SYSTEMATIC REVIEW

Diagnostic Imaging in Disasters: A Bibliometric Analysis

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ABSTRACT

Objective: To investigate the role of diagnostic imaging in the clinical diagnosis, treatment, and follow-up management of patients in response to disasters.

Methods: A MEDLINE (OVID) search of original research articles identified 177 articles on this topic published since 2000. A bibliometric analysis was conducted on the top 100 articles ranked by average yearly citation.

Results: The most frequently studied disaster categories were disease outbreak (55 articles), armed conflict (23 articles), terrorist incident (10 articles), and earthquake (7 articles). The most studied disasters were the H1N1 influenza outbreak in 2009 (28 articles), Severe Acute Respiratory Syndrome outbreak in 2003 (24 articles), War in Afghanistan, 2001-2014 (8 articles), Iraq War, 2003-2011 (6 articles), and the Sichuan earthquake (China) in 2008 (6 articles). Among the first authors, 59 were primarily affiliated with Radiology. The United States of America produced the most articles (25 articles), followed by the People's Republic of China (24 articles). Eighty-one studies were retrospective, with 19 studies being prospective. Computed tomography was the most investigated modality (52.8%), followed by conventional radiography (33.3%) and ultrasound (9.7%).

Conclusions: Our study identifies intellectual milestones in the utility of diagnostic imaging in response to various disasters, and could help guide future research in developing disaster management plans. (*Disaster Med Public Health Preparedness*. 2018;12:265-277)

Key Words: diagnostic imaging, disaster, bibliometrics

Disasters, natural or human-made, can cause significant morbidity and mortality, leading to substantial economic and human loss.[1] According to the EM-DAT international disaster database maintained by the Centre for Research on the Epidemiology of Disasters, for the period from 2005 to 2014, an average of 367 country-level natural disasters were reported each year, including floods, storms, droughts, landslides, earthquakes, tsunamis, wildfires, volcanic activities, etc.[2] In 2015 alone, natural disasters caused the deaths of 22,773 people, and an economic damage of 66.5 billion US dollars.[2] Examples of common human-made disasters include armed conflicts, terrorist incidents, explosions, nuclear disasters, and transportation accidents.[3] The 9/11 terrorist attacks on the United States in 2001, in particular, marked the beginning of the 21st century, in which there has been a heightened impact, both of terrorism and the war against it.[4]

The definition of "disaster" provided by the United Nations Office for Disaster Risk Reduction emphasizes a level of disruption that "exceeds the ability of the affected community or society to cope using its own resources."[5] Medical resources, a key component of the disaster preparedness and management,[1] must be properly allocated and triaged to deliver the best possible care for a potentially large number of victims.[6] As a fast evolving field, diagnostic imaging has been increasingly relied upon to make rapid and non-invasive diagnoses and triage or care decisions for patients.[7] It is thus important to analyze how diagnostic imaging has been utilized in disaster management in the past, to augment future disaster management plans.

Bibliometric analysis involves the quantitative and qualitative analysis of research literature,[8] and is commonly used as an objective measurement of the productivity of individual researchers or organizations.[9] It can also be used to reveal the emergence of novel techniques and topics, and to guide future research.[10-12] Several specialties and journals have previously compiled and published lists of the most-cited articles in their field.[11,13-16] According to our literature search, no current bibliometric analysis has focused specifically on the role of imaging in disaster management in an English language peer-reviewed indexed journal. To fill this void, we conducted a bibliometric analysis of articles published since 2000 that depicted the role of diagnostic imaging in clinical diagnosis, treatment and follow-up management of patients in response to disasters, for an understanding of the current utility of diagnostic imaging in disasters.

METHODS

This study did not require ethical approval because it was a retrospective evaluation of publicly available research literature.

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Literature Search

MEDLINE indexes more than 5600 journals and contains more than 23 million references in life sciences and medicine.[17] All MEDLINE records were indexed with the National Library of Medicine Medical Subject Headings (MeSH) system,[17] which greatly facilitates comprehensive searches on complex topics. We conducted a MEDLINE search via OVID on January 9, 2017, with the detailed search steps listed in Table 1. In brief, MeSH terms related to various types of disasters were first queried (Steps 1-16). To ensure a comprehensive search, specific terms of 4 major outbreaks in the 21st century[18] (outbreaks of Ebola, Severe Acute Respiratory Syndrome [SARS], H1N1 influenza, and Middle East Respiratory Syndrome) were searched along with the MeSH term "epidemics" (Steps 12-16). Results from each individual search were combined using the Boolean operator "OR" (Step 17-18). Articles about diagnostic imaging were searched and combined in a similar fashion (Steps 19-22). The Boolean operator "AND" was then used to identify the overlapping set of articles in the two sets of combined results (Step 23). The results were then filtered to include only articles pertaining to "humans," and published in or after 2000 (Steps 24-26). A total of 1262 unique articles were identified.

