MEDICAL SCIENCE MONITOR

DATABASE ANALYSIS

e-ISSN 1643-3750
© Med Sci Monit, 2022; 28: e936327
DOI: 10.12659/MSM.936327

Received: 2022.02.08
Accepted: 2022.03.30
Available online: 2022.04.05
Published: 2022.05.18

Technique Innovation and Clinical Application of Electrical Impedance Tomography: Bibliometric Research from 2001 to 2020

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

BCE Li Xiao*
BCE Kang Yu*
CDF Ying Cao
CDF Xiaowan Lin
CDF Xiao Liu
AE Hui Qiao
AEG Huihui Miao
AE Tianzuo Li

Department of Anesthesiology, Beijing Shijitan Hospital, Capital Medical University, Beijing, PR China

* Li Xiao and Kang Yu are the co-first authors

Corresponding Authors: Tianzuo Li, e-mail: litz@bjsjth.cn, Huihui Miao, e-mail: iverymhh@hotmail.com, Hui Qiao, e-mail: qiaohui240@163.com
Financial support: This study was funded by Beijing Municipal Administration of Hospitals' Youth Programme (QML20200102) to HHM
Conflict of interest: None declared

Background: Electrical impedance tomography (EIT) is a new test that has been widely used by clinicians in recent years at bedside or in ICU wards. Studies and publications on EIT increased quickly and the hotspot trends changed; however, the overview and characteristics of such studies have not yet been reported. Therefore, we have attempted to interpret the evolution of EIT and to anticipate its possible future clinical use by conducting a statistical analysis of EIT articles over the past 20 years.

Material/Methods: We analyzed EIT-related articles from 2020 and the 20 years prior, sourced from the Web of Science database. The data collected included the number of articles published, the classification of the articles, basic information, and author affiliation.

Results: Our study retrieved a total of 1427 EIT-related articles through screening, with the most articles published from Chinese authors and the Chinese Air Force Military Medical University, and the most cited article type being EIT-related basic research. Most articles on EIT have been published in the journal *Physiological Measurement*. Furthermore, the hotspots and research trends of EIT have changed from basic innovation development to clinical application in the past 20 years.

Conclusions: This paper presents a statistical analysis of articles on EIT over the last 20 years, focusing on trends from the mechanisms of EIT to its clinical use.

Keywords: Anesthesiology • Positive-Pressure Respiration • Respiration

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/936327

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Background

Since its discovery, EIT has been widely used in clinics and has now become a new type of imaging tool [1-5]. Compared with other techniques, EIT has the advantages of non-radiation and non-invasiveness, and the imaging results depend on the electrical potential of the chest wall surface. When EIT is conducted, an electric current passes through the set plane, generates a potential gradient on the surface of the chest wall, and displays two-dimensional impedance imaging on the computer. Previous studies have shown that EIT can cause local changes in lung ventilation [6-10]. The final qualitative information extracted by EIT was similar to that reported by computed tomography (CT) or ventilation scintillation [11-13]. EIT can reflect the state of lung ventilation function from the side and can be used as an index to evaluate the effect of positive end-expiratory pressure [10,14], which helps understand the risk of ventilator-induced lung injury [10,14].

EIT can dynamically observe regional lung ventilation [15] and calculate the size of the local mechanical energy. Positive end-expiratory pressure (PEEP) is an important component of mechanical energy. The adjustment of PEEP can affect the distribution of gas in the lungs [16], in turn affecting the magnitude of the local mechanical energy. In recent years, clinicians have used EIT technology to observe the characteristics of moisture distribution and local mechanical energy changes during PEEP titration, which can provide useful information for the setting of PEEP parameters [14].

Bibliometric analysis is a uniform and objective analysis of a number of published papers that have had some influence in a particular line of research [17,18]. We searched databases and found that there are no high-quality bibliometric analyses of EIT. This study aimed to discover the citation trend of published papers on EIT to help understand the current status of EIT research and provide clinicians with better lung function reference indicators.

Material and Methods

Search Strategy

The Web of Science database was used to survey articles on EIT published between 2001 and 2020. The search was conducted using "Electrical impedance tomography" as the title, restricting the article type to "article review" and searching for English language publications only. The following bibliometric information were collected: year of publication; country; journal publication; number of citations; author; grant; discipline; institution; and subject. No other exclusion criteria were used.

Statistical Analysis

SPSS22.0 statistical software was used for statistical analysis of the data. The data are expressed as mean±standard deviation by *t* test, and the count data are expressed as rate (%) by the chi-square test. $P<0.05$ indicates that a difference was statistically significant.

Results

Year and Country of Publication

For articles since 2001, our statistical analysis revealed no significant differences in the number of publications per year until 2013, and the number of published articles was small. However, the number of EIT articles rose sharply since 2014, and China and Germany have contributed a larger proportion, with over 100 articles/year published in 2019 and 2020 (**Figure 1A**). A statistical analysis showed that the largest number of articles were published by authors from China (n=254), followed by England (n=246), and Germany (n=244). The US ranked fourth highest in number of published articles, but they had the highest number of citations (n=7972) (**Table 1**). The number of collaborations by country was also counted, and the number of collaborations with Germany and China was greater than in other countries (**Figure 1B**). For more detailed data, see **Figure 1 and Table 1**.

Authors and Institutions

We ranked the number of posts and put together a tally of the information underlying these articles. Feng Fu from the Air Force Military Medical University (n=18) published the largest number of articles. The authors with the highest H-index among the top 20 were Inez Frerichs (H-index=11) from the University Medical Center Schleswig Holstein. More detailed data are presented in **Table 2**. The 20 most published institutions were also counted, and the 2 most published institutions were the University of London (n=90) and the University College London (n=87) from the UK, followed by the University of Kiel (n=70). The University of Eastern Finland (2575 citations; 39.62 citations per article) had the highest number of citations, with the third highest H-index of 27. This information is detailed in **Table 3 and Figure 2**.

