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Review

The highly-cited Electrocardiogram-related articles in science citation index expanded: characteristics and hotspots ☆

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Abstract We used bibliometric analysis methodology in the expanded Science Citation Index to identify highly-cited electrocardiogram (ECG)-related articles with total citations (TC2012) exceeding 100 from the publication year to 2012. Web of Science search tools were used to identify the highly-cited articles. The aspects analyzed for highly cited publications included effect of time on citation analysis, journals and Web of Science categories, number of authors per publication, originating institutions and countries, total citation and total citation per year life cycles of articles (C2012) and research hotspots. Results showed that a total of 467 electrocardiogram-related publications were regarded as the highly-cited publications. TC2012 ranged from 101 to 2879, with 215 as the average number of citations. No highly-cited publications have emerged yet during the first two years of the present 2010 Decade. All 11 countries and institutions originating highly-cited ECG-related publications were developed countries, USA in 9 of them. Four subject categories were identified as hotspots by total citations TC2012 and C2012: atrial fibrillation, long QT syndrome, angina and myocardial infarction, and risk factor analysis and health evaluation.
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Keywords: Bibliometric; Electrocardiogram (ECG); Highly-cited articles; Hotspots

Introduction

Electrocardiogram (ECG) has played an important role in our understanding of heart disease. With the fast expansion of ECG research and applications, review articles have assumed an increasingly important role in evaluating trends in ECG research and in identification of hotspots in this realm of research. Review articles written by experts on their field of research are one of the primary sources of information about research findings, trends and hot spots in specific high priority areas. However, the high volume of ECG-related publications in many subject areas makes consideration of all potentially relevant articles an impossible task. Furthermore, each expert has his own preferences and special focus. Advances in bibliometric analysis methodology such as expanded Science Citation Index and Web of Science search tools have made it possible to perform an objective comprehensive analysis of ECG-related publications ever published [1–4]. We used these tools to identify highly-cited publications with total citations 100 or more since 1900, and analyzed the characteristics including effect of time on citation analysis, journals and Web of Science subject categories, publication performances (authors,

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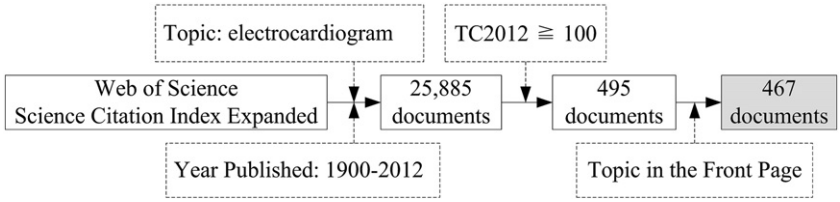

Fig. 1. Schematic for searching the highly-cited ECG articles.

institutions, and countries), total citation (TC2012) and total citation per year life cycles of articles (C2012). TC2012 and C2012 were also used to identify research hotspots.

Methods

We used bibliometric analysis methodology to perform a systematic search for highly-cited ECG publications in the database of Web of Science from Thomson Reuters (updated on 19 June 2013). A schematic for the search is shown in Fig. 1 [1]. Documents from 1900 to 2012 with keyword "electrocardiogram" in document titles, abstracts, author keywords, and keywords plus were searched in Web of Science. Other document types, such as meeting abstracts, notes, reviews, letters, editorial materials, corrections, book chapters, correction additions, discussions, book reviews, abstracts of published items, reprints, news items, bibliographies, items about an individual, software reviews, biographical items, and hardware reviews were excluded [1]. Secondly, in order to ensure repeatability to provide more scientific and accurate information, TC2012 was used as a filter. The label 'TC2012' refers to the count of total citations since the article was published to the end of 2012. And publications identified by TC2012 with more than 100 citations were referred to as the highly-cited publications. The final filter was the front page with searched keywords in their title, abstract, and author keywords. Web of Science search tools were used to identify the highly-cited articles, describing their characteristics such as effect of time on citation analysis, journals, and Web of Science subject categories, publication performances (authors, institutions, and countries), citation life cycles with the highest TC2012 and C2012 and the research topic. In bibliometric terminology, TC2012 signifies total count of citations since the article was published to the end of 2012, C2012 is the total number of citations of the document in 2012 [2], and C0 is the total number of citations of a document in its publication year [3]. TC2012 and C2012 were used to identify research hotspots. All results were analyzed using Microsoft Excel 2007. For more details, refer to article by Chiu et al. [4].

