docs	% docs	
Type of research							
Humans	889	97.91	2781	98.58	1029	98.94	0.42
Animals	25	2.75	41	1.45	11	1.06	0.42
Gender							
Female	601	66.19	1598	56.65	576	55.38	0.52
Male	594	65.42	1549	54.91	533	51.25	0.20
Age group							
Infant, Newborn	8	0.88	118	4.18	18	1.73	< 0.001
Infant	51	5.62	118	4.18	125	12.02	< 0.001
Child, Preschool	75	8.26	250	8.86	210	20.19	< 0.001
Child	117	12.89	453	16.06	288	27.69	< 0.001
Adolescent	164	18.06	578	20.49	246	23.65	0.023
Adult	432	47.58	1351	47.89	379	36.44	< 0.001
Young Adult	179	19.71	187	6.63	34	3.27	< 0.001
Middle Aged	479	52.75	1280	45.37	355	34.13	< 0.001
Aged	304	33.48	636	22.55	230	22.12	0.80
Aged, 80 and over	112	12.33	140	4.96	46	4.42	0.93
Type of study							
Retrospective Studies	297	32.71	451	15.99	157	15.10	0.53
Follow-Up Studies	111	12.22	272	9.64	96	9.23	0.61
Cohort Studies	23	2.53	32	1.13	7	0.67	0.21

* The totals in this column are smaller than those of CSF rhinorrhea and CSF otorrhea, because a one documents can be included in both MeSH

Visual representation of the network of MeSH terms

Figure 2a maps the general visual representation of the field under analysis, with the main MeSH terms and their ties. Among the most important links were “Treatment Outcome” and “Postoperative Complications” with “Reconstruction Surgical Procedure,” and with regard to diagnosis, “Tomography, X-Ray Computed” and “Magnetic Resonance Imaging.” In CSF rhinorrhea, the most important MeSH terms were “Tomography, X-Ray Computed,” “Endoscopy,” and “Postoperative Complications” (Fig. 2b). In CSF otorrhea the most important were “Tomography, X-Ray Computed,” “Retrospective Studies,” “Treatment Outcome,” and “Tempore Bone” (Fig. 2c).

Discussion

The number of articles published on CSF increased throughout the study period, which is normal, as most bibliometric analyses on other diseases also reveal an upward trend in the number of publications [3, 13, 10]. The most significant aspect to point out is the predominance of case reports (approx. 35%), which show similar values as for other surgical areas, such as maxillofacial surgery (31%) [10]. Individually, case reports are insufficient grounds on which to base treatment decisions, but when they are considered together and adequately codified and integrated into structured information systems, they can provide early insight toward characterizing rare diseases, as they allow physicians to compare cases and check diagnoses [5].

At a journal level, this study shows the important multidisciplinary approach in the area, as the three most prominent publications are journals of otorhinolaryngology, surgery, and clinical neurology. The multidisciplinary approach of the science is a scientific reality that has been associated with greater advances in knowledge, translation of results, and impact of research [4, 6].

The USA was the predominant country in research production, followed by various European countries (UK, Germany, France and Italy) and Japan. This situation is also apparent in the otolaryngology field [3, 17, 18], neurosurgery [2, 15, 16], as in other health sciences [3, 10]. The top countries did not include any from Africa, while the only Latin American country was Brazil. The top-contributing Asian countries (in addition to Japan) were India, China, and South Korea, while Turkey ranked eighth. A combination of factors can explain these observations. First of all, the USA emerges as the main point of reference in CSF, reflecting its global leadership in all scientific research spheres. Furthermore, the need to have a surgical structure to produce research in this field would favor the most developed countries to a greater extent [3, 7, 18].

The level of international collaboration was very low (6.21%), which highlights the need to develop surgical structures that favor the promotion of research in countries with less scientific development and implement strategies that favor multidisciplinary collaboration [4].

With regard to the MeSH terms, CSF rhinorrhea was the main branch, while surgery and postoperative complications were the most important sub-topics. Relevant topics related to managing patients with CSF were otorhinolaryngology and clinical neurology [21]. Research also focused on identifying risk factors and assessing different treatments and their outcomes, as shown by the terms related to etiology ("Skull Fracture" of "Skull Base"), diagnosis (especially via "Tomography, X-Ray Computed" or "Magnetic Resonance Imaging"), treatment ("Treatment Outcome" or "Endoscopy"), and complications (meningitis).

