Original Article

The evolution and current situation in the application of dual-energy computed tomography: a bibliometric study

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Background: Dual-energy computed tomography (DECT) has received extensive attention in clinical practice; however, a quantitative assessment of published literature in this domain is presently lacking. This study thus aimed to characterize the application conditions, developmental trends, and research hot spots of DECT using bibliometric analysis.

Methods: All literature on DECT was retrieved from the Web of Science Core Collection (WoSCC) on January 22, 2023. The co-occurrence, cooperation network, and co-citation of countries, institutions, references, authors, journals, and keywords were analyzed using CiteSpace, VOSviewer, and R-bibliometrix software.

Results: In total, 4,720 original articles and reviews were included. The number of publications related to DECT has rapidly increased since 2006. The USA (n=1,662) and Mayo Clinic (n=178) were found to be the most productive country and institution, respectively. The most cited article was published by Johnson TRC *et al.*, while the article published by McCollough CH *et al.* in 2015 had the most co-citations. Schoepf UJ ranked first with most articles among 16,838 authors. The journal with the most published articles was *European Radiology*, with 411 publications. The timeline analysis indicated that material decomposition was the most recent topic, followed by gout, radiomics, proton therapy, and bone marrow edema.

Conclusions: An increasing number of researchers are committed to researching DECT, with the USA making the most significant contributions in this area. Prior studies have primarily concentrated on cardiovascular diseases, and contemporary hot spots include expansion into to other fields, such as iodine quantification, deep learning, and bone marrow edema.

Keywords: Dual-energy computed tomography (DECT); bibliometrics; cocitation

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Introduction

Dual-energy computed tomography (DECT) has been extensively explored since it was first proposed in 1973 (1); however, DECT was not widely expanded in clinic until the introduction of the first-generation dual-source CT system in 2006 (2). Compared to conventional CT, DECT requires obtaining two datasets at high and low X-ray energies simultaneously through multiple imaging acquisition techniques, including dual-source CT, fast-switching X-ray tubes, and dual-layer detectors (3). It allows for different algorithms and postprocessing analyses, including virtual monoenergetic imaging (VMI), effective atomic number (Zeff), electron density mapping, energy spectrum curve, material decomposition [including virtual noncontrast (VNC) imaging, iodine mapping, virtual noncalcium (VNCa) mapping, and lung ventilation maps], and material differentiation or labeling (including urinary stone component analysis, gout imaging, bone removal, pulmonary vascular analysis, fat and iron quantification, and material prominence) based on two datasets (4).

Currently, VMI and iodine maps are primarily used to optimize image quality (5). Low-energy VMI has high soft tissue contrast and enhances the conspicuity of tumor and vascular lesions, while high-energy VMI can reduce metal artifacts. The electrode density and Zeff obtained with DECT are helpful for dose calculation in proton therapy and for distinguishing tissue components such as renal stones and tumor types. Among a growing list of diagnostic applications, lung ventilation mapping, gout imaging, and VNCa mapping have been increasingly used for pulmonary embolism, gout visualization, and bone marrow edema (6-8). In addition, the multimaterial differentiation or labeling method can be used for the quantitative analysis of specific substances, such as fat and iron (9).

A wide variety postprocessing algorithms have promoted the wider application of DECT. However, despite the substantial effort and many related studies being published in this area, systematic collation and scientific analysis of DECT literature are lacking. Bibliometrics is a reliable method that is capable of evaluating trends in research activity over time based on literature database analysis (10). It provides a scientific statistical basis for understanding the developing trends in a specific field and can rank academic groups and individual researchers according to different data. This study thus aimed to characterize the applications in various systems and identify the trends in DECT research by analyzing articles published over the past few decades.

Methods

Database

The bibliometric analysis data in this study were derived from the Web of Science Core Collection (WoSCC) database, which contains a comprehensive collection of literature. As one of the largest bibliometric databases in the world, the WoSCC database is the most commonly used database for bibliometric analysis (11).

Inclusion criteria and search strategy

On January 22, 2023, we retrieved all literature related to DECT from the WoSCC published prior to August 31, 2022. The search strategy was as follows: TS = ("dual-energy CT" OR "dual-source CT" OR "spectral CT" OR "dual-layer detector spectrum CT" OR "split-filter dual-energy CT" OR "single-source sequence acquisition dual-energy CT" OR "DECT" OR "dual-energy computer tomography") AND date of publication (DOP) = (January 1, 1982, to August 31, 2022). Original articles and reviews of DECT studies were included, while conference papers and papers related to engineering were excluded. The language used was limited to English. Ultimately, 4,720 studies were retrieved. Records for all data, including title, authors, nationalities, affiliations, journal name, keywords, abstracts, and references, were downloaded in plain-text format.

