



# Bibliometric analysis of chest pain: A holistic approach from an emergency medicine perspective

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## Abstract

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**Aim:** Chest pain is the second reason of admissions to the emergency department (ED) after injury. In this study it was aimed to make a perspective by examining scientific manuscripts published on chest pain from an emergency medicine perspective with statistical methods.

**Materials and Methods:** Exploratory and descriptive bibliometric study conducted in Ankara, Turkey. Database of Web of Science (WoS) was the source of this study. The articles indexed between the years 1980 and 2022 were included. The manuscripts of the current year (2023) were excluded because the factors affecting it were not yet clear. "Chest Pain" were the used keyword in searching the articles.

**Results:** By analyzing the WoS database using the term "chest pain", we arrived at a total of 3,329 publications. When the citations of the documents written about chest pain were evaluated, we detected that in 2021 more citations were made than the other years. Co-citation analysis showed 11,310 authors researching the topic of chest pain. Collaboration and citation collaboration has been observed between Duke University, Harvard University, and the Mayo Clinic. Coronary artery disease and acute coronary syndrome were found the strongest relationship with chest pain.

**Conclusion:** It is observed that publications on chest pain are associated with acute coronary syndrome (ACS) and this diagnosis has the highest publication, citation and impact power. The number of publications on other fatal clinical conditions presented with chest pain is relatively low.



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## Introduction

Chest pain is the second reason of admissions to the emergency department (ED) after injury in United States of America (USA). The number of ED applications per year due to chest pain is more than 7.6 million, accounting for 4.7% of all admissions. The annual number of outpatient visits reaches approximately 4 million [1]. The prevalence of chest pain is between 20-40% in the USA, and women describe this complaint more than men [2]. Extensibility of pain around the chest, neck, arms, shoulders, upper abdomen, or pain, tension, pressure or discomfort in jaw, like dyspnea and fatigue must be considered as equal to angina pectoris [3].

Diagnoses of patients applied to the ED with non-traumatic chest pain often present a challenge, and there is an extensive list of suspected diagnoses for patients complaining of acute chest pain. Chest pain is often the clinical manifestation of many benign conditions, with a few

fatal cases. 5.1% of patients in ED complaining of chest pain are diagnosed with acute coronary syndrome (ACS). About half receive non-cardiac diagnoses [4]. Still, chest pain is the most common presenting symptom for ACS. In USA, more than 18.2 million adults are affected by ACS. Therefore, ACS is the most common reason of death regardless of gender, as causes more than 365,000 deaths per year [5].

Optimal management should be initiated quickly in life-threatening conditions. Pulmonary embolism (PE) and aortic dissection are other life-threatening conditions along with ACS as well as in patients with non-vascular syndromes (tension pneumothorax or esophageal rupture, etc.) [6].

The first step of evaluation should include medical history, physical examination, vital signs, and related techniques. Based on the possibility that symptoms are attributable to myocardial infarction (MI), an accurate and effective triage takes place first in the emergency approach to chest pain. It should not be rushed to register for atypical chest

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pain. Also, the chest pain is not always correlated with the severity of the clinical condition, and sometimes the patient may talk about a feeling of restlessness. Instead of all the classifications of chest pain as typical and atypical; pain must be defined as non-cardiac, possibly cardiac, or cardiac as these terms around it's relationship with cardiac pathologies are more specific to the possible diagnosis [3]. Evaluation of chest pain begins in ED to determine the etiology. This includes evaluation of life-threatening pathologies such as ACS, aortic dissection, pulmonary embolism and tension pneumothorax. In clinic, the shape, location, duration, spread, factors that alleviate or increase the pain, and additional complaints should be recorded. Anginal symptoms are felt by patients in retrosternum as chest discomfort (eg, pressure, heaviness, tension, discomfort, constriction, tightness). Sharp-type chest pain that tends to increase with inspiration and lying down on the back is unlikely to be in relationship with due to ischemic heart disease (for example, symptoms like this often signs to a potential diagnose of pericarditis). Following examination and auscultation evaluation after the anamnesis, the relevant initial evaluation techniques include electrocardiogram and direct chest X-ray [3].