TABLE 1

Steps Used in MEDLINE (OVID) Search to Identify Recent Original Research Articles Depicting the Roles of Diagnostic Imaging in Clinical Diagnosis, Treatment, and Follow-Up Management of Patients in Response to Disasters

Step	Searches	Results
1	Disasters/ or mass casualty incidents/	19,726
2	Exp terrorism/	12,349
3	Exp nuclear reactors/	5163
4	Exp structure collapse/	94
5	Exp "Warfare and Armed Conflicts"/	48,020
6	Avalanches/ or earthquakes/ or landslides/ or tidal waves/ or tsunamis/ or volcanic eruptions/	4845
7	Droughts/ or tornadoes/	5246
8	Explosions/ or fires/ or spontaneous combustion/	12,384
9	Blast injuries/ or war-related injuries/	4134
10	Cyclonic storms/ or droughts/ or floods/	8368
11	Exp starvation/	10,403
12	Exp epidemics/	13,107
13	*Hemorrhagic fever, Ebola/di, pc, ra, us	1218
14	*Severe Acute Respiratory Syndrome/di, pc, ra	1182
15	H1N1.mp. and *Influenza, Human/di, pc, ra, us	4222
16	*Middle East Respiratory Syndrome Coronavirus/	493
17	12 or 13 or 14 or 15 or 16	19,210
18	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 17	126,840
19	Exp diagnostic imaging/	2,308,878
20	Radiology/ or exp nuclear medicine/	30,415
21	Exp Radiology Department, hospital/	5111
22	19 or 20 or 21	2,332,852
23	18 and 22	2717
24	Limit 23 to humans	2002
25	Limit 24 to year = "2000-Current"	1483
26	Remove duplicates from 25	1262

Abbreviation: di, diagnosis; pc, prevention and control; ra, radiography; us, ultrasonography.

We restricted our analysis to only literature published since 2000, for two reasons. First, the rise of terrorism and the following anti-terrorism wars in the beginning of the 21st century marked a change in the landscape of human-made disasters.[4] It was therefore interesting to conduct an analysis in the context of this new era. Second, this approach allowed us to focus on the more recent disaster management experiences, in light of decade-long disaster reduction efforts led by the United Nations throughout the 1990s (the International Decade for Natural Disaster Reduction).[19]

Screening of Original Research Articles

Two board-certified, emergency radiology fellowship-trained radiologists reviewed both the title and abstract (as well as full-text when necessary) of all the articles according to the inclusion and exclusion criteria predetermined before the screening. In case of disagreement regarding inclusion decisions, a third radiologist was consulted to make a final decision.

Specifically, only original research articles depicting the role of diagnostic imaging in clinical diagnosis, treatment and follow-up management of patients in response to disasters were included. Articles excluded from this study were as follows: (1) literature reviews, pictorial reviews, meta-analyses, opinion pieces, and case reports; (2) studies in which diagnostic imaging was not used for the direct diagnosis, treatment, or follow-up management of patients; (3) studies that did not involve human patients; (4) studies concerned with postmortem victim identification; (5) studies not related to an actual disaster, such as articles about disaster preparedness or studies involving simulated training. After the screening, a total of 177 articles met our inclusion criteria.

With PubMed IDs as unique identifiers, bibliometric data of these 177 articles were then retrieved from Web of Science All Databases, including author names, author affiliations, title, journal, publication year, abstract, and times cited in Web of Science All Databases. The abstract and full-text of each article were again examined to collect the following additional information: number of authors, country of origin (defined as the country of affiliation of the first author), primary affiliated department (defined as the department that the first author was affiliated with), study design (retrospective or prospective), sample size, disaster type, specific disaster event, and utilized imaging modalities.

Ranking of Articles

The articles were ranked by the average yearly citation, calculated as follows: total citation count from Web of Science

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All Databases/number of years between publication and January 2017, accurate to month (1/12th of a year).