There is difference in the patient profile of research in CSF rhinorrhea and CSF otorrhea, with the former area concentrating on older patients ("Adult" or "Middle Age"). Spontaneous CSF rhinorrhea is associated with increased intracranial pressure and considered a manifestation of idiopathic intracranial hypertension in middle-aged people, whereas secondary CSF rhinorrhea is associated with trauma in the same age group [12]. On the other hand, CSF otorrhea research focused on the "Infant," "Child, Preschool," "Child" and "Adolescent" age groups, reflecting the fact that CSF otorrhea can be primary and in most of cases is secondary to pediatric skull base fractures [19]. Thus, even though CSF rhinorrhea and CSF otorrhea are included under the same umbrella MeSH term, the profile of research is quite different in these sub-fields.

The main limitation of this study was that we did not analyze citations, with a focus on the journals with the highest impact and dissemination at an international level; this perspective would be necessary to reach a truly comprehensive view of research in the field. [10] Likewise, other aspects could also be considered, such as co-authorship networks or gender disparities in scholarly productivity [6, 18]

Conclusion

The present study has revealed some features that differ notably from bibliometric analyses on other clinical pathologies: the predominant interest in surgery and the weight of clinical case reports, which emerge as the primary channel for generating and disseminating knowledge in the field. Postoperative complications, diagnostic aspects related to computerized tomography and magnetic resonance imaging, treatment outcomes, and surgery procedures such as endoscopy were also topics of interest. The USA led research production, while European countries and emerging countries such as China contributed less than in other research areas.

Abbreviations

CSF: Cerebrospinal fluid

MeSH: medical subject headings

MH: MeSH Terms

SH: MeSH Subheadings

UK: United Kingdom

USA: United States of America

WOS: Web of Science

Declarations

Ethics approval and consent to participate

For this type of study formal consent is not required.

Consent for publication

All the authors give their consent for publication

Availability of data and material

J.M. Ramos-Rincon has full access to and is the guarantor for the data. The datasets generated are available from the corresponding author on reasonable request.

Competing interests

None declared

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Authors' contributions

Conceptualization: JMRR, GGA. Formal analysis: JMRR, IMC, JAO, JTGA, IBR and GGA. Methodology: JMRR, IBR, and GGA. Visualization: JMRR, IMC and GGA. Writing ± original draft: JMRR, IMC and GGA, Writing ± review & editing: JMRR, IMC, JAO, JTGA, IBR and GGA. All authors have read and approved the manuscript

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Figures

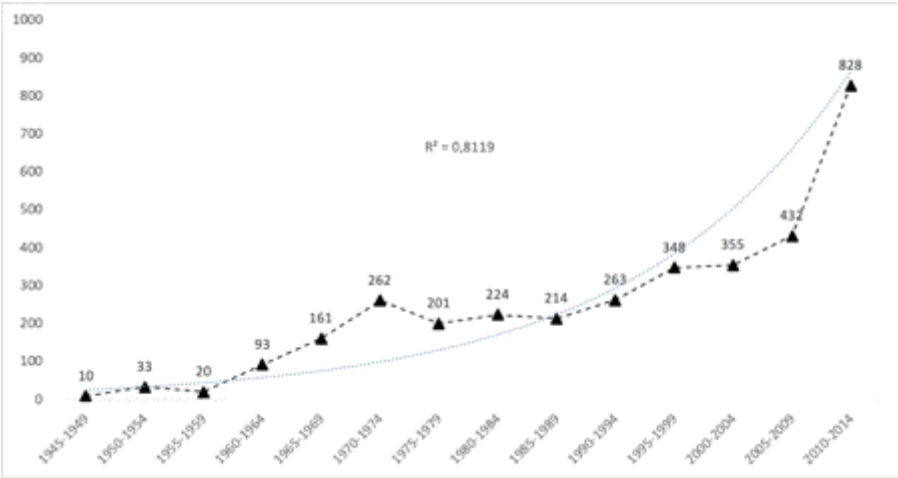

Figure 1

Evolution of number of documents published on cerebrospinal fluid leak by 5-year period* * The number of documents indexed in 2015-2018 period was 686 (lower because it is a four-year period and time lags in indexing the documents of the most.