Studies that analyze scientific publications and books on a subject with statistical methods are bibliometrics. With reading a bibliometric study, a researcher can dominate the literature about a determined subject in a very short time [6]. Although there are many publications, clinical guidelines and systematic reviews in the literature on chest pain, there is no bibliometric analysis presenting them together. Within the framework of all these reasons, it was aimed in this study to make statistical analyzes on the chest pain literature and to make a general evaluation from a multidisciplinary perspective.

## Materials and Methods

### Access to the database

Database of Web of Science (WoS) database is the source of the study and this database includes Russian Science Citation Index, Korean journal database, Sci ELO citation index and core collection index. Articles published between the years 1980 and 2022 were included, and the studies of current year (2023) were excluded since their effects are not clear now. "Chest Pain" were used as keywords in searching the WoS.

### Visualizing the data

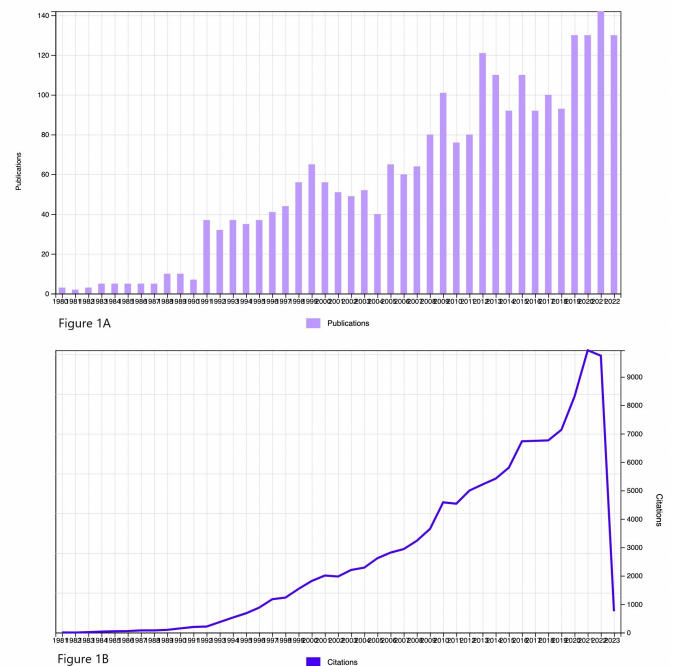
A free open web-based application (Datawrapper) was used to see global productivity of researchers. Another program called Vos-viewer 2019 was used to notice the scientific validity of data. While using keywords in WoS, the results were categorized on the basis of related branches of science, related institutes, working groups and funding agencies, adhering to the website interface. In order to avoid repetition and missing data during categorization, the obtained data text was visualized twice on the WoS viewer interface. The images obtained with the visualization program used have been rearranged to be reader friendly, adhering to the original. The author made power analysis for the sample size, and it was determined that

at least 1500 articles should be reached with 90% reliability and 5% margin of error. During the power analysis, the bibliometric analysis of Emre Demir was taken as a basis [7].

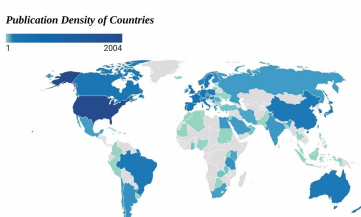
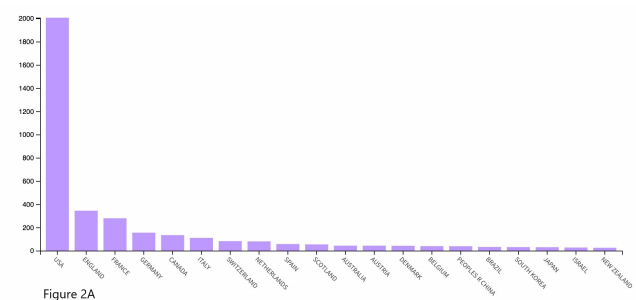
## Results

### Global productivity and general features

We found 3,329 publications by scanning the database of WoS using the term "Chest Pain". We excluded 429 studies of current year (2023) from evaluation, because the citations were incompleated yet. We saw that the earliest



**Figure 1.** A Graph of publications about chest pain by years. B Graph of citations about chest pain by years.



**Figure 2.** A The top ten publishing country charts on chest pain. B Chest pain publication density according to the countries.