Only the top 100 most highly cited articles, as ranked by the average yearly citation, were included in our final bibliometric analysis.

RESULTS

We identified a total of 177 articles published since 2000 that met our inclusion criteria. It has been widely accepted that, to a certain degree, the citation level of an article could indicate its relative significance in its research field.[20] We thus ranked these articles by average yearly citation, and conducted the final bibliometric analysis on the top 100 most highly cited articles, as listed in Table 2. The usage of average yearly citation, instead of total citation, for the ranking allowed for a fair assessment of more recently published articles.

Overall, the average total citation count was 23.3 times (highest citation: 231, median: 11). A total of 85 articles had been cited at least 5 times, 62 articles at least 10 times, and 29 articles at least 20 times. The average citation count per year was 2.89 times/year (highest yearly citation: 18.1 times/year, median: 1.82 times/year).

Type of Disaster

These 100 articles studied a total of 8 types of disaster, encompassing human-made and natural disasters, as listed in Table 3. The most studied disaster types were disease outbreak (55 articles), armed conflict (23 articles), terrorist incident (10 articles), and earthquake (7 articles).

Individual Disaster

Of the 100 articles, 92 articles provided sufficient information to identify a specific disaster event; 1 article discussed 2 types of disasters. The most studied individual disasters were the H1N1 influenza outbreak in 2009 (28 articles), the SARS outbreak in 2003 (24 articles), the War in Afghanistan, 2001-2014 (8 articles), the Iraq War, 2003-2011 (6 articles), and the Sichuan earthquake (China) in 2008 (6 articles). Table 4 lists the individual disasters and the number of articles in which they were studied.

Year of Publication

Figure 1 illustrates the distribution of the 100 most highly cited articles by their year of publication. The largest numbers of highly cited articles were published in 2010 (15 articles), followed by 2004 (14 articles) and 2011 (13 articles). The yearly trend shows two peaks for article publication: one from 2003 to 2005, another from 2010 to 2012.

This yearly trend correlates well with the most reported disasters in our analysis. From 2003 to 2005, a total of 29 highly cited articles were published, and 23 (79.3%) of them were about the SARS outbreak in 2003. From 2010 to 2012, a total of 40 highly cited articles were published, and 26 (65.0%) of them were about the H1N1 influenza outbreak in 2009, with another 4 (10.0%) about the Sichuan earthquake (China) in 2008.

A time lag existed between the occurrence of a disaster event and the publication of articles. For example, in the case of the 2008 Sichuan earthquake in China, although the disaster occurred on May 12, 2008, among the 6 highly cited articles studying this earthquake included in our analysis, 2 articles were published in 2009, 3 in 2010, and 1 in 2011, with an average disaster-to-publication time of around 2 years.

The publication of articles regarding the SARS and H1N1 influenza outbreaks, on the other hand, was much more rapid. SARS was recognized at the end of February 2003.[21] The first highly cited research article on SARS was published electronically as early as May 8, 2003.[22] Similarly, the H1N1 influenza outbreak in 2009 was recognized in April.[23] The first highly cited research article about this outbreak was accepted for publication in September 2009.[24]

Country of Origin

The country of origin of an article was determined as the country of the primary affiliation of the first author. The 100 most highly cited articles originated from 23 countries/regions, with most articles being from the United States (25 articles), the People's Republic of China (24 articles), and Canada (6 articles). Table 5 lists these 23 countries with the number of articles from each country.

The countries of origin of these articles reflect the geographic or national relationship with the investigated disasters. For example, out of the 25 highly cited articles that originated from the United States, 10 were about armed conflicts in Iraq or Afghanistan in which United States was involved, 7 were about terrorist incidents in New York and Boston, and 5 were about the H1N1 outbreak. Out of the 24 articles from the People's Republic of China, 14 were about the SARS outbreak that affected Mainland China and Hong Kong the most, and 6 were about the Sichuan earthquake in China. For Canada, 5 of the 6 highly cited articles were about the SARS outbreak, in which Canada was the most affected area in the Western world.