Subjects and Funds

The journal disciplines were analyzed by counting the journal disciplines in which EIT articles were published. EITs consistently appeared most frequently in engineering (29%), followed by physiology (10%) and biophysics (9%). Anesthesiology accounted for approximately 1% of this field during this

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

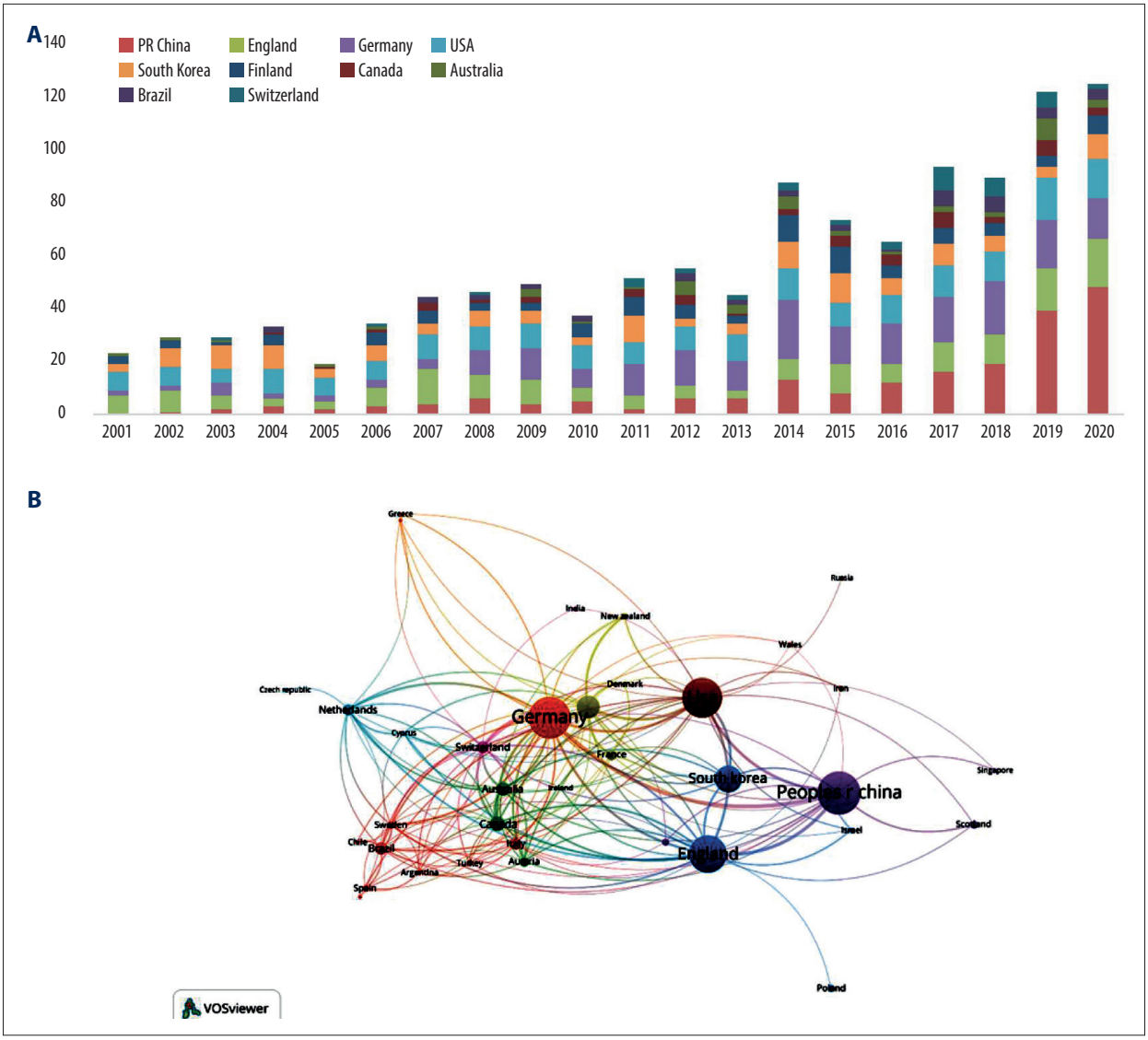

Figure 1. Countries where EIT articles are published through statistical analysis. (**A**) Number of articles published in different countries by year. (**B**) Map of cooperation between countries.

period (**Figure 3**). Again, the top 10 organizations with the highest number of sponsored articles have been counted according to the number of sponsored articles. One sponsoring institution from China, 4 from the United States, and 5 from Europe were included. The funding agency with the most articles was the National Natural Science Foundation of China (n=168), followed by 2 sponsors from the USA, namely the National Institutes of Health (n=90) and the United States Department of Health and Human Services (n= 90). More detailed data can be found in **Table 4**.

Journal Analysis

We then looked at the number of published EIT articles and ranked them by number (**Table 5**). The highest published journal was *Physiological Measurement* (n=228), followed by *Inverse Problems* (n=64), and *IEEE Transactions on Medical Imaging* (n=60). Among these journals, *Intensive Care Medicine* had the highest frequency of citations (76.14 citations per article) and the highest impact factor (IF=17.44). **Figure 4** shows the results of a statistical analysis of the top 10 most published journals. *Physiological Measurement* accounted for a high percentage of the number of publications per year. Interestingly, from 2014 onwards, the number of journals receiving EIT articles and the number of articles published in these journals began to increase, like *IEEE Transactions on Instrumentation and Measurement* and *IEEE Sensors Journal*. One journal in anesthesiology, *Acta Anaesthesiologica Scandinavica,* was included.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 1. Table of the 10 countries with the highest number of published EIT articles.

Number	Country	Number of publications	Number of cited	Average number of citations per article
1	Peoples R China	254	2245	8.84
2	England	246	5959	24.22
3	Germany	244	6146	25.19
4	USA	241	7972	33.08
5	South Korea	134	3089	23.05
6	Finland	108	3367	31.18
7	Canada	60	1566	26.1
8	Australia	52	1155	22.21
9	Brazil	48	1730	36.04
10	Switzerland	46	1179	25.63
11	France	44	910	20.68
12	Netherlands	40	1526	38.15
13	Italy	37	754	20.38
14	Austria	32	464	14.5
15	Spain	26	1162	44.69
16	Scotland	25	417	16.68
17	Japan	24	234	9.75
18	Poland	23	155	6.74
19	Sweden	22	948	43.09
20	Turkey	22	545	24.77

Table 2. Table of the 20 authors with the highest number of published EIT articles.