Data visualization

This study analyzed the number of articles published annually, countries and institutions, highly cited and co-cited articles, authors, journals, and keywords. Excel 2019 (Microsoft Corp., Redmond, WA, USA) was used to display the trends in the number of articles published by year. CiteSpace and VOSviewer were used for data visualization, both of which have been widely used in bibliometric analyses. Visualization analysis of the co-occurrence of institutions and countries, authors, references, cocitations, and keywords was completed using CiteSpace. In the visual map, different countries, institutions, and authors were simultaneously depicted in their respective networks. In these networks, the size of nodes represents the number of publications or cocitations, and the thickness of the links represents the strength of the association or frequency of the cooperation between countries or institutions, commonly known as total link strength (TLS). Betweenness centrality (BC) was used as an indicator to measure the

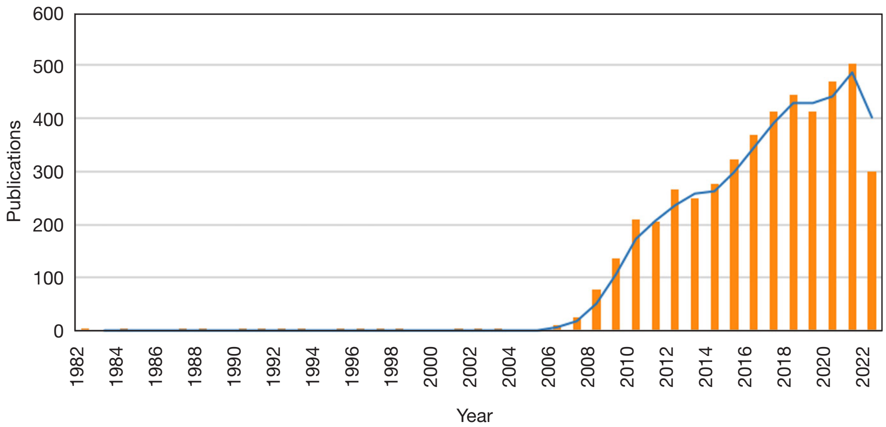

Figure 1 Trend of annual publications in the application of DECT. DECT, dual-energy computed tomography.

likelihood of a given node being located in the center of the network to assess the importance of the node. Generally, nodes with a BC ≥0.1 occupy a pivotal position and are usually indicated by purple rings (12). In the cocitation network, modularity value (Q) is an index used to assess the extent of the modularity of networks. A Q>0.3 indicates that a cluster structure is significant. Another similar evaluation indicator for the quality of networks, mean silhouette value (S), is often used to assess the homogeneity of networks. S>0.7 indicates that the clustering result is reliable and satisfactory (13). The R-bibliometrix software package in R-Studio was used to analyze the number of publications per journal. The h-index was used to evaluate the quantity and level of academic output of researchers and journals. VOSviewer was used to analyze the number of articles published by each country and the keyword co-occurrence. A high output rate of studies indicates that the influence of a country in the field is large. Additionally, in an overlay visualization map of keywords, the size of nodes represents the number of keyword occurrences, and future research hot spots can be reflected by keyword occurrence frequency (14).

Synonym substitution of keywords

Any synonyms, such as “dual-energy CT” and “dual-energy computed tomography”, “dual-source CT” and “dual source CT”, and “CT angiography” and “angiography”, that could possibly lead to a bias in the results were substituted using VOSviewer before data analysis.

Results

Publication year

The first paper on DECT was published in 1982. However, annual publications did not increase, even gradually, until after 2006. The number of published articles has exhibited a general upward trend in recent years, reaching 504 by 2021 (*Figure 1*).

Analysis of the most productive countries and institutions

A total of 64 countries have published articles on DECT. The top 10 countries with the most publications are listed in *Table 1*. The highest contributing countries in terms of published articles were the USA (n=1,662), Germany (n=1,171), and China (n=867), with the USA also being the country with the most citations (n=51,565). The co-occurrence map of countries (*Figure 2A*) and collaboration map among countries (*Figure 2B*) display the co-occurrence links and cooperative relationships between countries, respectively. In *Figure 2A*, the “USA” node has a distinct purple ring, indicating its significant impact. The USA has collaborated with many countries internationally, with Germany and China being the most common partners. More than 3,000 institutions have published articles on DECT. The top 10 most productive institutions are listed in *Table 1*, with the top 3 being the Mayo Clinic (178 articles), Massachusetts General Hospital (158 articles), and Harvard Medical School (133 articles). Massachusetts General Hospital (BC =0.11) occupied a key position in the