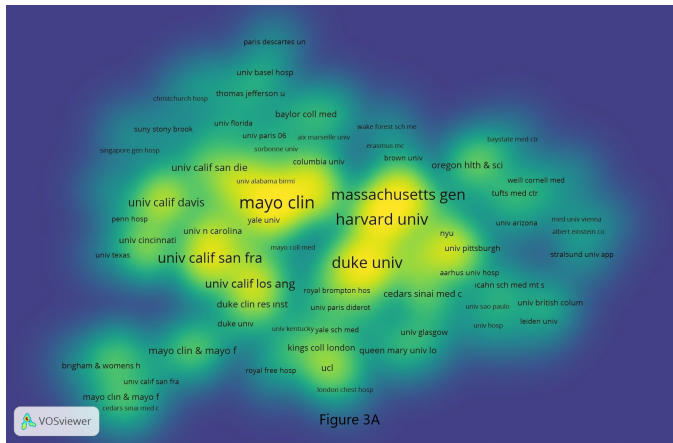


Figure 3A

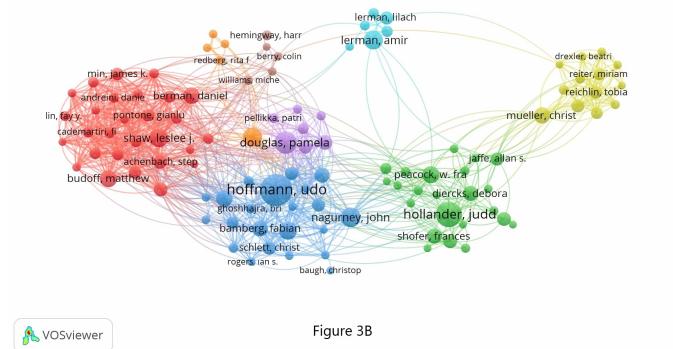


Figure 3B

**Figure 3.** A Intensity map of the cooperation analysis of the institutes. B Network visualization map of co-citation analysis of active authors.

article was published in 1980. First article in 1980 was an article examining the patients with a normal coronary arteriogram but complains from chest pain [8]. Manuscripts were most frequently (97.8%) written in English, but we found that 4 more languages were also used.

73.95% of the manuscripts were research articles. This was followed by reviews and meeting abstracts (Table 1). When we analyzed their distribution according to science branches, we saw that there were articles from 45 different disciplines. The majority of the manuscripts were related

**Table 1.** Publication types of chest pain literature between 1980-2022.

Research Areas	Number of Publication	% of 3329
Research Article	2462	73.95
Review	274	8.21
Meeting Abstracts	205	6.1
Proceedings Paper	177	5.1
Editorial Material	88	2.6
Letters	73	2.1
Book Chapter	38	1.1
Correction	5	0.15
Early Access	5	0.15
News Item	2	0.06

**Table 2.** The top ten research areas of documents in chest pain according to Web of Science database between 1980-2022.

Research Areas	Number of Publication
Cardiac- Cardiovascular Systems	1585
General Internal Medicine	816
Emergency Medicine	526
Surgery	286
Respiratory System	276
Radiology Medical Imaging	237
Critical Care Medicine	121
Health Care Sciences Services	56
Multidisciplinary	42
Sciences Oncology	22

to Cardiac-Cardiovascular Systems (n=1585). Cardiology was followed by general internal medicine, emergency medicine, surgery, respiratory system and radiology medical imaging respectively (Table 2). Number of manuscripts written about chest pain was shown an increase in every year. Since 1991, a large number of manuscripts have been written and published, and 2021 was the leading year in productivity (Figure 1A) with 188 articles and the most of these manuscripts were research articles. The trend of