Results

Effect of time on citation analysis results

There were 25,885 articles from 1900 to 2012 with "electrocardiogram" or "Electrocardiography" in titles, abstracts, author keywords, or keywords plus in Web of Science. At the latest count, a total of 467 ECG-related articles were considered highly-cited (TC2012 > 100). TC2012 ranged from 101 to 2789 citations and 215 citations per publication (CPP).

Fig. 2 illustrated the distribution of these 467 articles over the years and their CPP. Only two of the highly-cited articles were published in the 1910s and 1920s, while 51% of the highly-cited articles appeared in the 1990s. In particular, the decade of the 1920's with two publication had much higher CPP (1424), which can be attributed to the article by Bazett in 1920 entitled "An analysis of the time-relations of electrocardiograms" [5] with a TC2012 of 2704. The CPP's of the other 10 decades were found to fluctuate from a range of 138 to 303. The article entitled "Über die richtung und die manifeste grösse der potentialschwankungen im menschlichen herzen und über den einfluss der herzlage auf die form des elektrokardiogramms" [6] was the only one article published in non-English language, German by Einthoven. Einthoven, as well known, received a Nobel Prize in 1924, not for his string galvanometer but for his discovery of the mechanism of the ECG. This article was also the earliest highly-cited ECG article in SCI-Expanded. All others were published in English between 1915 and 2010. The latest highly-cited articles were published in 2010, including "Patient-specific induced pluripotent stem-cell models for long-QT syndrome"[7], "Coronary computed tomography angiography with a consistent dose below 1 mSv using prospectively electrocardiogram-triggered high-pitch spiral acquisition" [8], "2010 appropriate use criteria for cardiac computed tomography" [9], and "Recommendations for interpretation of 12-lead electrocardiogram in the athlete" [10]. No highly-cited articles have yet emerged in the most recent years 2011 and 2012. Similar result in lack of recent highly-cited articles was also reported in engineering [2] and social science [11] research fields.

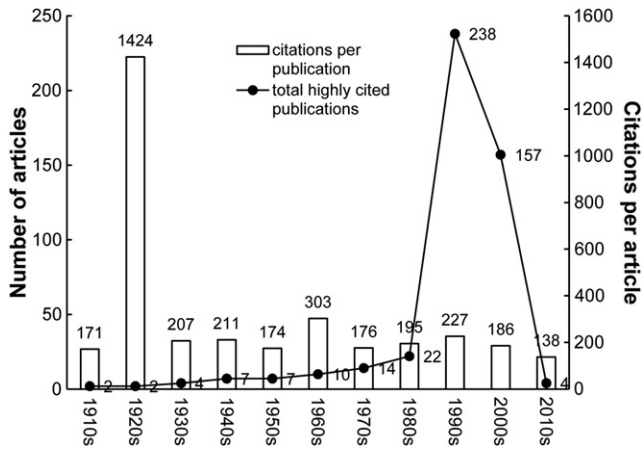

Fig. 2. Number of the highly-cited ECG-related articles and citations per publication by decade.

Table 1
Characteristics of top 11 journals with the highly-cited Articles.