Table 1 Top 10 productive countries and institutions in publications for DECT

Rank	Country				Institution		
	Content	Document, n	Citation, n	TLS*	Content	Document, n	BC
1	USA	1,662	51,565	1,258	Mayo Clinic, USA	178	0.04
2	Germany	1,171	42,793	1,003	Massachusetts General Hospital, USA	158	0.11
3	China	867	10,659	276	Harvard Medical School, USA	133	0.07
4	Japan	323	5,221	142	Medical University of South Carolina, USA	118	0.06
5	South Korea	317	7,204	144	Siemens Healthcare, Germany	115	0.1
6	Italy	279	6,588	384	University Hospital Frankfurt, Germany	104	0.03
7	Netherlands	270	8,395	404	University Hospital Zurich, Switzerland	101	0.06
8	Switzerland	257	8,880	285	University of Erlangen-Nuremberg, Germany	98	0.04
9	Canada	251	8,107	294	Harvard University, USA	90	0.07
10	France	155	3,867	169	Duke University, USA	87	0.05

*, TLS indicates the collaboration intensity between nodes. DECT, dual-energy computed tomography; TLS, total link strength; BC, betweenness centrality.

co-occurrence networks, as illustrated in *Figure 2C*.

Analysis of the top cited references and cocited references

A high citation analysis can help us understand the influence of articles, authors, and institutions in relevant fields (15). The most cited article, found according to the total citations among the publications, was "*Material differentiation by dual energy CT*: *initial experience*", published by Johnson TRC *et al.* The co-citation analysis of references implies that 2 references or authors are cited together in other articles. Analysis of cocitations may contribute to understanding influential references or authors in the certain field and the association between them. *Table 2* displays the 15 most co-cited references; the paper "*Dual- and multi-energy CT*: *principles*, *technical approaches*, *and clinical applications*", published by McCollough CH *et al.*, ranked first with 281 citations, followed by the papers by Johnson TRC *et al.* and Flohr TG *et al.*

Analysis of authors and co-cited authors

A total of 16,838 authors were included in this study. The top 10 most highly productive authors and the top 10 most co-cited authors are listed in *Table 3*. The most productive author was Schoepf UJ, who published 155 articles. This was followed by Vogl TJ and Alkadhi H, with 113 and 100 articles, respectively. Johnson TRC was the author with the highest number of cocitations and was cited 1,104 times in total. However, the BC value of Johnson TRC was not the highest.

Analysis of published journals

The top 15 journals in terms of publication volume are listed in *Table 4*. *European Radiology* (n=411) had the most number of articles, followed by the *European Journal of Radiology* (n=334) and the *American Journal of Roentgenology* (n=240), which accounted for 15.85%, 12.88%, and 9.25%