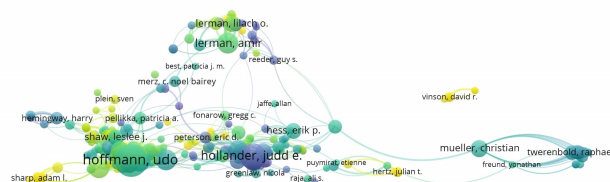


Figure 4A



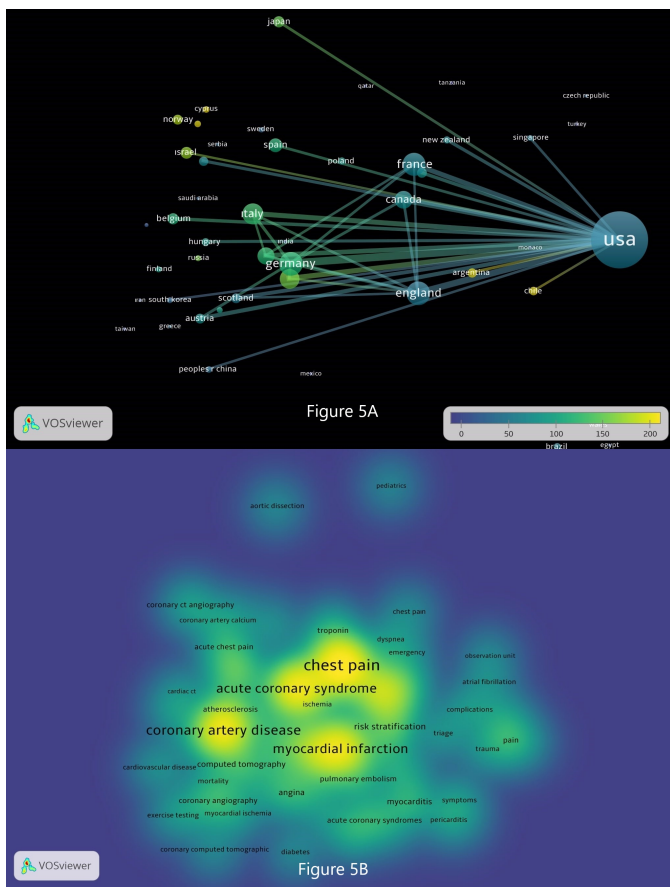
Figure 4B

**Figure 4.** A Network visualization map of co-citation analysis of most cited documents. B Network visualization of productivity of journals.

**Table 3.** The first ten authors by record count in chest pain literature between 1980-2022.

Authors	Institution	Record Count	% of 3329	H-index
Hoffman U.	Innovat Imaging Consulting LLC, 163 Longfellow Rd, Waltham, MA 02453 USA	151	4.5	91
Hollander JE.	Jefferson University Harvard University Brigham & Women’s Hospital	128	3.8	84
Douglas PS.	Duke Univ, Sch Med, Div Cardiol, Durham, NC USA	77	2.3	124
Ferencik M.	Harvard Med Sch, Massachusetts Gen Hosp, Cardiovasc Imaging Res Ctr, Boston, MA USA	69	2.0	46
Lerman A.	Mayo Clin & Mayo Fdn, Dept Internal Med, Div Cardiovasc Dis, Rochester, MN 55905 USA	66	1.9	2
Peacock WF.	Baylor Coll Med, Houston, TX USA	61	1.8	43
Nagurney JT.	Massachusetts Gen Hosp, Dept Emergency Med, 55 Fruit St, Boston, MA USA	57	1.7	32
Lee TH.	Gyeongsang Natl Univ, Engr Res Inst, Dept Ceram Engr, KS011 Jinju Si, South Korea	54	1.6	44
Budoff MJ.	Harbor UCLA Med Ctr, Lundquist Res Inst, Torrance, CA 90509 USA	53	1.5	119
Shaw LJ.	Icahn Sch Med Mt Sinai, Dept Populat Hlth, New York, NY USA	53	1.5	120

Univ: University; USA: United States of America.



**Figure 5.** A Network of co-contributing / collaborative countries on chest pain. B Network visualization map of relationships between the most commonly used trends keywords.

articles on chest pain published in the three-year period between 2020 and 2022 compared to previous years has been predominantly due to the Covid 19 pandemic. The most cited article of these three years was the "2020 ESC Guidelines for the management of ACSs in patients without permanent ST segment elevation" published in the European Heart Journal [9].