Journal	TC (%)	IF2012	Web of Science Category
Journal of the American College of Cardiology	68 (15)	14.086	cardiac and cardiovascular systems
American Journal of Cardiology	29 (6.2)	3.209	cardiac and cardiovascular systems
New England Journal of Medicine	28 (6.0)	51.658	general and internal medicine
Circulation	25 (5.4)	15.202	cardiac and cardiovascular systems peripheral vascular disease
JAMA—Journal of the American Medical Association	23 (4.9)	29.978	general and internal medicine
Lancet	22 (4.7)	39.06	general and internal medicine
American Heart Journal	18 (3.9)	4.497	cardiac and cardiovascular systems
British Heart Journal	16 (3.4)	N/A	cardiac and cardiovascular systems history and philosophy of science
IEEE Transactions On Biomedical Engineering	13 (2.8)	2.348	biomedical engineering
Annals of Internal Medicine	11 (2.4)	13.976	general and internal medicine
Diabetes Care	10 (2.1)	7.735	endocrinology and metabolism

TC: Total number of highly-cited articles; *IF2012*: impact factor in 2012.

Journals and Web of Science Subject Categories

Medical journals have become increasingly concerned about the subject categories of highly-cited articles revealing current research trends because of their concern about maintaining or enhancing their impact factor [1,3]. Although not shown, the highly-cited ECG-related articles were distributed broadly, among 134 journals which implied that ECG was the foundation to many research topics. Of these journals, 84 (63%) contained only one article; 25 (19%) contained two articles; 5 (3.7%) contained three articles; and 20 (15%) contained more than three articles. Table 1 showed the top 11 journals which published at least 10 highly-cited articles, accounting for 57% of all highly-cited articles. This demonstrates that high quality ECG research was published in a relatively narrow forum of journals which covered mostly two subject areas: cardiac and cardiovascular systems, and general and internal medicine. Five journals in the category of cardiac and cardiovascular systems accounted for 154 articles from the 261 articles in 11 top journals considered. In the journals of the general and internal medicine category, four journals accounted for 84 articles from the 261 articles in 11 top journals considered. From the top 6 journals considered in the above counts, the American Journal of Cardiology had an impact factor 3, and the remaining 5 had an impact factor over 10.

The highly-cited publications were distributed among 56 Web of Science categories: The category cardiac and cardiovascular systems was the most common category in 122 journals considered (190;41%), followed by the categories of general and internal medicine (102; 22%) with 151 journals, and peripheral vascular disease (52; 11%) with 67 journals. These three main categories published 67% of all highly-cited articles.

Publication performances: authors, institutions, and countries

Total number of the highly-cited ECG-related articles and number of authors per article by depicted were shown in Fig. 3. The average number of authors per article increased from 2.0 in 1910s and 1.0 in 1920s to 10 in 1990s and up to 16 in 2010s. Of the 467 highly-cited articles, 17 (3.6%) were written by single author, 31 (6.6%) by two authors, 52 (11%) by three authors, 57 (12%) by four authors, 65 (14%) by five authors, 55 (12%) by six authors, 24 (5.1%) by seven authors, and 166 (36%) by more than seven authors. The average number of authors per publication was 8.6 with 380 as the largest number of authors for a single article in 1996, who were members of work group for the global use of strategies to open occluded coronary arteries (GUSTO) IIb trial [12].

The contributions from institutes and countries/territories were identified by the appearance of at least one author in the articles. Collaboration type was determined by the affiliations of the authors. 28 articles were excluded, because they did not have any author address information in the Web of Science. The 439 articles that specified addresses were further analyzed regarding institutions, and countries/territories. Of the 439 highly-cited ECG-related articles, 171 (81%) articles were from independent institutions, 268 articles from inter-institutional collaborations publications, 355 (81%) articles from single-country and 84 (19%) articles from internationally-collaborations.

USA has a dominant role in ECG-related research as demonstrated by the fact that most of the 11 institutions with highly-cited publications were from USA (Table 2). Harvard University ranked first with 25 highly-cited publications. University of Padua (Italy) and St George Hosp. (UK) were