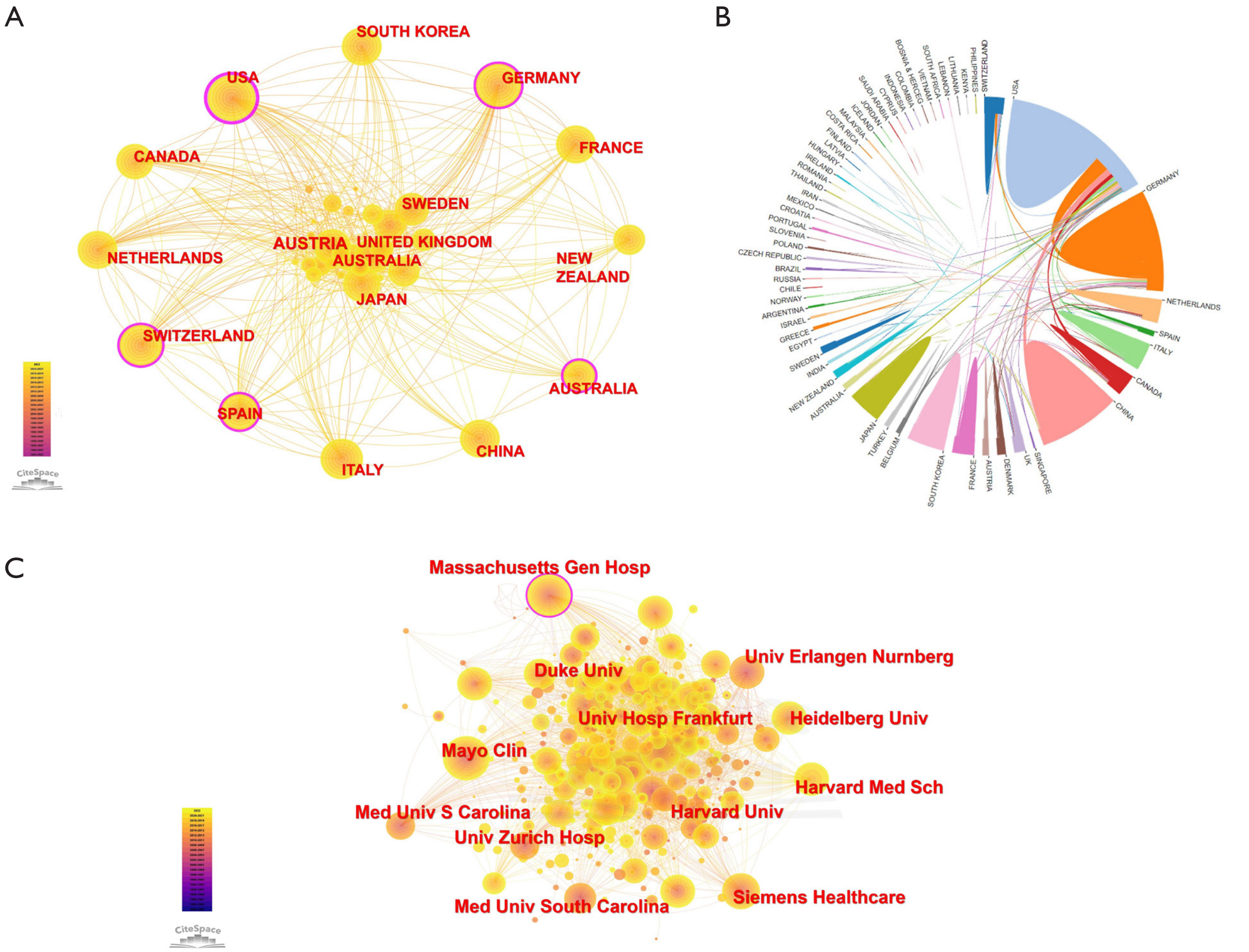

Figure 2 The visualization map of countries and institutions. (A) Map of country co-occurrence. (B) Visualization of the countries or regions. The thickness of the line represents the frequency of collaboration. (C) Co-occurrence of institutions.

of the total number of publications in the top 15 journals, respectively. Meanwhile, the top 5 journals based on h-index were *Radiology* (h-index =58), *European Radiology* (h-index =56), *American Journal of Roentgenology* (h-index =53), *Investigative Radiology* (h-index =49), and *Medical Physics* (h-index =47).

Analysis of keywords

A total of 10,173 keywords, including author keywords and keyword plus, were included in this study. We set the keyword frequency to no less than 25 times using VOSviewer, and 323 keywords were identified. After merging the keyword synonyms, the top 10 keywords in terms of frequency were "CT" (2,296 times), "dual-energy CT" (2,293 times), "CT angiography" (1,065 times), "dual-source CT" (803 times), "image quality" (642 times), "multidetector CT" (470 times), "diagnosis" (373 times), "accuracy" (371 times), "spectral CT" (334 times), and "diagnostic accuracy" (291 times). "Spectral CT", "iodine", "head", and "cancer" appeared frequently in recent years as can be seen from the overlay visualization map of keywords in *Figure 3*.

Citation burst refers to the rapid increase in the value of a variable (such as a keyword) in a short period of time. It indicates that a variable has become a hot spot during a given period and has been intensely examined and studied by the academic community (16). The top 25 keywords with

Table 2 Top 15 most cocited references

Rank	Title	First author	Journal	Year	Citation, n
1	Dual- and multi-energy CT: principles, technical approaches, and clinical applications	McCollough CH	*Radiology*	2015	281
2	Material differentiation by dual energy CT: initial experience	Johnson TRC	*European Radiology*	2007	246
3	First performance evaluation of a dual-source CT (DSCT) system	Flohr TG	*European Radiology*	2006	241
4	Dual energy CT: preliminary observations and potential clinical applications in the abdomen	Graser A	*European Radiology*	2009	117
5	State of the art: dual-energy CT of the abdomen	Marin D	*Radiology*	2014	117
6	Dual-source CT cardiac imaging: initial experience	Johnson TRC	*European Radiology*	2006	107
7	Assessment of an advanced image-based technique to calculate virtual monoenergetic computed tomographic images from a dual-energy examination to improve contrast-to-noise ratio in examinations using iodinated contrast media	Grant KL	*Investigative Radiology*	2014	106
8	Estimated radiation dose associated with cardiac CT angiography	Hausleiter J	*JAMA-Journal of the American Medical Association*	2009	102
9	Accuracy of dual-source CT coronary angiography: first experience in a high pre-test probability population without heart rate control	Scheffel H	*European Radiology*	2006	100
10	Dual-energy CT in patients suspected of having renal masses: can virtual nonenhanced images replace true nonenhanced images?	Graser A	*Radiology*	2009	100
11	Technical principles of dual source CT	Petersilka M	*European Journal of Radiology*	2008	93
12	Contrast-enhanced coronary artery visualization by dual-source computed tomography--initial experience	Achenbach S	*European Journal of Radiology*	2006	91
13	Dual-source CT in step-and-shoot mode: noninvasive coronary angiography with low radiation dose	Stolzmann P	*Radiology*	2008	90
14	Dual-energy CT-based monochromatic imaging	Yu LF	*American Journal of Roentgenology*	2012	90
15	Radiation dose estimates from cardiac multislice computed tomography in daily practice: impact of different scanning protocols on effective dose estimates	Hausleiter J	*Circulation*	2006	90

CT, computed tomography.