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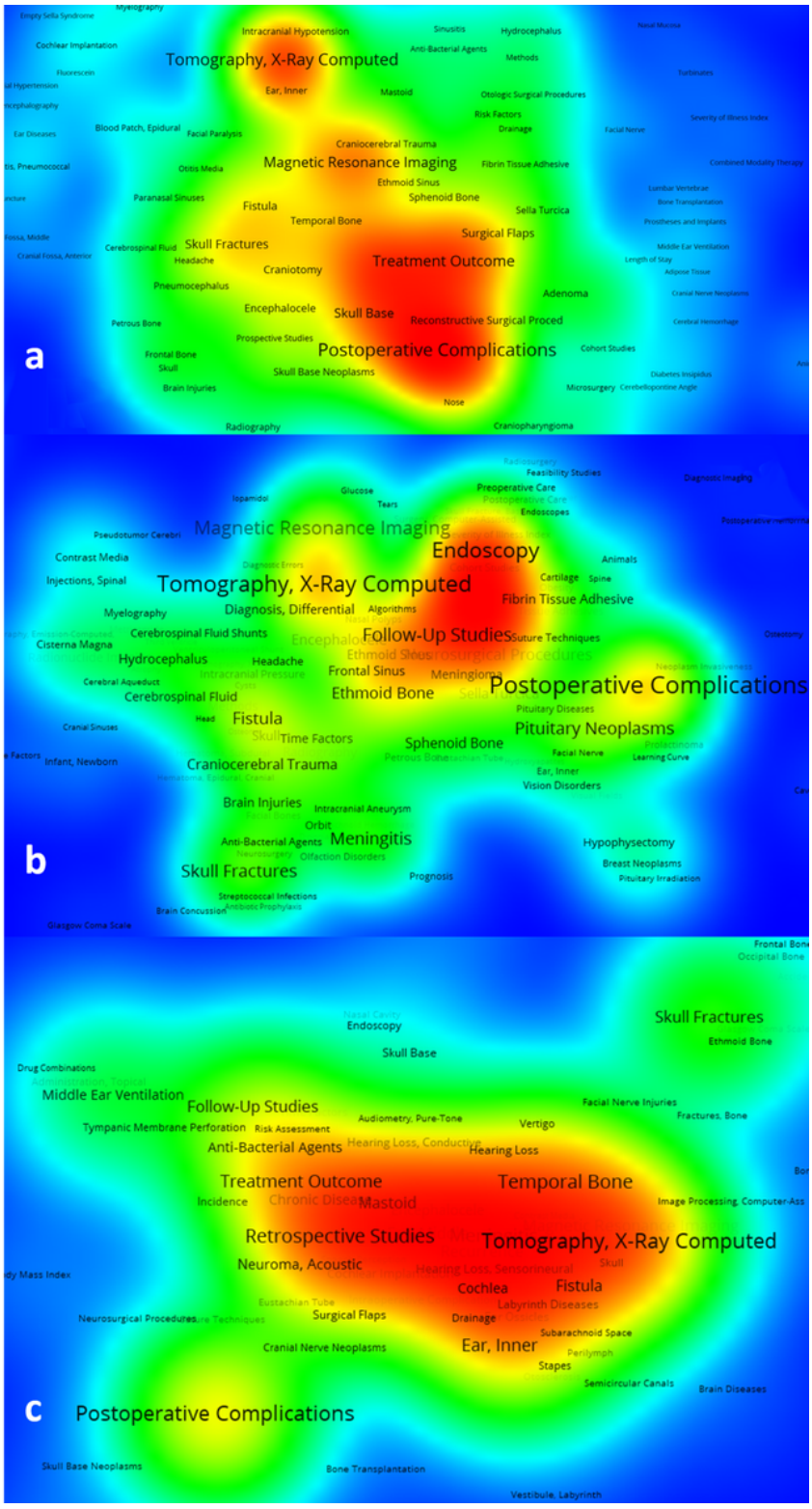
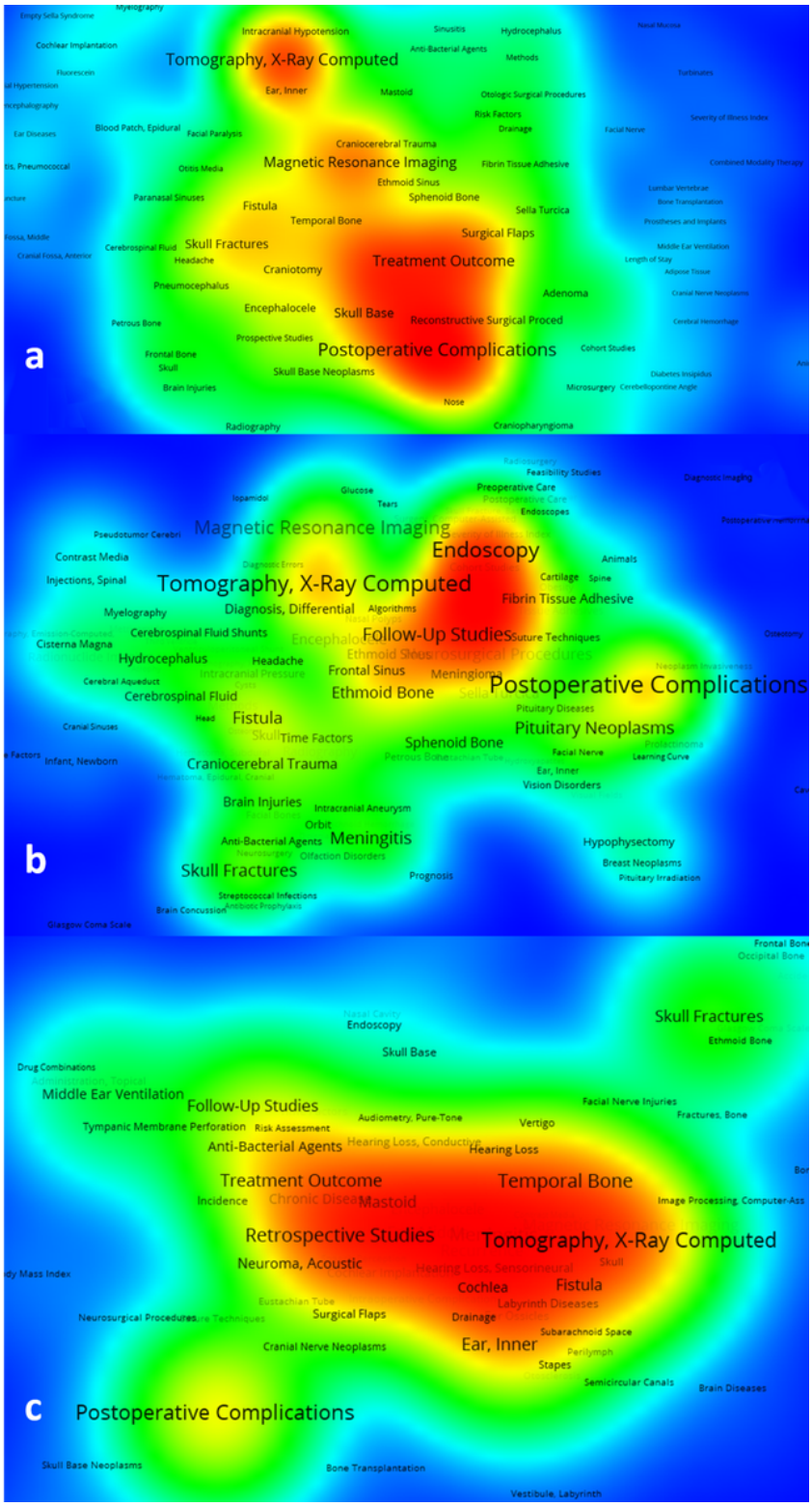


Figure 2

Analysis of topic clusters according MeSH assigned to publications (a) on cerebrospinal fluid (CSF) leak, (b) CSF rhinorrhea, and (c) CSF otorrhea Footnote: The different groupings, in the form of "islands" in red tones, represent the main clusters of the thematic networks, while the chromatic gradation illustrates the areas with a lower density of relations between the MeSH in yellow and green tones. The spatial

distribution of the MeSH and their proximity to each other responds to the intensity of co-occurrence between them.



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