Number	Name	Institution	Number of articles	H index
1	Fu, Feng	Air Force Military Medical University	18	5
2	Kim, Kyung Youn	Jeju National University	16	9
3	Dong, Xiuzhen	Air Force Military Medical University	15	9
4	Hyvonen, N	Aalto University	14	8
5	Liu, Dong	University Sci & Technol China	13	9
6	Zhao, Zhanqi	Furtwangen University	13	7
7	Frerichs, Inez	University Med Ctr Schleswig Holstein	11	11
8	Dong, Feng	Tianjin University	9	4
9	Mueller, J L	Colorado State University	9	5
10	Oh, Tong In	Kyung Hee University	9	5
11	Woo, Eung Je	Kyung Hee University	9	8

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 2 continued. Table of the 20 authors with the highest number of published EIT articles.

Number	Name	Institution	Number of articles	H index
12	Kim, M C	Cheju Natl University	8	6
13	Kaipio, Jari P	University Kuopio	7	7
14	Yue, Shihong	Tianjin University	7	4
15	Borcea, Liliana	Rice University	6	5
16	Choi, Charles T. M.	Natl Chiao Tung University	6	5
17	Hamilton, Sarah Jane	Marquette University	6	6
18	Holder, D S	University London University Coll	6	10
19	Jia, J B	University Edinburgh	6	5
20	Ren, S J	Tianjin University	6	3

Table 3. Table of the 20 institutions that publish the most EIT articles.

Number	Institution	Number of articles	Cited times	Average citation per article	H index
1	University of London	90	2205	24.50	28
2	University College London	87	2194	25.22	28
3	University of Kiel	70	1928	27.54	25
4	Schleswig Holstein University Hospital	69	1889	27.38	25
5	Air Force Military Medical University	66	557	8.44	14
6	University of Eastern Finland	65	2575	39.62	27
7	Tianjin University	54	532	9.85	15
8	Kyung Hee University	53	1736	32.75	21
9	Furtwangen University	50	1116	22.32	16
10	Jeju National University	43	484	11.26	13
11	Aalto University	41	1263	30.80	17
12	Yonsei University	41	1691	41.24	24
13	Rwth Aachen University	37	1235	33.38	16
14	University of São Paulo	36	1537	42.69	16
15	Dartmouth College	35	807	23.06	16
16	University of Sheffield	33	936	28.36	16
17	Carleton University	32	839	26.22	12
18	University of California System	31	1312	42.32	16
19	Konkuk University	30	1154	38.47	17
20	Middlesex University	30	1131	37.70	16

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

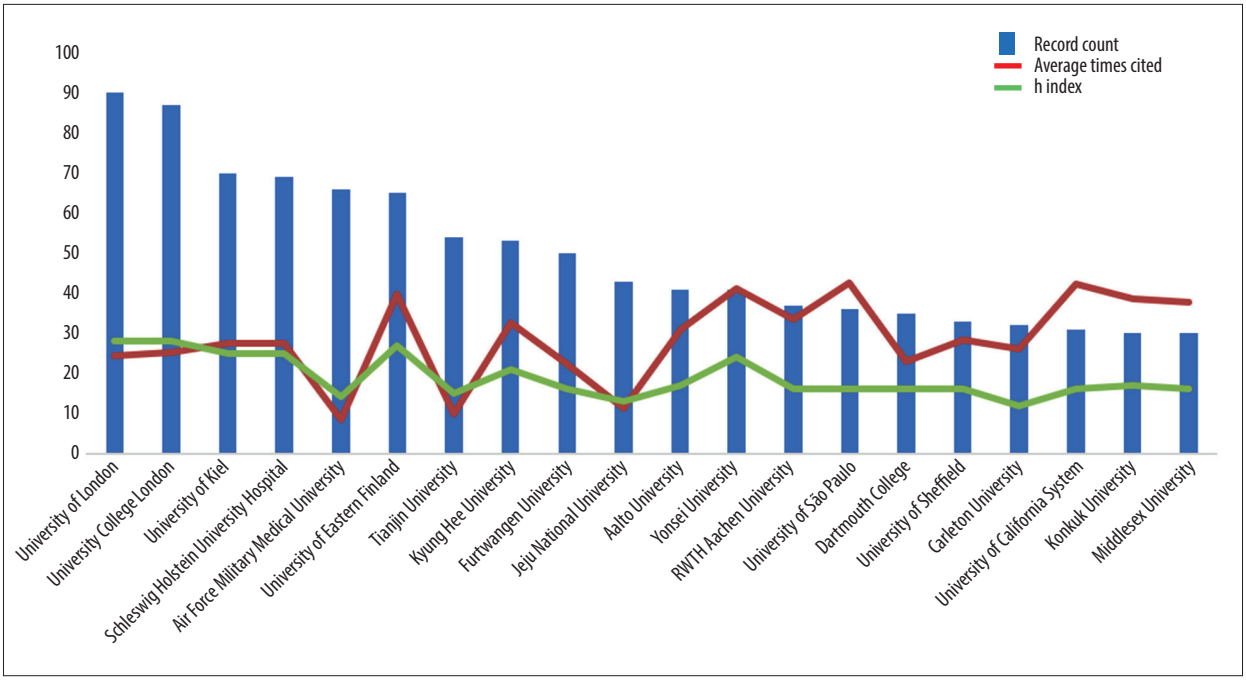

Figure 2. Statistics of the articles published by institutions. The blue bar is the number of articles issued, the red line is the frequency of citations and the green line is the institutional H-index.