Table 3 Top 10 most productive authors and top 10 most cocited authors with the highest citation number

Rank	Author				Cocited author		
	Content	Document, n	Citation, n	TLS*	Content	Citation, n	BC
1	Schoepf UJ	155	5,540	795	Johnson TRC	1,104	0.16
2	Vogl TJ	113	2,908	687	McCollough CH	671	0.15
3	Alkadhi H	100	5,371	460	Flohr TG	623	0.1
4	Wichmann JL	95	2,344	675	Graser A	563	0.05
5	Schmidt B	81	4,989	354	Achenbach S	495	0.06
6	McCollough CH	77	5,887	236	Stolzmann P	495	0.04
7	De Cecco CN	68	1,738	440	Yu LF	472	0.11
8	Achenbach S	61	4,284	268	Alvarez RE	434	0.2
9	Nikolaou K	61	3,409	259	Leschka S	416	0.03
10	Krauss B	59	4,421	168	Primak AN	394	0.05

*, TLS indicates collaboration intensity between nodes. TLS, total link strength; BC, betweenness centrality.

Table 4 Top 15 journals in terms of highest number of publications

Rank	Journal	Country	H-index	Publication, n	Citation, n
1	*European Radiology*	Germany	56	411	14,984
2	*European Journal of Radiology*	Netherlands	41	334	7,569
3	*American Journal of Roentgenology*	USA	53	240	9,463
4	*Medical Physics*	United Kingdom	47	225	7,173
5	*Journal of Computer Assisted Tomography*	USA	25	169	2,091
6	*Radiology*	USA	58	151	10,856
7	*Physics in Medicine and Biology*	United Kingdom	37	149	4,258
8	*Investigative Radiology*	USA	49	145	6,652
9	*Academic Radiology*	USA	26	123	2,233
10	*British Journal of Radiology*	United Kingdom	23	121	1,748
11	*International Journal of Cardiovascular Imaging*	Netherlands	28	118	2,581
12	*Journal of Cardiovascular Computed Tomography*	Netherlands	33	108	4,003
13	*Acta Radiologica*	USA	17	107	1,010
14	*Clinical Radiology*	United Kingdom	22	98	1,440
15	*Abdominal Radiology*	USA	18	94	1,050