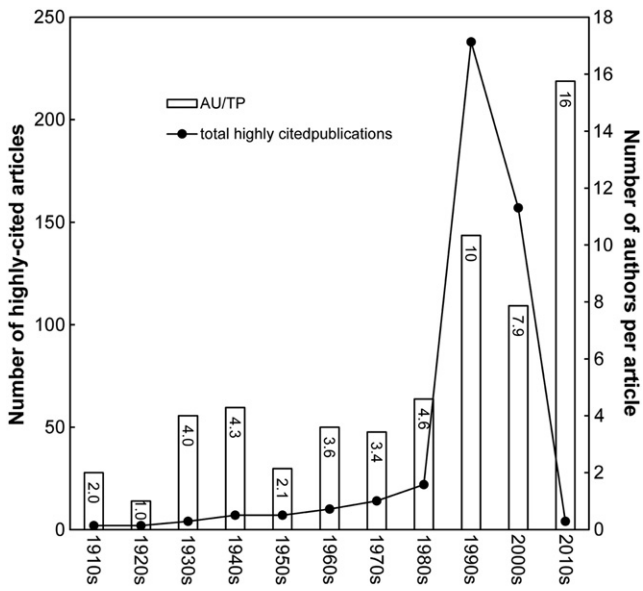

Fig. 3. Number of the highly-cited ECG-related articles and number of authors per article by decade.

Table 2
Top 11 institutions of highly-cited articles (TC ≥ 10).

Institute	TC	TCR (%)	ICR (%)	CCR (%)	FCR (%)	RCR (%)	S%
Harvard Univ, USA	25	1 (5.7)	10 (1.2)	1 (8.6)	1 (1.6)	2 (1.6)	8.0
Brigham & Women's Hosp, USA	17	2 (3.9)	N/A	2 (6.4)	1 (1.6)	6 (1.1)	N/A
NHLBI, USA	14	3 (3.2)	N/A	3 (5.2)	78 (0.23)	65 (0.27)	N/A
Univ Washington, USA	14	3 (3.2)	8 (1.7)	4 (4.1)	8 (1.1)	6 (1.1)	21
Duke Univ, USA	12	5 (2.7)	29 (0.58)	4 (4.1)	8 (1.1)	6 (1.1)	8.3
Univ Pittsburgh, USA	12	5 (2.7)	10 (1.2)	8 (3.7)	15 (0.91)	6 (1.1)	17
Univ Michigan, USA	11	7 (2.5)	1 (2.9)	15 (2.2)	5 (1.4)	2 (1.6)	45
Boston Univ, USA	11	7 (2.5)	N/A	4 (4.1)	21 (0.68)	16 (0.82)	N/A
Univ Padua, Italy	11	7 (2.5)	N/A	4 (4.1)	5 (1.4)	4 (1.4)	N/A
St George Hosp, UK	10	10 (2.3)	3 (2.3)	15 (2.2)	1 (1.6)	1 (1.9)	40
Washington Univ, USA	10	10 (2.3)	3 (2.3)	15 (2.2)	1 (1.6)	16 (0.82)	40

TC: total number of highly-cited articles; TCR (%), ICR (%), CCR (%), FCR (%), and RCR (%): the rank and percentage of total articles, country independent articles, internationally collaborative articles, first author articles, and corresponding author articles in their total articles; S%: the percentage of country independent articles in total articles for each country.

the other two institutions of highly-cited articles ranking 9th and 10th. Table 3 showed the top 11 countries producing the most amount of highly-cited articles. And USA also ranked first in producing highly-cited articles (246 articles, of these 181 single-country articles, 77 international collaborative articles) with an overwhelming majority. The US produced the most single-country (51%), internationally-collaborative (77%), first-author (50%), and corresponding-author articles (48%). UK, Germany and Japan ranked from 2 to 4 in all of these indicators. Articles originating from Japan were mostly single country articles demonstrating its ability to conduct its own research.