Authors

The articles had 2-21 authors (median: 7). Among the first authors, 59 were primarily affiliated with the Radiology department. Other identified medical specialties of the first authors were Surgery (12 authors), Emergency Medicine (9), Infectious Disease (4), other Internal Medicine specialties (4), Respiratory Medicine (3), Military Medicine (3), Pediatrics (2), Atomic Bomb Disease (1), Chemical Injuries (1), and

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TABLE 2

The 100 Most Highly Cited Original Research Articles Published Since 2000 Depicting the Roles of Diagnostic Imaging in Clinical Diagnosis, Treatment and Follow-Up Management of Patients in Response to Disasters, Ranked by Yearly Average Citation

Rank	Article	Disaster	Average Yearly Citation (Total Citation)
1	Agarwal PP, Cinti S, Kazerooni EA. Chest radiographic and CT findings in novel swine-origin influenza A (H1N1) virus (S-OIV) infection. *AJR Am J Roentgenol*. 2009; 193(6):1488-1493. [PubMed ID: 19933638]	H1N1 influenza outbreak, 2009 (worldwide)	18.07 (128)
2	Prezant DJ, Weiden M, Banauch GI, McGuinness G, Rom WN, Aldrich TK, Kelly KJ. Cough and bronchial responsiveness in firefighters at the World Trade Center site. *N Engl J Med*. 2002; 347(11):806-815. [PubMed ID: 12226151]	9/11 World Trade Center attack, 2001 (USA)	16.12 (231)
3	King MS, Eisenberg R, Newman JH, Tolle JJ, Harrell FE, Jr, Nian H, Ninan M, Lambright ES, Sheller JR, Johnson JE, Miller RF. Constrictive bronchiolitis in soldiers returning from Iraq and Afghanistan. *N Engl J Med*. 2011; 365(3):222-230. [PubMed ID: 21774710]	War in Afghanistan, 2001-2014 (Afghanistan)	14.91 (82)
4	Hon KL, Leung CW, Cheng WT, Chan PK, Chu WC, Kwan YW, Li AM, Fong NC, Ng PC, Chiu MC, Li CK, Tam JS, Fok TF. Clinical presentations and outcome of severe acute respiratory syndrome in children. *Lancet*. 2003; 361(9370):1701-1703. [PubMed ID: 12767737]	SARS outbreak, 2003 (37 countries)	12.95 (177)
5	Wong KT, Antonio GE, Hui DS, Lee N, Yuen EH, Wu A, Leung CB, Rainer TH, Cameron P, Chung SS, Sung JJ, Ahuja AT. Severe acute respiratory syndrome: radiographic appearances and pattern of progression in 138 patients. *Radiology*. 2003; 228(2):401-406. [PubMed ID: 12759474]	SARS outbreak, 2003 (37 countries)	9.02 (121)
6	Skarbinski J, Jain S, Bramley A, Lee EJ, Huang J, Kirschke D, Stone A, Wedlake T, Richards SM, Page S, Ragan P, Bullion L, Neises D, Williams RM, Petruccelli BP, Vandermeer M, Lofy KH, Gindler J, Finelli L. Hospitalized patients with 2009 pandemic influenza A (H1N1) virus infection in the United States – September-October 2009. *Clin Infect Dis*. 2011; 52(Suppl 1):S50-S59. [PubMed ID: 21342900]	H1N1 influenza outbreak, 2009 (worldwide)	8.17 (49)
7	Ajlan AM, Ahyad RA, Jamjoom LG, Alharthy A, Madani TA. Middle East Respiratory Syndrome Coronavirus (MERS-CoV) infection: chest CT findings. *AJR Am J Roentgenol*. 2014; 203(4):782-787. [PubMed ID: 24918624]	MERS outbreak, 2012-2015 (29 countries)	8.00 (18)
8	Hayashida N, Imaizumi M, Shimura H, Okubo N, Asari Y, Nigawara T, Midorikawa S, Kotani K, Nakaji S, Otsuru A, Akamizu T, Kitaoka M, Suzuki S, Taniguchi N, Yamashita S, Takamura N. Thyroid ultrasound findings in children from three Japanese prefectures: Aomori, Yamanashi and Nagasaki. *PLoS One*. 2013; 8(12):e83220. [PubMed ID: 24376666]	Fukushima Daiichi nuclear disaster, 2011 (Japan)	7.46 (23)
9	Aviram G, Bar-Shai A, Sosna J, Rogowski O, Rosen G, Weinstein I, Steinvil A, Zimmerman O. H1N1 influenza: initial chest radiographic findings in helping predict patient outcome. *Radiology*. 2010; 255(1):252-259. [PubMed ID: 20308461]	H1N1 influenza outbreak, 2009 (worldwide)	6.67 (45)