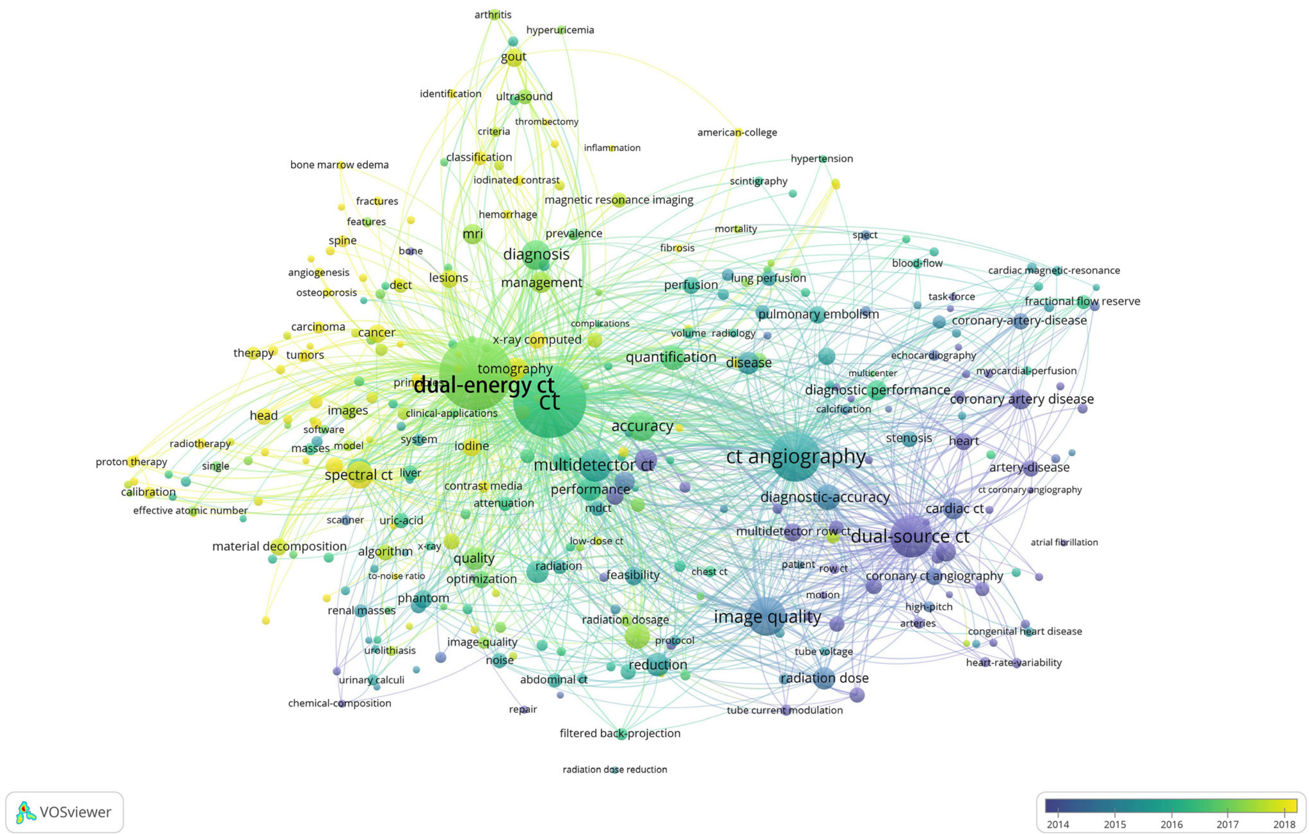

Figure 3 Overlay visualization map of keywords on VOSviewer. The size of the node represents the occurrence number of keywords. The color represents the average time of occurrence, and a color closer to yellow indicates a time closer to the present.

the strongest citation bursts are listed in *Figure 4*. "Dual-source CT", "spiral computed tomography", "coronary angiography", "initial experience", and "heart rate" were the top 5 most highly cited keywords. And the citation bursts of the above keywords mainly occurred before 2013. *Figure 4* shows the keywords "X-ray computed", "iodine quantification", "principal", "head", "deep learning", and "bone marrow edema" have been frequently cited since 2018.

A timeline map of reference cocitation is depicted in *Figure 5*, which displays 12 clusters (Q=0.85, S=0.93). As seen in *Figure 5*, the clusters arranged from top to bottom is "radiomics", "dual-energy CT", "cholangiography", "virtual monoenergetic imaging", "radiation dose", "myocardial perfusion", "gout", "pulmonary embolism", "proton therapy", "metal artifact reduction", "material decomposition", and "bone marrow edema", respectively. The earliest cluster was focalized around radiation dose. Clusters focused around radiomics, gout, proton therapy, material decomposition, and bone marrow edema have persisted until the present period.

Discussion

The number of publications on DECT has grown rapidly since 2006, indicating that DECT application remains an intense area of research. Compared with conventional reviews, bibliometric methods can help scholars grasp the developmental characteristics of a given field and guide future research by analyzing the characteristics of publications, including year of publication, authors, journals, countries, and keywords (17). Our study analyzed 4,720 reviews and articles on DECT using visualization software, including VOSviewer and CiteSpace, to summarize the status of research and hot spots.

The country collaboration analysis demonstrated that the USA published the most literature and was home to 6 of the top 10 institutions in terms of publication volume. Moreover, the USA occupied a critical position in the

Top 25 keywords with the strongest citation bursts

Keywords	Year	Strength	Begin	End
Coronary angiography	1997	31.47	1997	2011
Spiral computed tomography	2005	32.65	2005	2013
Heart	2005	15.75	2005	2011
Dual-source CT	2006	66.91	2006	2013
Initial experience	2006	30.11	2006	2013
Heart rate	2006	28.25	2006	2011
Multidetector row CT	2006	20.6	2006	2013
Diagnostic accuracy	2006	17.66	2006	2011
Performance evaluation	2006	14.89	2006	2011
Coronary artery disease	1995	14.36	2006	2013
Helical CT	2007	13.84	2007	2013
Multislice computed tomography	2008	20.46	2008	2015
Artery disease	2006	15.82	2008	2013
Radiation exposure	2008	13.48	2008	2011
Source computed tomography	2008	13.29	2008	2013
Shoot mode	2009	13.24	2009	2013
Cardiac CT	2006	12.97	2008	2013
Heart rate variability	2008	12.73	2008	2015
Renal masse	2010	12.78	2012	2015
X-ray computed	2010	26.55	2018	2022
Iodine quantification	2014	21.22	2018	2022
Principle	2015	17.22	2018	2022
Head	2014	12.81	2018	2022
Deep learning	2020	24.53	2020	2022
Bone marrow edema	2014	13.42	2020	2022