Citation life cycles of articles with the highest TC2012 and C2012

Citation life cycles of articles with the highest TC2012

Characteristics of the top five highly-cited ECG-related articles with more than 1000 total citations by 2012 were shown in Fig. 4 and summarized in Table 4. Ranked number 2 was Bazett's article titled "An analysis of the time-relations of electrocardiograms", which was published in 1920 in Heart—A Journal for the Study of the Circulation [5] and reprinted in the Annals of Noninvasive Electrocardiography in 1997 [13]. The second "old-timer" from the five highly-cited articles was the 1960 article by Blackburn et al. published in Circulation [14]. Then there were 3 more recent highly-cited articles. The top-ranking article from these three was the article by Haissaguer et al. from 1998 titled "Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary vein" with 2789 citation [15]. The data in this article opened up new prospects for invasive intervention on atrial fibrillation. Ranked number 3 was the article by Marmott et al. from 1991 titled " Health inequalities among British civil servants: The Whitehall II study" published in Lancet [16]. The most recent of the highly-cited articles was the article by Antman et al. titled " The TIMI risk score for unstable angina/non-ST elevation MI: A method for prognostication and therapeutic decision making" published in 2000 in JAMA [17]. All five of these top-ranking articles involved topics which had turned out to be important for risk stratification for diagnostic/therapeutic applications or preventive intervention efforts.

One interesting observation from our careful bibliometric review was that Bazett in fact did not introduce the formula bearing his name. Bazett introduced a formula for electrical systole as a function of square root of the cycle length [5]. The formula labeled QTc was introduced in 1947 by Taran and Szilagyi [18]. This finding also demonstrates the versatility of the blibiometric method.

Table 3
Top 11 countries of highly-cited articles.

Country	TC	*TCR* (%)	*ICR* (%)	*CCR* (%)	FCR (%)	RCR (%)	S%
USA	246	1 (56)	1 (51)	1 (77)	1 (50)	1 (48)	74
UK	66	2 (15)	2 (11)	2 (33)	2 (11)	2 (11)	58
Germany	42	3 (9.6)	3 (7.3)	4 (19)	3 (6.8)	3 (7.9)	62
Italy	40	4 (9.1)	5 (5.4)	3 (25)	4 (6.4)	4 (6.5)	48
Netherlands	34	5 (7.7)	4 (5.6)	5 (17)	5 (5.2)	5 (4.9)	59
Canada	25	6 (5.7)	7 (3.1)	5 (17)	7 (2.7)	7 (2.4)	44
France	20	7 (4.6)	8 (2.8)	8 (12)	8 (2.5)	9 (2.2)	50
Japan	20	7 (4.6)	6 (5.1)	21 (2.4)	6 (4.1)	6 (4.6)	90
Finland	19	9 (4.3)	9 (2.3)	7 (13)	8 (2.5)	7 (2.4)	42
Sweden	15	10 (3.4)	10 (1.4)	8 (12)	10 (1.8)	9 (2.2)	33
Belgium	11	11 (2.5)	16 (0.28)	8 (12)	14 (0.68)	14 (0.82)	9

TC: total number of highly-cited articles; TCR (%), ICR (%), CCR (%), FCR (%), and RCR (%): the rank and percentage of total articles, country independent articles, internationally collaborative articles, first author articles, and corresponding author articles in their total articles; S%: the percentage of country independent articles in total articles for each country.

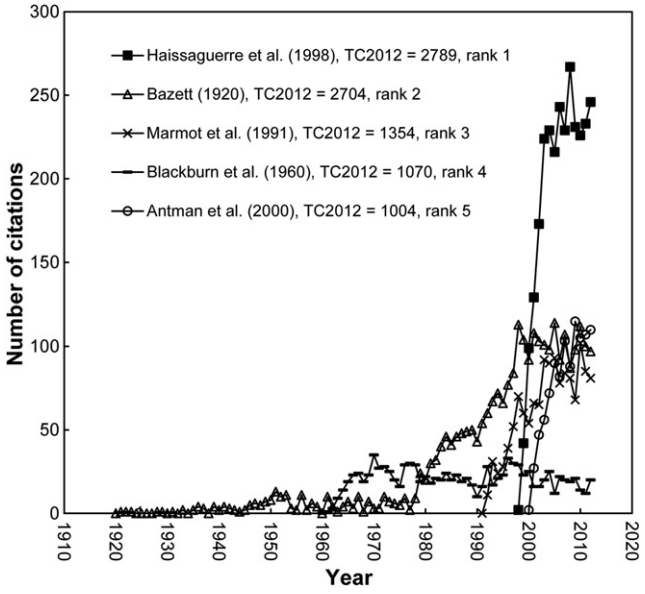

Fig. 4. Citation life cycles of the top five highly-cited ECG-related articles (TC2012 > 1000).