10	Skloot G, Goldman M, Fischler D, Goldman C, Schechter C, Levin S, Teirstein A. Respiratory symptoms and physiologic assessment of ironworkers at the World Trade Center disaster site. *Chest*. 2004; 125(4):1248-5125. [PubMed ID: 15078731]	9/11 World Trade Center attack, 2001 (USA)	6.59 (84)
11	Wong KT, Antonio GE, Hui DS, Lee N, Yuen EH, Wu A, Leung CB, Rainer TH, Cameron P, Chung SS, Sung JJ, Ahuja AT. Thin-section CT of severe acute respiratory syndrome: evaluation of 73 patients exposed to or with the disease. *Radiology*. 2003; 228(2): 395-400. [PubMed ID: 12738877]	SARS outbreak, 2003 (37 countries)	6.48 (87)
12	Marchiori E, Zanetti G, Hochhegger B, Rodrigues RS, Fontes CA, Nobre LF, Mancano AD, Meirelles GS, Irion KL. High-resolution computed tomography findings from adult patients with Influenza A (H1N1) virus-associated pneumonia. *Eur J Radiol*. 2010; 74(1):93-98. [PubMed ID: 19962842]	H1N1 influenza outbreak, 2009 (worldwide)	6.22 (42)
13	Rainer TH, Cameron PA, Smit D, Ong KL, Hung AN, Nin DC, Ahuja AT, Si LC, Sung JJ. Evaluation of WHO criteria for identifying patients with severe acute respiratory syndrome out of hospital: prospective observational study. *BMJ*. 2003; 326(7403):1354-1358. [PubMed ID: 12816820]	SARS outbreak, 2003 (37 countries)	6.18 (84)
14	Cohen JG, Boue Y, Boussat B, Reymond E, Grand S, Blancher M, Ferretti GR, Bouzat P. Serum potassium concentration predicts brain hypoxia on CT after avalanche-induced cardiac arrest. *Am J Emerg Med*. 2016; 34(5):856-860. [PubMed ID: 26935228]	Unspecified avalanche, 2002-2014	6.00 (4)
15	Lee EY, McAdam AJ, Chaudry G, Fishman MP, Zurakowski D, Boiselle PM. Swine-origin influenza a (H1N1) viral infection in children: initial chest radiographic findings. *Radiology*. 2010; 254(3):934-941. [PubMed ID: 20032128]	H1N1 influenza outbreak, 2009 (worldwide)	5.41 (37)
16	Das KM, Lee EY, Al Jawder SE, Enani MA, Singh R, Skakni L, Al-Nakshabandi N, AlDossari K, Larsson SG. Acute Middle East Respiratory Syndrome Coronavirus: temporal lung changes observed on the chest radiographs of 55 patients. *AJR Am J Roentgenol*. 2015; 205(3): W267-W274. [PubMed ID: 26102309]	MERS outbreak, 2012-2015 (29 countries)	5.25 (7)
17	Avidan V, Hersch M, Armon Y, Spira R, Aharoni D, Reissman P, Schecter WP. Blast lung injury: clinical manifestations, treatment, and outcome. *Am J Surg*. 2005; 190(6):927-931. [PubMed ID: 16307948]	Unspecified terrorist bomb attacks	4.96 (55)
18	Bell RS, Vo AH, Roberts R, Wanebo J, Armonda RA. Wartime traumatic aneurysms: acute presentation, diagnosis, and multimodal treatment of 64 craniocervical arterial injuries. *Neurosurgery*. 2010; 66(1):66-79; discussion [PubMed ID: 20023539]	Iraq War, 2003-2011 (Iraq)	4.57 (32)
19	Elicker BM, Schwartz BS, Liu C, Chen EC, Miller SA, Chiu CY, Webb WR. Thoracic CT findings of novel influenza A (H1N1) infection in immunocompromised patients. *Emerg Radiol*. 2010; 17(4):299-307. [PubMed ID: 20111882]	H1N1 influenza outbreak, 2009 (worldwide)	4.46 (29)
20	Amirjamshidi A, Abbassioun K, Rahmat H. Minimal debridement or simple wound closure as the only surgical treatment in war victims with low-velocity penetrating head injuries. Indications and management protocol based upon more than 8 years follow-up of 99 cases from Iran-Iraq conflict. *Surg Neurol*. 2003; 60(2):105-110; discussion 10-1. [PubMed ID: 12900110]	Iran-Iraq war, 1980-1988 (Iran, Iraq)	3.65 (49)
21	Muller NL, Ooi GC, Khong PL, Nicolaou S. Severe acute respiratory syndrome: radiographic and CT findings. *AJR Am J Roentgenol*. 2003; 181(1):3-8. [PubMed ID: 12818821]	SARS outbreak, 2003 (37 countries)	3.48 (47)
22	Morrison JJ, Clasper JC, Gibb I, Midwinter M. Management of penetrating abdominal trauma in the conflict environment: the role of computed tomography scanning. *World J Surg*. 2011; 35(1):27-33. [PubMed ID: 20845038]	War in Afghanistan, 2001-2014 (Afghanistan)	3.17 (19)