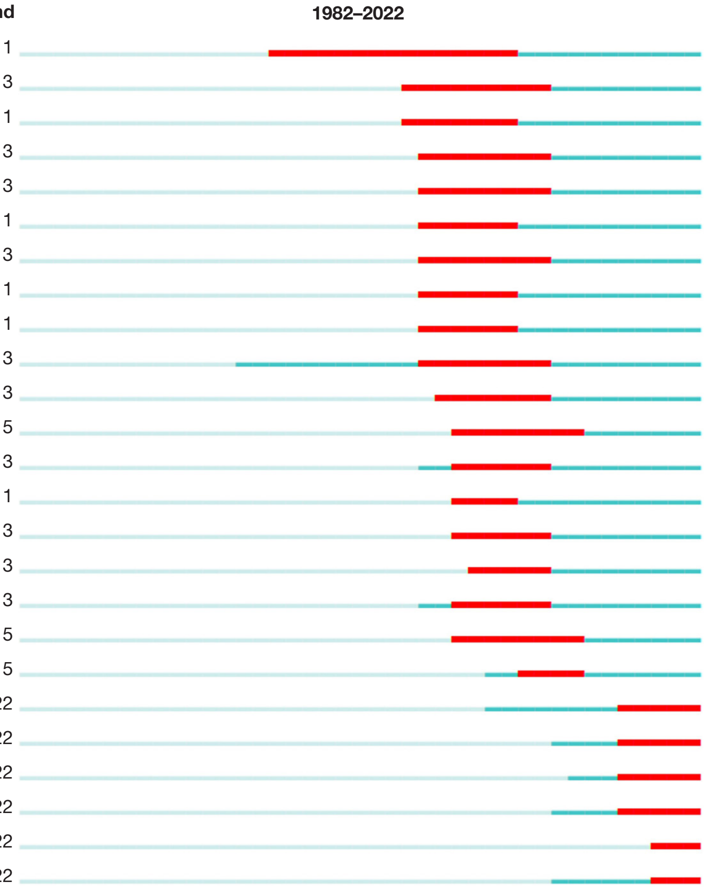

Figure 4 Top 25 keywords with the strongest citation bursts. A green line represents the time period from 1982 to 2022. A light green line indicates that a keyword has not yet appeared. A dark green line represents the period during which a keyword was studied. A red line represents the time span of a burst. CT, computed tomography.

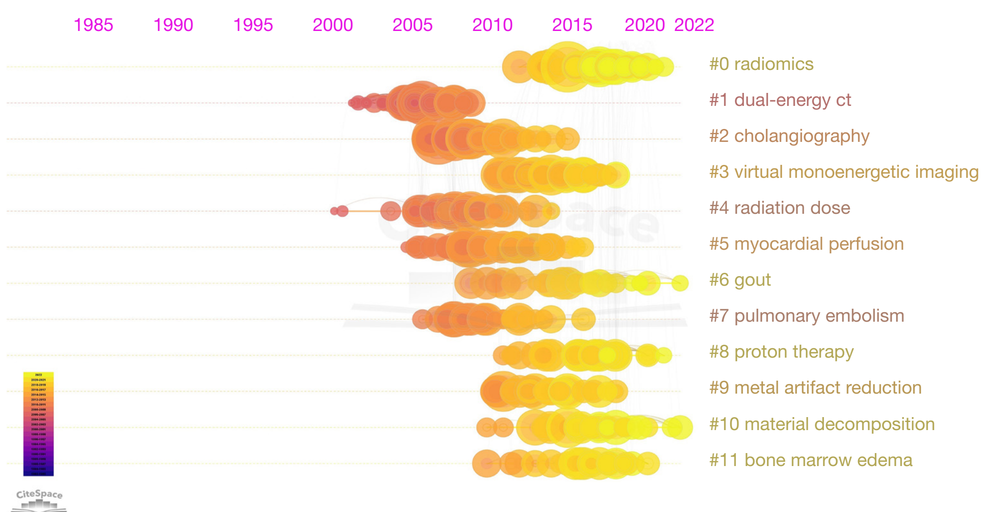

Figure 5 Timeline of reference co-citation on the application of DECT. DECT, dual-energy computed tomography. CT, computed tomography.

collaboration network, indicating that it has assumed a leading position in DECT. Germany ranked as the country with the second most publications, hosting 3 of the top 10 institutions. Although China ranked third in the number of publications, it has published far fewer articles and has much fewer citations than do the 2 countries ranked above it. China also has no top 10 institutions, suggesting a large gap between developing and developed countries. Visual analysis of the authors indicated that the author with the most publications did not also have the most citations. Among the top 10 most productive authors, only McCollough CH and Achenbach S appeared in the top 10 authors with the most citations, suggesting that prolific authors should consider not only the number of articles but also their quality. Among the top 15 most co-cited papers, 5 were published in *European Radiology* and 4 in *Radiology*. Meanwhile, the top 2 journals ranked by h-index were *Radiology* (h-index =58) and *European Radiology* (h-index =56). *European Radiology* received up to 14,984 citations, a far greater number than that of other journals, reflecting its high influence and academic status in the DECT field (14). A total of 2,593 articles were published in the top 15 productive journals, accounting for approximately 55% of the 4,720 articles. Predictably, high-quality articles with major breakthroughs are published in these journals. Cocitation analysis demonstrated that the most co-cited article, which mainly discussed the principles, acquisition techniques, and clinical applications of DECT, was published by McCollough in *Radiology* in 2015 (18).