When citations of the documents are evaluated, we found that the biggest number of citation was in 2021. When the manuscripts from all 23 years were listed, most cited

**Table 4.** The top ten funding organisations by number of chest pain literature.

Research Areas	Number of Publication	% of 3329
United States Department Of Health Human Services	394	16.0
National Institutes Of Health Nih Usa	351	14.2
Nih National Heart Lung Blood Institute Nhlbi	192	7.7
Siemens Ag	72	2.9
Abbott Laboratories	52	2.1
Astrazeneca	47	1.9
UK Research Innovation Ukri	44	1.7
Agency For Healthcare Research Quality	43	1.7
General Electric	43	1.7
Medical Research Council Uk Mrc	40	1.6

Univ: University; USA: United States of America.

article was 2015 ESC guideline, which determines the management of patients with ACS [10]. 526 articles were published on chest pain in the field of emergency medicine. 324 of these articles were published by the Annals of Emergency Medicine, Academic Emergency Medicine, and the American Journal of Emergency Medicine. The most cited year for the articles on chest pain published in the field of Emergency Medicine was 2021. The year in which the most articles were published is 2009. The article by Kachalia A, in which professional liability insurance data were shared in the light of diagnoses, was the most cited article [11].

We also researched the countries in which documents written about chest pain were prepared, and detected the most productive countries as the USA, England and France. About 81.2% of all publications were produced in the USA (Figure 2A). We found that the productivity of Central Asian Countries and African countries are very low on chest pain. The most productive countries were in Europe North America (Figure 2B).

*Productivity of institutions and authors*

We compared institutions, authors’ productivities and H-Indexes. Hoffman U, Innovat Imaging Consulting LLC, USA was found most productive author. Authors and



**Table 5.** The top ten most cited manuscripts about chest pain.

No	Article	Author	Journal Name/Published	TC	ACY
1	2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC)	Roffi, M; Patrono, C; Collet, JP; et al.	European Heart Journal, 2015	3845	480.6
2	The International Registry of Acute Aortic Dissection (IRAD) - New insights into an old disease	Hagan, PG; Nienaber, CA; Isselbacher, EM; et al.	Journal of The American Medical Association, 2000	2260	94.17
3	The TIMI risk score for unstable angina/non-ST elevation MI - A method for prognostication and therapeutic decision making	Antman, EM; Cohen, M; Bernink, PJLM; et al.	Journal of The American Medical Association, 2000	2198	91.5
4	Neurohumoral features of myocardial stunning due to sudden emotional stress	Wittstein, IS; Thiemann, DR; Lima JAC; et al.	New England Journal Of Medicine, 2005	2086	109.7
5	Cardiovascular Magnetic Resonance in Myocarditis: A JACC White Paper	Friedrich, MG; Sechtem, U; Schulz-Menger, J; et al.	Journal of the American College of Cardiology, 2009	1550	103.3
6	Diagnostic Performance of 64-Multidetector Row Coronary Computed Tomographic Angiography for Evaluation of Coronary Artery Stenosis in Individuals Without Known Coronary Artery Disease	Budoff, MJ; Dowe, D; Jollis, JG; et al.	Journal of the American College of Cardiology, 2008	1545	95.6
7	2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation	Collet, JP ; Thiele, H; Barbato, E; et al.	European Heart Journal, 2021	1457	485.6
8	The effect of race and sex on physicians' recommendations for cardiac catheterization	Schulman, KA; Berlin, JA; Harless, W; et al.	New England Journal Of Medicine, 1999	1372	54.8
9	Inhibition of platelet glycoprotein IIb/IIIa with eptifibatide in patients with acute coronary syndromes	Topol, E; Califf, R; Simoons, M; et al	New England Journal Of Medicine, 1998	1335	51.3
10	Apical ballooning syndrome (Tako-Tsubo or stress cardiomyopathy): A mimic of acute myocardial infarction	Prasad, A; Lerman, A;Rihal, CS; et al.	American Heart Journal, 2008	1170	73.13

TC: Total Citation; ACY: Average Citations per Year.