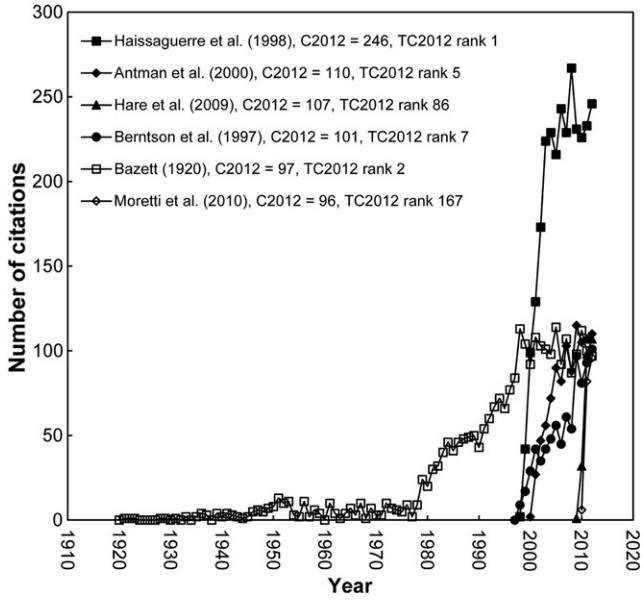

Fig. 5. Citation life cycles of the top six highly-cited ECG-related articles (C2012 > 90).

Citation life cycle of articles with the highest C2012

TC2012 of highly cited articles was a good indicator to identity the research hotspots in ECG related field. Yet some defects exist, such as the low citations of recent publications, and high TC2012 for a sufficiently long time to accumulate. Therefore, the number of times one ECG-related article cited in 2012 (C2012) was a necessary indicator used to research the hotspots. As shown in Fig. 5 and more detailed in Table 5, five out of the six top-ranking articles were published in 1997 and later, and only the Bazett's 1920 article remained among the six high-ranking articles in 2012. This indicated that QT and QT prolongation were among the more recent high interest topics in ECG-related research. The five other highly-cited ECG-related publications ranked by C2012 as hot topics were the 1998 article by Haissaquerrre titled "Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins" [15], the article by Antman et al. from 2000 titled "The TIMI risk score for unstable angina/non-ST elevation MI: A method for prognostication and therapeutic decision making" [17], the 2009 article by Hare et al. titled "A Randomized, Double-Blind, Placebo-Controlled, Dose-Escalation Study of Intravenous Adult Human Mesenchymal Stem Cells (Prochymal) After Acute Myocardial Infarction [19], the article from 1997 by Berntson et al. titled "Heart rate variability: Origins, methods, and interpretive caveats"[20], and the sixth article titled "Patient-Specific Induced Pluripotent Stem-Cell Models for Long-QT Syndrome" by Moretti et al. from 2010 [7].

Discussion

The characteristics and hotspots of the highly-cited ECG-related articles were identified and analyzed in this article. The results of citation analysis over time showed that the ECG-related research had a quickly increasing trend in the Twentieth century, especially from the 1980s to 2010s, which suggests that more and more researchers become concerned about this subject. The analysis of the journals also suggests that the authors were inclined to submit their best publications to journals with a high impact factor, to obtain a wider recognition for their publication. On the other hand, high-quality articles also tend to enhance the impact factor of the journal publishing the article. This was a

Table 4
Characteristics of the top five highly-cited ECG-related articles (*TC2012* > 1000).