Analysis of keywords indicated that the top 10 keywords with the highest frequency from high to low were "CT", "dual-energy CT", "CT angiography", "dual-source CT", "image quality", "multidetector CT", "diagnosis", "accuracy", "spectral CT", and "diagnostic accuracy", respectively. Dual-source and spectral CT are imaging acquisition approaches that are widely used in clinical practice (19). The dual-source CT system is equipped with two X-ray tubes and two detectors that are positioned orthogonal to each other for dual-energy scanning (20). Spectral CT includes a two-layer detector and fast-switching X-ray tubes. This method has been frequently examined in scientific research in recent years. Regardless of which approach is used, the purpose of DECT is to increase diagnostic accuracy by improving image quality or obtaining more information compared with conventional CT. For example, image quality can be improved by reducing metal artifacts with high-kiloelectron volt VMI and increasing soft tissue contrast with low-kiloelectron volt VMI (5). DECT angiography has attracted increased attention and has been widely used in diagnosing vascular diseases. DECT can be used with iodine mapping or virtual VMI to reduce the dose of contrast agent, with VMI to remove metal hardening artifacts, and with VNCa technology to remove bone or calcification in the image to disclose the lesion might be covered (21).

Timeline view and keyword burst analyses can effectively characterize the current research hot spots and emerging trends within a given timeframe. In our study, these analyses demonstrated that research on DECT can be categorized into two periods. During the first period prior to 2015, research efforts were primarily focused on disease diagnosis, with a particular emphasis on cardiovascular diseases. Atherosclerotic plaques are the predominant type of coronary artery disease. The plaque can be classified into two distinct categories of calcified and noncalcified plaques, the latter of which encompasses lipid and fibrous plaques, according to composition (22). In comparison to fibrous plaque, the lipid plaque has lower stability, and thus the accurate differentiation of these types is necessary for patient treatment. However, the conventional approach of use multidetector CT (MDCT) has difficulty in accurately discerning lipid plaque due the substantial overlap of Hounsfield values between these types (23). In contrast, DECT can accurately discriminate lipid and fibrous plaques through use of element decomposition based on quantitative parameters (e.g., Zeff), thereby facilitating individualized precision therapy (24,25).

Furthermore, DECT is also used for cardiac imaging evaluation, particularly in the assessment of infarcted myocardial tissue. Compared to myocardial perfusion imaging and single-energy CT, DECT has the ability to provide more information, such as that concerning myocardial blood supply, anatomy and function of the coronary artery, and the extent of myocardial fibrosis, without an elevated radiation dose (26-28). Of note, during the latter years of the first period, a considerable number of researchers began to pay attention to the use of DECT for imaging renal masses. This could be attributed to its imaging reconstruction benefits derived from iodine subtraction, which has enabled the acquisition of both the VNC and the enhancement of images in a single scan with a lower radiation dose (29,30). The appearance of the "renal masses" burst may represent a transition in DECT-related research focus from cardiovascular diseases to other fields.

During the second period from 2015 to 2022, the scope of research on DECT was enlarged beyond the confines of cardiovascular diseases. This period witnessed the successive emergence of keyword bursts including "iodine quantification", "deep learning", and "bone marrow edema". Iodine quantification is a typical application of material decomposition techniques, enabling the quantification of lesion enhancement degree and the illustration of the iodine distribution in blood vessels or tissues. Due to this advantage, DECT has been applied broadly in the treatment of various diseases, including both nonneoplastic and neoplastic types (31-34). Deep learning is a branch of artificial intelligence which has propelled the movement of the studies on DECT. In terms of image reconstruction, some studies have found that low-kiloelectron volt VMI reconstruction via deep learning can improve image quality in the evaluation of hypoenhanced hepatic metastasis and other liver diseases (35-37). Furthermore, deep learning can automatically segment brain tumors and surrounding healthy tissues to assist in the diagnosis of multiple myeloma (38,39). It can even predict head and neck lymph node metastasis of papillary thyroid carcinoma on DECT images (40). Furthermore, bone marrow edema is also detectable via VNCa imaging, with DECT being able to discern bone marrow edema caused by osteonecrosis, inflammatory arthritis, multiple myeloma, and bone metastases (41-43).

Limitations

Our study has some limitations. First, all documents were retrieved and downloaded from WoSCC. Although WoSCC is the most frequently used database, the literature included in this study may not represent all articles in the DECT field. Second, all papers analyzed were restricted to original articles and reviews, and conference papers were not considered. In addition, the language was limited to English. Finally, factors such as self-citation, which may have a subtle impact on bibliometrics, were not specifically considered in this study.

Conclusions

DECT has been widely used in research and clinical practice since the application of the first-generation dual-source CT system. The USA is the leading country in the field and has made a significant contribution. Prior studies in DECT were primarily concentrated on cardiovascular diseases, whereas contemporary hot spots of research have expanded to other fields, such as iodine quantification, deep learning, and bone marrow edema. With further research on postprocessing algorithms, DECT is expected to make an even greater contribution to the field of clinical imaging.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-23-467/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All data were obtained through literature retrieval based on a canonical database. No medical institutions or patients were included, and thus ethical approval or informed consent was not applicable.

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