**Table 6.** The first fifteen journal by number of publications and citations on chest pain.

Journal Name	No	% of 3329	C
Journal of The American College of Cardiology	204	6.1	4288
Annals of Emergency Medicine	143	4.2	3344
American Journal of Cardiology	131	3.9	4423
American Heart Journal	118	3.5	5123
Academic Emergency Medicine	109	3.2	2435
New England Journal of Medicine	103	3.0	18738
European Heart Journal	101	3.0	8194
Mayo Clinic Proceedings	93	2.7	2142
Chest	89	2.6	4410
American Journal of Emergency Medicine	81	2.4	1154
Journal of Emergency Medicine	69	2.0	727
Heart	61	1.8	1654
American Journal of Medicine	60	1.8	1823
International Journal of Cardiology	59	1.7	1312
JACC Cardiovascular Imaging	57	1.7	1966

No: Number of publications; C: Citations (Without Self Citations).

countries with most productivity are presented in Table 3. We also analyzed the productivity of organizations (Table 4) and universities in the database of WoS. Harvard

University was the leader and presented 915 (27.4%) publications about chest pain (Figure 3A).

#### *Co-citation institutions and authorship*

Analysis of co-citation has shown that there are 11,310 authors works about the issue of chest pain. Organizations which published 10 or more documents in the field of chest pain and cited 10 times were classified. 145 organizations were able to meet these qualifications in the total of 2,835. In these 145, Harvard University was the most active one. Collaboration and citation collaboration have been observed between Harvard University, Duke University, and the Mayo Clinic. European Union countries were cooperating among themselves around the United Kingdom in organizations (Figure 3A).

10,823 authors wrote at least 25 manuscripts on chest pain were separated. After this separation, 116 more active authors were detected, and their cooperation was evaluated among themselves. A clustered collaboration on 5 active authors was detected. Udo Hoffman, Pamela Douglas and Judd Hollander were the most active and collaborative in these five (Figure 3B).

### Significant publications

Documents were evaluated and the most cited manuscripts, average amount of citations per documents in a year, publishers and authors were searched. Roffi et al. 2015 ESC Guidelines for the management of ACSs in patients presenting without persistent ST-segment elevation was the document has the highest amount of citations and highest average amount of citations per year [10]. Most cited 10 manuscripts are presented in Table 5. Citation relationships between articles were indicative of publishers and authors' trends. It was also detected that the most cited articles were published between 2010-2015 (Figure 4A).

### Productivity of journals

Journals were analyzed according to the number of publications and the number of citations they received. Accordingly, the 15 journals with the highest number of publications and citations are presented in Table 6. 376 journals publishing on chest pain were examined, the 60 journals published 10 or more articles were detected. It was found that the Journal of The American College of Cardiology published 6.1 % of the articles published on chest pain. Impact factor of this journal in 2022 is 4.74, and its influence on chest pain seems to be bigger (Figure 4B).

### International collaboration

When articles classified by countries they published on chest pain were examined, USA was the most leading country. Collaborations between countries on studies were also evaluated. It was seen that all researcher countries intersect in the USA. France, Canada and England were co-operated more than the others with USA (Figure 5A). A collaborative connection was seen around Germany. Italy, Belgium and Canada were also included in this cluster. Eastern countries didn't formed a network separately for cooperation (Figure 5A).

### Trend topics

In this study new trends and topics were also identified. The keywords used in the articles, how often these words are used and their relations with each other will guide new research topics. The words coronary artery disease and ACS documented the subjects in relationship with chest pain. Atherosclerosis, ischemia and pulmonary embolism were detected to be types of clinical conditions that had the biggest relationship with chest pain. The most frequently made clinical analyzes in the manuscripts on chest pain were seen as troponin, computed tomography and angiography (Figure 5B).

### Discussion

In this study, we made a bibliometric analysis of articles on "Chest Pain" in the database of WoS. 3,329 articles have been reached and we evaluated the citations of these articles, the most active researchers and the most active journals. The most active country was observed to be USA. The most active researcher was Hoffman U, the most active journal was the Journal of The American College of Cardiology. The most productive year was observed as

2022. The most cited article was the guideline written by the ESC in 2015, describing the management of ACS. The 2022 guideline of the same society was observed as the most cited article of the last three years. Groups who manage chest pain were cardiologists, pulmonologists, and emergency medicine specialists.

The management of chest pain is multidisciplinary, and medical team that first evaluates this symptom is mostly emergency medicine workers. Patients applying to ED with chest pain present a difficult challenge because the most of symptoms were non-cardiac and usually benign pathologies in which immediate treatment or hospitalization are not necessary [12]. Updates in the 2015 and 2020 ESC guidelines for the management of chest pain caused by ACS have revealed various differences in the evaluation of patient in terms of ACS. The 2020 version of the ESC guideline for the management of ACSs in patients without ST-segment elevation provides the most evidence-based suggestions for physicians on how to diagnose and manage these patients [9]. However, differences between ESC and ACC guidelines may leave physicians uncertain about management of non-ST-elevation ACS (NSTEMI-ACS).