TABLE 2

(Continued)

Rank	Article	Disaster	Average Yearly Citation (Total Citation)
23	Abbo L, Quartin A, Morris MI, Saigal G, Ariza-Heredia E, Mariani P, Rodriguez O, Munoz-Price LS, Ferrada M, Ramee E, Rosas MI, Gonzalez IA, Fishman J. Pulmonary imaging of pandemic influenza H1N1 infection: relationship between clinical presentation and disease burden on chest radiography and CT. *Br J Radiol*. 2010; 83(992):645-651. [PubMed ID: 20551254]	H1N1 influenza outbreak, 2009 (worldwide)	3.12 (20)
24	Thach AB, Ward TP, Dick JS, 2nd, Bauman WC, Madigan WP, Jr., Goff MJ, Thordsen JE. Intraocular foreign body injuries during Operation Iraqi Freedom. *Ophthalmology*. 2005; 112(10):1829-1833. [PubMed ID: 16095702]	Iraq War, 2003-2011 (Iraq)	3.11 (35)
25	Shorter M, Macias DJ. Portable handheld ultrasound in austere environments: use in the Haiti disaster. *Prehosp Disaster Med*. 2012; 27(2):172-177. [PubMed ID: 22595772]	Haiti earthquake, 2010 (Haiti)	2.95 (14)
26	Singh AK, Goralnick E, Velmahos G, Biddinger PD, Gates J, Sodickson A. Radiologic features of injuries from the Boston Marathon bombing at three hospitals. *AJR Am J Roentgenol*. 2014; 203(2):235-239. [PubMed ID: 25055253]	Boston Marathon bombing, 2013 (USA)	2.90 (7)
27	Beekley AC, Blackbourne LH, Sebesta JA, McMullin N, Mullenix PS, Holcomb JB. Selective nonoperative management of penetrating torso injury from combat fragmentation wounds. *J Trauma*. 2008; 64(2 Suppl):S108- S116; discussion S16-7. [PubMed ID: 18376152]	Iraq War, 2003-2011 (Iraq)	2.80 (25)
27	Testa A, Soldati G, Copetti R, Giannuzzi R, Portale G, Gentiloni-Silveri N. Early recognition of the 2009 pandemic influenza A (H1N1) pneumonia by chest ultrasound. *Crit Care*. 2012; 16(1):R30. [PubMed ID: 22340202]	H1N1 influenza outbreak, 2009 (worldwide)	2.80 (14)
29	Mendelson DS, Roggeveen M, Levin SM, Herbert R, de la Hoz RE. Air trapping detected on end-expiratory high-resolution computed tomography in symptomatic World Trade Center rescue and recovery workers. *J Occup Environ Med*. 2007; 49(8):840-845. [PubMed ID: 17693781]	9/11 World Trade Center attack, 2001 (USA)	2.76 (26)
30	Ghanei M, Fathi H, Mohammad MM, Aslani J, Nematizadeh F. Long-term respiratory disorders of claimers with subclinical exposure to chemical warfare agents. *Inhal Toxicol*. 2004; 16(8):491-495. [PubMed ID: 15204740]	Unspecified armed conflicts	2.72 (34)
31	Grinblat L, Shulman H, Glickman A, Matukas L, Paul N. Severe acute respiratory syndrome: radiographic review of 40 probable cases in Toronto, Canada. *Radiology*. 2003; 228(3):802-809. [PubMed ID: 12853655]	SARS outbreak, 2003 (37 countries)	2.70 (36)
32	Brunner J, Rocha TC, Chudgar AA, Goralnick E, Havens JM, Raja AS, Sodickson A. The Boston Marathon bombing: after-action review of the Brigham and Women's Hospital emergency radiology response. *Radiology*. 2014; 273(1):78-87. [PubMed ID: 25025582]	Boston Marathon bombing, 2013 (USA)	2.67 (6)