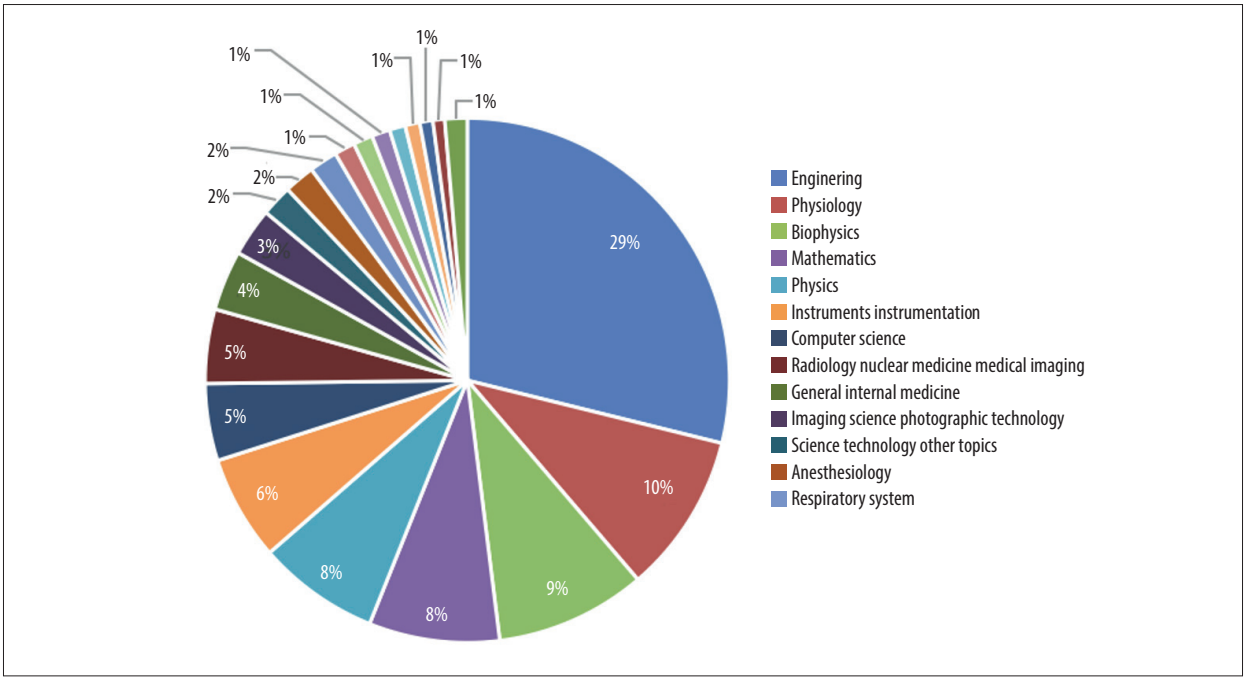

Figure 3. The percentage of EIT articles published in different disciplines.

Citations and Correlation Analysis

Each article has a different number of citations and we have summarized the most frequently cited articles over the last 20 years for comparison. These 20 articles included 14 basic studies, 1 retrospective clinical study, and 5 reviews (**Figure 5A**). The research content of the articles about new algorithms and protocols for EIT were classified as "EIT innovation articles" by us. EIT used to guide clinical treatment was classified as "clinical applications". Fifteen articles described new ideas and proposed hypotheses for EIT, and 5 articles focused on the application of EIT to clinical work (**Figure 5B**). Interestingly, the

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 4. Table of the 10 funding bodies that published the highest number of EIT articles.

Number	Funding agency	Number of publications
1	National Natural Science Foundation of China (NSFC)	168
2	National Institutes of Health NIH USA	90
3	United States Department of Health Human Services	90
4	European Commission	83
5	UK Research Innovation (UKRI)	60
6	Academy of Finland	57
7	Engineering Physical Sciences Research Council (EPSRC)	50
8	NIH National Institute of Biomedical Imaging Bioengineering (NIBIB)	35
9	German Research Foundation (DFG)	29
10	National Science Foundation (NSF)	29

Table 5. Table of the 20 journals with the highest number of published EIT articles.

Number	Name	Number of articles	Number of cited	Citations per article	IF	JCR partition
1	Physiological Measurement	228	4610	20.22	2.833	Q3
2	Inverse Problems	64	2296	35.88	2.407	Q1
3	IEEE Transactions on Medical Imaging	60	2638	43.97	10.048	Q1
4	IEEE Transactions on Biomedical Engineering	51	2461	48.25	4.538	Q2
5	Measurement Science and Technology	46	1135	24.67	2.046	Q3
6	IEEE Transactions on Instrumentation and Measurement	31	346	11.16	4.016	Q1
7	IEEE Sensors Journal	28	341	12.18	3.301	Q2
8	Clinical Physics and Physiological Measurement	24	330	13.75	–	–
9	Inverse Problems and Imaging	23	280	12.17	1.639	Q2
10	Critical Care	22	734	33.36	9.097	Q1
11	Physics in Medicine and Biology	20	648	32.4	3.609	Q2
12	IEEE Transactions on Magnetics	18	253	14.06	1.7	Q3
13	IEEE Transactions on Biomedical Circuits and Systems	17	298	17.53	3.833	Q2
14	Siam Journal on Applied Mathematics	17	494	29.06	2.08	Q2
15	Medical Biological Engineering Computing	16	406	25.38	2.602	Q2
16	PLoS One	15	140	9.33	3.24	Q2
17	Intensive Care Medicine	14	1066	76.14	17.44	Q1
18	Inverse Problems in Science and Engineering	14	118	8.43	1.95	Q3
19	Review of Scientific Instruments	14	132	9.43	1.523	Q3
20	Acta Anaesthesiologica Scandinavica	13	360	27.69	2.105	Q4