Rank (TC2012)	Rank (C2012)	Rank (TC/Y)	Article title (Journal)	Year	Reference
1 (2789)	1 (246)	1 (199)	Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins. (*New England Journal of Medicine*)	1998	Haissaguerre et al. (1998)
2 (2704)	5 (97)	52 (29)	An analysis of the time-relations of electrocardiograms. (*Heart—A Journal for the Study of the Circulation*)	1920	Bazett (1920)
3 (1354)	7 (81)	9 (64)	Health inequalities among British civil servants: The Whitehall II study. (*Lancet*)	1991	Marmot et al. (1991)
4 (1070)	83 (20)	89 (21)	The electrocardiogram in population studies: A classification system. (*Circulation*)	1960	Blackburn et al. (1960)
5 (1004)	2 (110)	4 (84)	The TIMI risk score for unstable angina/non-ST elevation MI: A method for prognostication and therapeutic decision making. (*JAMA—Journal of the American Medical Association*)	2000	Antman et al. (2000)

TC2012: number of citations till 2012; *C2012*: number of citations in 2012; *TC/Y*: total citations per year.

Table 5
Characteristics of the top six highly-cited ECG-related articles (*C2012* > 90).

Rank (TC2012)	Rank (C2012)	Rank (TC/Y)	Article title (Journal)	Year	Reference
1 (2789)	1 (246)	1 (199)	Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins. (*New England Journal of Medicine*)	1998	Haissaguerre et al. (1998)
5 (1004)	2 (110)	4 (84)	The TIMI risk score for unstable angina/non-ST elevation MI: A method for prognostication and therapeutic decision making. (*JAMA—Journal of the American Medical Association*)	2000	Antman et al. (2000)
86 (238)	3 (107)	5 (79)	A Randomized, Double-Blind, Placebo-Controlled, Dose-Escalation Study of Intravenous Adult Human Mesenchymal Stem Cells (Prochymal) After Acute Myocardial Infarction (Journal of the American College of Cardiology)	2009	Hare et al.(2009)
7 (810)	4 (101)	14 (54)	Heart rate variability: Origins, methods, and interpretive caveats (Psychophysiology)	1997	Berntson et al. (1997)
2 (2704)	5 (97)	52 (29)	An analysis of the time-relations of electrocardiograms. (*Heart-A Journal for the Study of the Circulation*)	1920	Bazett (1920)
167 (184)	6 (96)	3 (92)	Patient-Specific Induced Pluripotent Stem-Cell Models for Long-QT Syndrome (*New England Journal of Medicine*)	2010	Moretti et al. (2010)

TC2012: number of citations till 2012; *C2012*: number of citations in 2012; *TC/Y*: total citations per year.

Matthew effect in the realm of medical publishing. The broad distribution of the highly-cited ECG-related articles among many journals demonstrates that ECG is the foundation related to many disciplines and research topics. Yet, the forum of journals publishing ECG-related articles is relatively narrow, converging to a small stage.

The highly-cited articles can show research hotspots and trends by themselves [21]. Yet bibliometric methods using TC2012 and C2012 were more efficient in identifying the hotspots in ECG-related research. The total citation analysis (TC2012) of highly-cited articles reflects overall performance and trends for the future [21]. The single-year citation analysis (C2012) of the highly-cited articles describes the characteristics and hotspots of that year [1]. Among the 11 articles selected, there were 3 common articles [5,15,17] ranked both by TC2012 and C2012. 1 article [14] was excluded from the 8 articles for the low citations of recent publications and the other 7 articles were reviewed and analyzed for the hotspots. In total, four hotspots were discovered: atrial fibrillation [15], long QT Syndrome [5,7,18], angina and myocardial infarction [17,19], and risk factor analysis and health evaluation [16].

Conclusion

Bibliometric analyses revealed that there was a strongly increasing trend in the frequency of citations of ECG-related publications from 1980s to 2010 with an increasing number of investigators becoming active in this realm of research. Most of the highly-cited publications originated from developed countries. Atrial fibrillation, long QT syndrome, angina and myocardial infarction, and risk factor analysis and health evaluation were identified as ECG-research hotspots.