Taking a medical history, physical examination, a 12-lead electrocardiography (ECG) within the first 10 minutes of arrival, and cardiac biomarkers are the basic applications to make an effective triage of chest pain in ED [10]. The most important priority is to identify the cases who need urgent referral to the catheterization laboratory. Emergency percutaneous coronary intervention (<2 hours) is recommended in patients with ST-elevation myocardial MI and some NSTEMI-ACS patients with at least one very high-risk condition. These criteria are; haemodynamic instability or cardiogenic shock, recurrent or persistent chest pain resistant to medical therapy, life-threatening arrhythmias or cardiac arrest, mechanical complications of MI, persistent angina or acute heart failure with ST deviation, recurrent dynamic ST or T wave changes, especially intermittent can be listed as ACS with ST elevation [13].

Clinical practice guidelines exist for the management of ACS, but the predominance of low-risk ED patients with chest pain as well as those presenting with recurrent chest pain is neglected [14]. The majority of chest pain presenting to the ED includes low-risk chest pain causes, and clinical practice guidelines can assist clinicians in the assessment of low-risk chest pain [15]. The widespread use of risk scoring for chest pain symptoms should be considered as a method that will provide rapid approach to triage and emergency patients [16].

HEART scoring is one of the scoring methods used in the ED to differentiate ACS from other causes of chest pain. Scoring an acronym of its components medical history, ECG, age, risk factors, and troponin values, and if the total score is less than 3, it was accepted as low risk for ACS, and many validation tests were applied [17-19]. There are also studies comparing the scoring that evaluates myocardial infarction and related death risks used in EDs. For example, the TIMI scoring is used to estimate the risk of death and developing a cardiac ischemic event based on information from the initial medical evaluation of patients. The Troponin Only Manchester ACS Score (T-MACS) is a single high score without serial troponin

tests in patients presenting to the ED with chest pain. It is a scoring system designed to exclude ACS with its sensitive troponin value [20, 21]. In a study comparing the two scores, the T-MACS score was more successful than the TIMI score in determining the low risk (very low risk for the T-MACS score), high risk, and estimated 1-month risk of major adverse cardiac events in patients presenting to the ED with chest pain [22].

When the most cited and most published journals are examined in the search made with the term "chest pain" in the WoS database, the studies of the cardiology department are listed the most. Another fatal and high-risk diagnosis to be remembered in the ED is "acute chest pain from pulmonary embolism". The diagnosis of pulmonary embolism is made by possible clinical history, if indicated, D-dimer and chest imaging [23]. In addition, pulmonary embolism is the second most common disease misdiagnosed in the ED [24]. It shows that 27.5% of patients with PE in the ED are initially misdiagnosed and half (53.6%) of all patients in inpatient settings are misdiagnosed [25]. ED clinicians should consider pulmonary embolism as a fatal diagnosis when they move away from ACS in patients with chest pain.

Other differential diagnoses such as pneumothorax, aortic dissection or pneumonia should also be considered in patients who are evaluated for chest pain in the ED. However, when the number of articles, the number of citations and the impact factor of the publications are examined, these diagnoses are less in number in terms of bibliometrics. Since it is very important for ED clinicians to make the diagnosis after the first examination, they need to know many guidelines and scoring systems well. In this respect, there is a need for more useful guideline or meta-analysis studies that include chest pain management from an emergency room perspective. In the next few years, we expect that there will be studies evaluating the relationship between chest pain and ACS.

## Conclusion

It is observed that the publications related to chest pain are associated with ACS and this diagnosis has the highest publication, citation and impact power. The number of publications related to other fatal clinical conditions in the differential diagnosis of chest pain is relatively low. There is a lack of guidelines or meta-analysis that includes a holistic approach to chest pain and covers the field of emergency medicine. We think that the number of studies evaluating chest pain will continue to increase in the near future and that these publications will be dominated by ACS.

## Ethical approval

It is a bibliometric study and does not require an ethics committee.

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