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

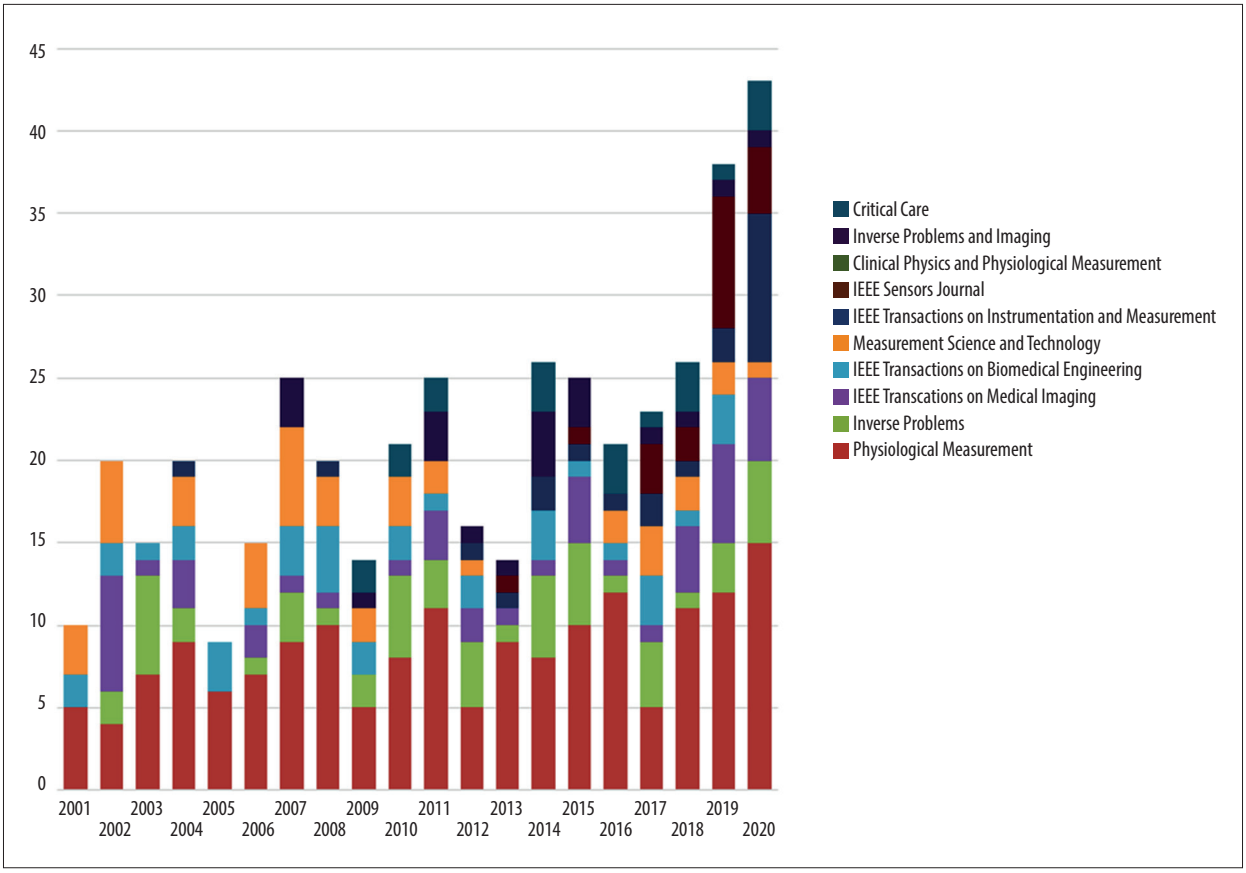

Figure 4. The number of articles published in different journals is counted on a yearly basis.

top 2 highest-cited articles had the same title. The first was *Electrical impedance tomography* by Cheney, published in 1999 (cited frequency 719), which reviewed the reconstruction algorithm for EIT [19]. The other, published by Borcea published in 2002 (cited frequency 481), reviewed theoretical and numerical studies of the EIT inverse problem [20]. Third was *Comparing reconstruction algorithms for electrical impedance*, published by Yorkey in 1987 (cited frequency 401), which presented a new reconstruction algorithm [21]. Notably, *Clinical recommendations when EIT is used in the chest*, published by Frerichs in 2017, presented a consensus on the use of EIT for clinical mechanical ventilation and had the highest average annual citation count (78.5 citations per year on average) [22] (**Table 6**).

There was no correlation except for a significant correlation between year of publication and frequency of citations (r=0.3879; *P*=0.05) (**Figure 5**).

Hotspots and Publication Trends

The classification of EIT articles into popular topics is based on the keywords of the article. The size of the circles in the graph and the thickness of the lines between them indicate how popular the topic is. All articles included in this period are categorized and summarized according to the first and last decade. For the first 10 years, the publications on EIT focused on innovation mechanism or system, as shown in the blue and green clusters (**Figure 6A**). In the latter decade, EIT articles began to become a more frequent and hot topic (**Figure 6B**). "Reconstruction or Image reconstruction" forms an important part of the green cluster. Meanwhile, the clinical application-related red cluster obviously increased, indicating the hotspots of EIT trends to clinical treatment. The key words "mechanical ventilation", "PEEP", "acute respiratory distress", "obese patients", "surgery", or "general anesthesia" demonstrated the clinical interest of EIT.

Discussion

We searched the database and collected EIT articles from the 20 years after 2001, analyzing the types of articles and basic information. By conducting a correlation analysis, we found that the newer the year of the article, the higher the number of citations of the article, but the impact factor was not related to the number of citations of the article. Finally, by analyzing the hot trends of articles in the last 10 years, we found that EIT tends to move from basic research to clinical.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