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References

[1] Fu HZ, Wang MH, Ho YS. The most frequently cited adsorption research articles in the Science Citation Index (Expanded). J Colloid Interface Sci 2012;379(1):148–56.
[2] Ho YS. Top-cited articles in chemical engineering in Science Citation Index Expanded: a bibliometric analysis. Chin J Chem Eng 2012;20(3):478–88.
[3] Ho YS. The top-cited research works in the Science Citation Index Expanded. Scientometrics 2013;94(3):1297–312.
[4] Chiu WT, Ho YS. Bibliometric analysis of homeopathy research during the period of 1991 to 2003. Scientometrics 2005;63(1):3–23.
[5] Bazett HC. An analysis of the time-relations of electrocardiograms. Heart A J Study Circ 1920;7(4):353–70.
[6] Einthoven W, Fahr G, de Waarf A. Über die richtung und die manifeste grösse der potentialschwankungen im menschlichen herzen und über den einfluss der herzlage auf die form des elektrokardiogramms. Pflugers Archiv fur die Gesamte Physiologie des Menschen und der Tiere 1913;150(6/8):275–315.
[7] Moretti A, Bellin M, Welling A, et al. Patient-specific induced pluripotent stem-cell models for long-QT syndrome. N Engl J Med 2010;363(15):1397–409.
[8] Achenbach S, Marwan M, Ropers D, et al. Coronary computed tomography angiography with a consistent dose below 1 mSv using prospectively electrocardiogram-triggered high-pitch spiral acquisition. Eur Heart J 2010;31(3):340–6.
[9] Taylor AJ, Cerqueira M, Hodgson JM, et al. ACCF/SCCT/ACR/AHA/ASE/ASNC/NASCI/SCAI/SCMR 2010 appropriate use criteria for cardiac computed tomography. J Am Coll Cardiol 2010;56(22):1864–94.
[10] Corrado D, Pelliccia A, Heidbuchel H, et al. Recommendations for interpretation of 12-lead electrocardiogram in the athlete. Eur Heart J 2010;31(2):243–59.
[11] Ho YS. Classic articles on social work field in Social Science Citation Index: a bibliometric analysis. Scientometrics 2014;98(1):137–55.
[12] Topol E, Califf R, Granger C, et al. A comparison of recombinant hirudin with heparin for the treatment of acute coronary syndromes. The Global Use of Strategies to Open Occluded Coronary Arteries (GUSTO) IIb investigators [J]. N Engl J Med 1996;335(11):775–82.

[13] Bazett HC. An analysis of the time-relations of electrocardiograms. Ann Noninvasive Electrocardiol 1997;2:177–94.
[14] Blackburn H, Keys A, Simonson E, et al. The electrocardiogram in population studies a classification system. Circulation 1960;21:1160–75.
[15] Haissaguerre M, Jais P, Shah DC, et al. Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins. N Engl J Med 1998;339:659–66.
[16] Marmot MG, Smith GD, Stansfeld S, et al. Health inequalities among British civil servants: the Whitehall II study. Lancet 1991;337(8754):1387–93.
[17] Antman EM, Cohen M, Bernink PJ, et al. The TIMI risk score for unstable angina/non-ST elevation MI: a method for prognostication and therapeutic decision making. JAMA 2000;284:835–42.
[18] Taran LM, Szilagyi N. The duration of the electrical systole (QT) in acute rheumatic carditis in children. Am Heart J 1947;33:14–26.
[19] Hare JM, Traverse JH, Henry TD, et al. A randomized, double-blind, placebo-controlled, dose-escalation study of intravenous adult human mesenchymal stem cells (prochymal) after acute myocardial infarction. J Am Coll Cardiol 2009;54:2277–86.
[20] Berntson GG, Thomas-Bigger J, Eckberg DL, et al. Heart rate variability: origins, methods, and interpretive caveats. Psychophysiology 1997;34:623–48, http://dx.doi.org/10.1111/j.1469-8986.1997.tb02140.x.
[21] Ma JP, Fu HZ, Ho YS. The top-cited wetland articles in Science Citation Index Expanded: characteristics and hotspots. Environ Earth Sci 2013;70:1039–46.