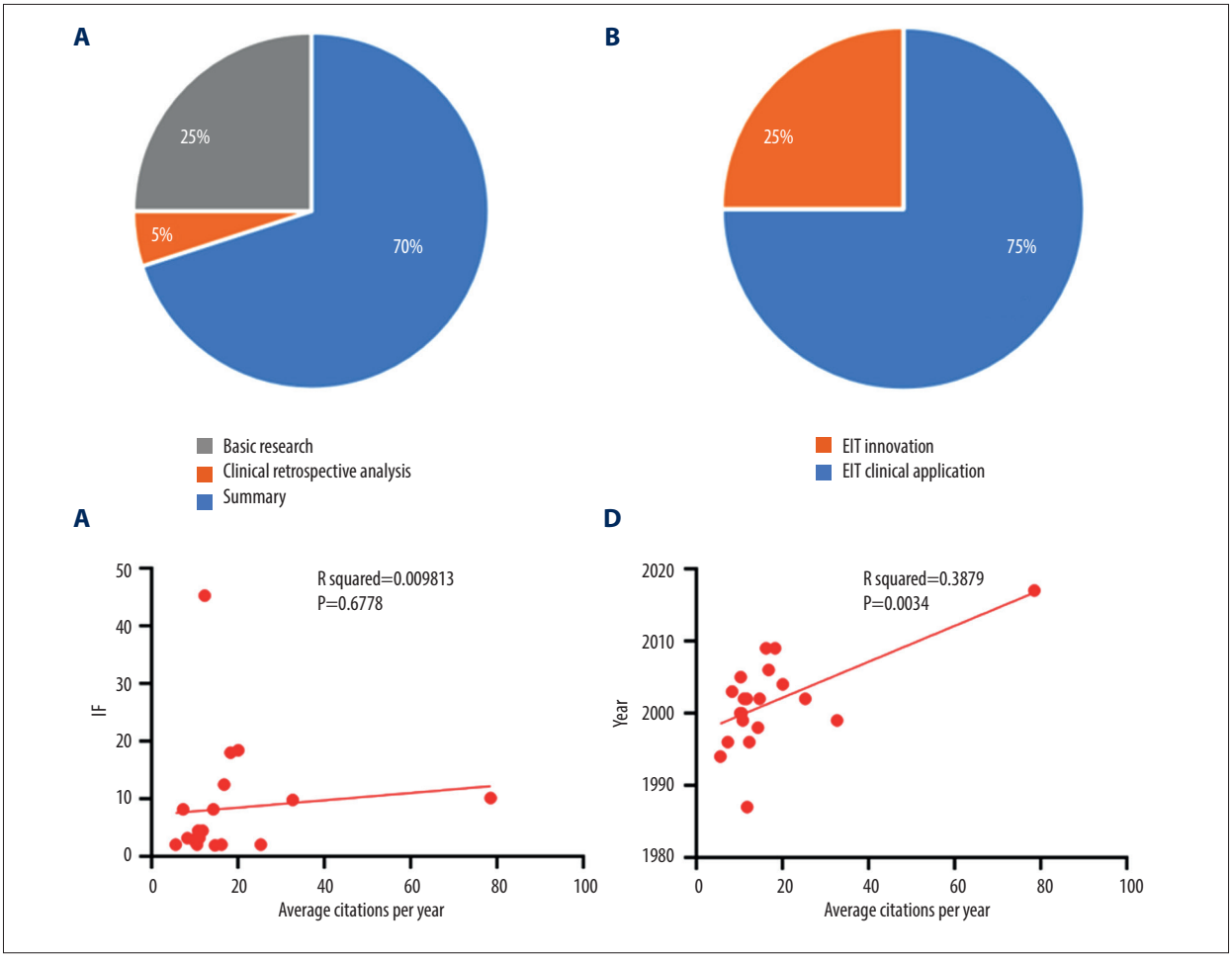

Figure 5. The classification and correlation analysis. (**A**) Proportions of classifications. (**B**) Proportions of categories. (**C**) Correlation between average citation per year and the impact factor. (**D**) Correlation between average citation per year and the year of analysis.

China contributed the highest number of articles and collaborated more with other countries. Among the authors with the highest number of articles, there were 6 from China, including the top author Feng Fu from the Air Force Military Medical University. The National Natural Science Foundation of China was the funding agency with the most articles. These results indicate that China was academically active in the field of EIT.

As a radiation-free non-invasive functional image monitoring technique, EIT provides lung ventilation, especially regional lung ventilation, and perfusion at the bedside [23]. Clinical needs have driven scientific and clinical interest in this advanced method. EIT assessment conveniently obtains unique clinical images without adverse effects compared with other similar techniques such as CT. For research hotspots, the co-existing keywords suggested that the earlier decade (2001 to 2010) was still the device development period, mainly focusing on image reconstruction, data analysis, and substitution algorithms. In the last decade, an increasing number of clinical trials in EIT applications have been published. EIT is widely used for acute respiratory distress syndrome (ARDS) or chronic obstructive pulmonary disease (COPD) patients in the intensive care unit (ICU), guiding mechanical ventilation therapy [24-27]. EIT is also a good choice due to its radiation-free features for neonates, infants, and children that require clinical interventions for lung function [28-30]. For patients under general anesthesia and undergoing surgery, EIT also provided excellent information for preoperative evaluation, perioperative personalized PEEP setup, and postoperative monitoring [31]. Several studies have titrated PEEP in obese patients to guide EIT during surgery to prevent postoperative atelectasis [32,33].

In the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic, EIT was used for the treatment of COVID-19-associated ARDS patients [34]. EIT is valuable as a bedside tool for evaluating ventilation distribution and perfusion and guiding PEEP titration [35,36]. Another case report suggested that in the time of COVID-19, EIT identified perfusion impairment

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 6. Table of top 20 highly cited articles.

Number	Topic	Corresponding Author	Institution	Journal	Year	Cited frequency	Average citations per year
1	Electrical impedance tomography	Cheney, M	Rensselaer Polytech Inst	Sian Review	1999	719	32.7
2	Electrical impedance tomography	Borcea, L	Rice Univ	Inverse Problems	2002	481	25.3
3	Comparing reconstruction algorithms for electrical-impedance	Yorkey, TJ	Univ Califlawrence	Ieee Transactions on Biomedical Engineering	1987	401	11.8
4	Imbalances in regional lung ventilation - A validation study on electrical impedance tomography	Amato, MBP	USP, Fac Med	American Journal of Respiratory and Critical Care Medicine	2004	341	20.1
5	Tikhonov regularization and prior information in electrical impedance tomography	Kaipio, JP	Univ Kuopio	Ieee Transactions on Medical Imaging	1998	329	14.3
6	Chest electrical impedance tomography examination, data analysis, terminology, clinical use and recommendations: consensus statement of the Translational EIT development study group	Frerichs, I	Univ Med Ctr Schleswig Holstein	Thorax	2017	314	78.5
7	Three-dimensional electrical impedance tomography	Metherall, P	Univ Sheffield	Nature	1996	308	12.3
8	A Matlab toolkit for three-dimensional electrical impedance tomography: a contribution to the Electrical Impedance and Diffuse Optical Reconstruction Software project	Lionheart, WRB	Univ Manchester	MeasurementScience and Technology	2002	279	14.7
9	Bioimpedance tomography (Electrical impedance tomography)	Bayford, RH	Middlesex Univ	Annual Review of Biomedical Engineering	2006	252	16.8
10	Three-dimensional electrical impedance tomography based on the complete electrode model	Vauhkonen, M	Univ Kuopio	Ieee Transactions on Biomedical Engineering	1999	238	10.8
11	Magnetic resonance electrical impedance tomography (MREIT): Simulation study of J-substitution algorithm	Woo, EJ	Kyung Hee Univ	Ieee Transactions on Biomedical Engineering	2002	223	11.7

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 6 continued. Table of top 20 highly cited articles.

Number	Topic	Corresponding Author	Institution	Journal	Year	Cited frequency	Average citations per year
12	Statistical inversion and Monte Carlo sampling methods in electrical impedance tomography	Kaipio, JP	Univ Kuopio	Inverse Problems	2000	220	10.5
13	Bedside estimation of recruitable alveolar collapse and hyperdistension by electrical impedance tomography	Amato, MBP	Univ São Paulo	Intensive Care Medicine	2009	219	18.3
14	Electrical impedance tomography (EIT) in applications related to lung and ventilation: a review of experimental and clinical activities	Frerichs, I	Univ Gottingen	Physiological Measurement	2000	215	10.2
15	Detection of local lung air content by electrical impedance tomography compared with electron beam CT	Frerichs, I	Univ Gottingen	Journal of Applied Physiology	2002	210	11.1
16	Electrical impedance tomography and Calderon's problem	Uhlmann, G	Univ Washington	Inverse Problems	2009	194	16.2
17	Electrical impedance tomography: Regularized imaging and contrast detection	Adler, A	Ecole Polytech	Ieee Transactions on Medical Imaging	1996	183	7.3
18	Electrical impedance tomography using level set representation and total variational regularization	Tai, XC	Univ Bergen	Journal of Computational Physics	2005	165	10.3
19	An image-enhancement technique for electrical-impedance tomography	D C Dobson	University of Minnesota System	Inverse Problems	1994	152	5.6
20	Conductivity and current density image reconstruction using harmonic B-z algorithm in magnetic resonance electrical impedance tomography	Oh, SH	Kyung Hee Univ	Physics in Medicine and Biology	2003	150	8.3

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

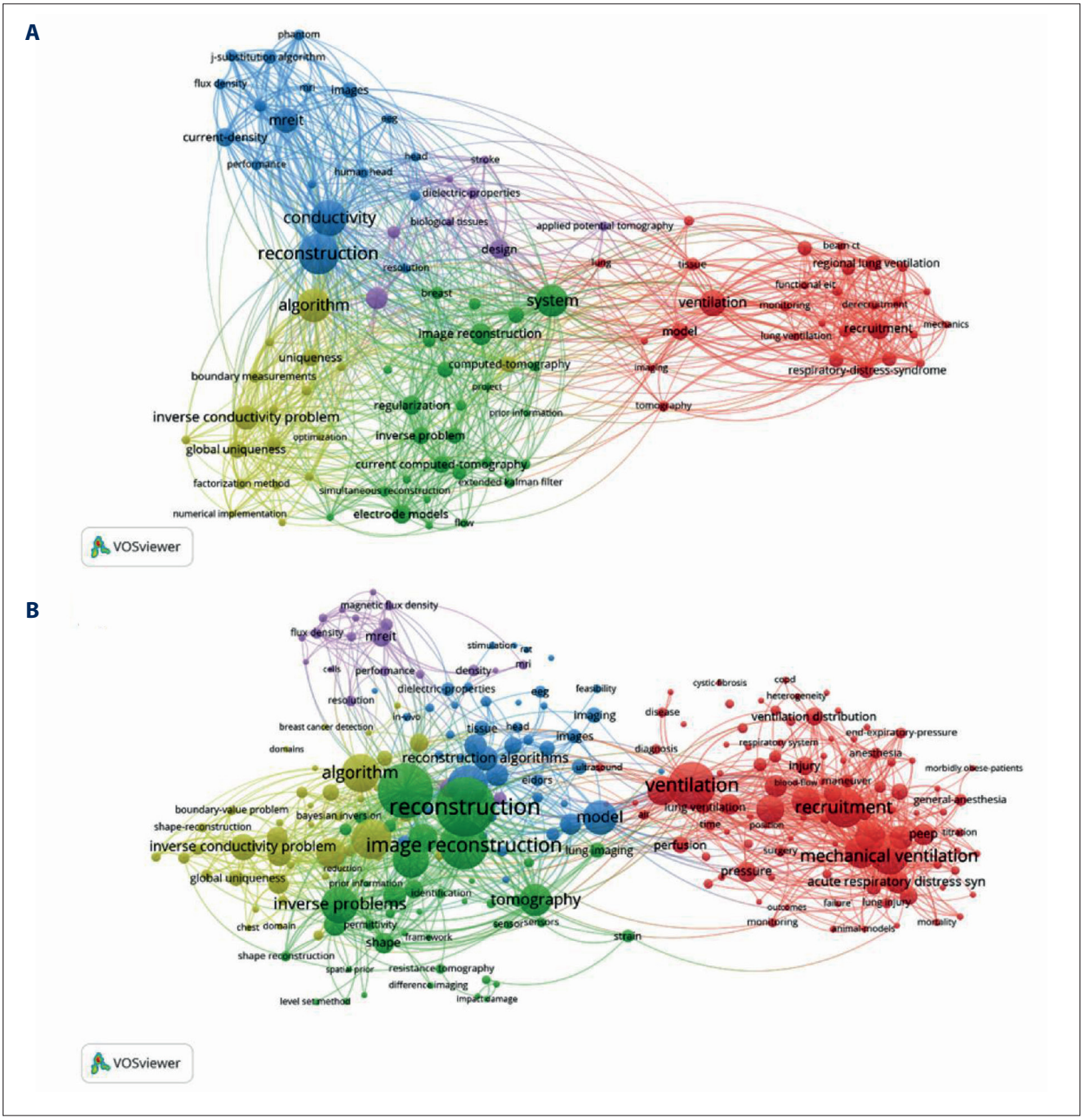

Figure 6. Summary of EIT Research Trends and Hotspots. (**A**) Hotspots for articles published in EIT in the previous decade. (**B**) Hot spots for articles published in EIT in the second decade.

that might require CT pulmonary angiography (CTPA) and evaluated the effect of therapy [37].

Some very influential articles are not counted in the list of high-frequency citations, probably because they were published very recently, for example, but that does not mean they are not important. Our search for EIT articles was limited to the Web of Science and did not include other databases [16], so some published articles may not have been collected by the search.

Conclusions

In conclusion, the hotspot and publication trends in the EIT from 2001 to 2020 were analyzed. This research clearly demonstrated that the study interest in EIT has increased yearly and has changed from technique development to clinical application. China contributed significantly to the field of EIT study, with the highest number of publications, the top author, and the funding agency with the most articles.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

References:

1. Adler A, Amyot R, Guardo R, et al. Monitoring changes in lung air and liquid volumes with electrical impedance tomography. J Appl Physiol. 1997;83(5):1762-67
2. Adler A, Shinozuka N, Berthiaume Y, et al. Electrical impedance tomography can monitor dynamic hyperinflation in dogs. J Appl Physiol. 1998;84(2):726-32
3. Barber DC, Brown BH. Applied potential tomography. J Phys E. 1984;17(9):723-33
4. Brown BH, Barber DC, Seagar AD. Applied potential tomography – possible clinical-applications. Clin Phys Physiol Meas. 1985;6(2):109-21
5. Long Y, Liu D-W, He H-W, Zhao Z-Q. Positive end-expiratory pressure titration after alveolar recruitment directed by electrical impedance tomography. Chin Med J (Eng). 2015;128(11):1421-27
6. Frerichs I, Hahn G, Hellige G. Gravity-dependent phenomena in lung ventilation determined by functional EIT. Physiol Meas. 1996;17:A149-57
7. Frerichs I, Schiffmann H, Oehler R, et al. Distribution of lung ventilation in spontaneously breathing neonates lying in different body positions. Intensive Care Med. 2003;29(5):787-94
8. Hinz J, Hahn G, Neumann P, et al. End-expiratory lung impedance change enables bedside monitoring of end-expiratory lung volume change. Intensive Care Med. 2003;29(1):37-43
9. Kunst PWA, Bohm SH, de Anda GV, et al. Regional pressure volume curves by electrical impedance tomography in a model of acute lung injury. Crit Care Med. 2000;28(1):178-83
10. Kunst PWA, de Anda GV, Bohm SH, et al. Monitoring of recruitment and derecruitment by electrical impedance tomography in a model of acute lung injury. Cr Care Med. 2000;28(12):3891-95
11. Gattinoni L, Dandrea L, Pelosi P, et al. Regional effects and mechanism of positive end-expiratory pressure in early adult respiratory-distress syndrome. JAMA. 1993;269(16):2122-27
12. Neumann P, Berglund JE, Andersson LG, et al. Effects of inverse ratio ventilation and positive end-expiratory pressure in oleic acid-induced lung injury. Am J Respir Crit Care Med. 2000;161(5):1537-45
13. Neumann P, Berglund JE, Mondejar EF, et al. Effect of different pressure levels on the dynamics of lung collapse and recruitment in oleic-acid-induced lung injury. Am J Respir Crit Care Med. 1998;158(5):1636-43
14. Genderingen HR, Vught AJ, Jansen JRC. Estimation of regional lung volume changes by electrical impedance tomography during a pressure-volume maneuver. Intensive Care Med. 2003;29(2):233-40
15. Bachmann MC, Morais C, Bugedo G, et al. Electrical impedance tomography in acute respiratory distress syndrome. Critical Care. 2018;22:263
16. Karsten J, Grusnick C, Paarmann H, et al. Positive end-expiratory pressure titration at bedside using electrical impedance tomography in post-operative cardiac surgery patients. Acta Anaesthesiol Scand. 2015;59(6):723-32
17. Gao H, Huang F-Y, Wang Z-P. Research trends of macrophage polarization: A bibliometric analysis. Chinese Med J (Engl). 2018;131(24):2968-75
18. Wang M, Xiao C, Ni P, et al. Correlation of betel quid with oral cancer from 1998 to 2017: A study based on bibliometric analysis. Chin Med J (Engl). 2018;131(16):1975-82
19. Cheney M, Isaacson D, Newell JC. Electrical impedance tomography. Siam Review. 1999;41(1):85-101
20. Borcea L. Electrical impedance tomography. Inverse Problems. 2002;18(6):R99-R136
21. Yorkey TJ, Webster JG, Tompkins WJ. Comparing reconstruction algorithms for electrical impedance tomography. IEEE Trans Biomed Eng. 1987; 34(11):843-52
22. Frerichs I, Amato MBP, van Kaam AH, et al. Chest electrical impedance tomography examination, data analysis, terminology, clinical use and recommendations: Consensus statement of the TRanslational EIT developmeNt stuDy group. Thorax. 2017;72(1):83-93
23. Spinelli E, Mauri T, Fogagnolo A, et al. Electrical impedance tomography in perioperative medicine: Careful respiratory monitoring for tailored interventions. BMC Anesthesiology. 2019;19(1):140
24. Vogt B, Pulletz S, Elke G, et al. Spatial and temporal heterogeneity of regional lung ventilation determined by electrical impedance tomography during pulmonary function testing. J Appl Physiol. 2012;113(7):1154-61
25. Vogt B, Zhao Z, Zabel P, et al. Regional lung response to bronchodilator reversibility testing determined by electrical impedance tomography in chronic obstructive pulmonary disease. Am J Physiol Lung Cell Mol Physiol. 2016;311(1):L8-L19
26. Pulletz S, Kott M, Elke G, et al. Dynamics of regional lung aeration determined by electrical impedance tomography in patients with acute respiratory distress syndrome. Multidiscipl Respir Med. 2012;7(1):44
27. Victorino JA, Borges JB, Okamoto VN, et al. Imbalances in regional lung ventilation. Am J Respir Crit Care Med. 2004;169(7):791-800
28. Miedema M, de Jongh FH, Frerichs I, et al. Changes in lung volume and ventilation during surfactant treatment in ventilated preterm infants. Am J Respir Crit Care Med. 2011;184(1):100-5
29. Wolf GK, Gómez-Laberge C, Kheir JN, et al. Reversal of dependent lung collapse predicts response to lung recruitment in children with early acute lung injury. Pediatr Crit Care Med. 2012;13(5):509-15
30. van Veenendaal MB, Miedema M, de Jongh FHC, et al. Effect of closed endotracheal suction in high-frequency ventilated premature infants measured with electrical impedance tomography. Intensive Care Med. 2009;35(12):2130
31. Girrbach F, Petroff D, Schulz S, et al. Individualised positive end-expiratory pressure guided by electrical impedance tomography for robot-assisted laparoscopic radical prostatectomy: A prospective, randomised controlled clinical trial. Br J Anaesth. 2020;125(3):373-82
32. Nestler C, Simon P, Petroff D, et al. Individualized positive end-expiratory pressure in obese patients during general anaesthesia: A randomized controlled clinical trial using electrical impedance tomography. Br J Anaesth. 2017;119(6):1194-205
33. Simon P, Girrbach F, Petroff D, et al. Individualized versus fixed positive end-expiratory pressure for intraoperative mechanical ventilation in obese patients: A secondary analysis. Anesthesiology. 2021;134(6):887-900
34. Sella N, Pettenuzzo T, Della Paolera M et al. Two consecutive runs of veno-venous extracorporeal membrane oxygenation in a peripartum patient with COVID-19 acute respiratory distress syndrome. Case Rep Crit Care. 2021;2021:2032197
35. Sella N, Zarantonello F, Andreatta G, et al. Positive end-expiratory pressure titration in COVID-19 acute respiratory failure: electrical impedance tomography vs. PEEP/FiO2 tables. Cri Care. 2020;24(1):540
36. Morais CCA, Safaee Fakhr B, De Santis Santiago RR, et al. Bedside electrical impedance tomography unveils respiratory "Chimera" in COVID-19. Am J Respir Crit Care Med. 2020;203(1):120-21
37. Safaee Fakhr B, Araujo Morais CC, De Santis Santiago RR, et al. Bedside monitoring of lung perfusion by electrical impedance tomography in the time of COVID-19. Br J Anaesth. 2020;125(5):e434-36

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]