33	Beck-Razi N, Fischer D, Michaelson M, Engel A, Gaitini D. The utility of focused assessment with sonography for trauma as a triage tool in multiple-casualty incidents during the second Lebanon war. *J Ultrasound Med*. 2007; 26(9):1149-1156. [PubMed ID: 17715308]	Lebanon War, 2006 (Lebanon, Israel and the Golan Heights)	2.57 (24)
34	Watchorn J, Miles R, Moore N. The role of CT angiography in military trauma. *Clin Radiol*. 2013; 68(1):39-46. [PubMed ID: 22824572]	War in Afghanistan, 2001-2014 (Afghanistan)	2.50 (10)
35	Jartti A, Rauvala E, Kauma H, Renko M, Kunnari M, Syrjala H. Chest imaging findings in hospitalized patients with H1N1 influenza. *Acta Radiol*. 2011; 52(3):297-304. [PubMed ID: 21498366]	H1N1 influenza outbreak, 2009 (worldwide)	2.43 (14)
35	Dong ZH, Yang ZG, Chen TW, Feng YC, Wang QL, Chu ZG. Spinal injuries in the Sichuan earthquake. *N Engl J Med*. 2009; 361(6):636-637. [PubMed ID: 19657135]	Sichuan earthquake, 2008 (China)	2.43 (18)
37	Li P, Zhang JF, Xia XD, Su DJ, Liu BL, Zhao DL, Liu Y, Zhao DH. Serial evaluation of high-resolution CT findings in patients with pneumonia in novel swine-origin influenza A (H1N1) virus infection. *Br J Radiol*. 2012; 85(1014):729-735. [PubMed ID: 22167502]	H1N1 influenza outbreak, 2009 (worldwide)	2.40 (11)
37	Singh AK, Buch K, Sung E, Abujudeh H, Sakai O, Aaron S, Lev M. Head and neck injuries from the Boston Marathon bombing at four hospitals. *Emerg Radiol*. 2015; 22(5):527-532. [PubMed ID: 25962489]	Boston Marathon bombing, 2013 (USA)	2.40 (3)
39	Lundy JB, Oh JS, Chung KK, Ritter JL, Gibb I, Nordmann GR, Sonka BJ, Tai NR, Aden JK, Rasmussen TE. Frequency and relevance of acute peritraumatic pulmonary thrombus diagnosed by computed tomographic imaging in combat casualties. *J Trauma Acute Care Surg*. 2013; 75(2 Suppl 2):S215-S2120. [PubMed ID: 23883911]	War in Afghanistan, 2001-2014 (Afghanistan)	2.34 (8)
40	Li P, Su DJ, Zhang JF, Xia XD, Sui H, Zhao DH. Pneumonia in novel swine-origin influenza A (H1N1) virus infection: high-resolution CT findings. *Eur J Radiol*. 2011; 80(2):e146-e152. [PubMed ID: 20566254]	H1N1 influenza outbreak, 2009 (worldwide)	2.13 (11)
41	Smith IM, Naumann DN, Marsden ME, Ballard M, Bowley DM. Scanning and War: utility of FAST and CT in the Assessment of Battlefield Abdominal Trauma. *Ann Surg*. 2015; 262(2):389-396. [PubMed ID: 25405557]	War in Afghanistan, 2001-2014 (Afghanistan)	2.12 (3)
42	Waage S, Poole JC, Thorgersen EB. Rural hospital mass casualty response to a terrorist shooting spree. *Br J Surg*. 2013; 100(9):1198-1204. [PubMed ID: 23842835]	Utøya shooting attacks, 2011 (Norway)	2.05 (7)
43	Grieser C, Goldmann A, Steffen IG, Kastrup M, Fernandez CM, Engert U, Deja M, Lojewski C, Denecke T. Computed tomography findings from patients with ARDS due to Influenza A (H1N1) virus-associated pneumonia. *Eur J Radiol*. 2012; 81(2):389-394. [PubMed ID: 21306851]	H1N1 influenza outbreak, 2009 (worldwide)	2.03 (10)
44	Henzler T, Meyer M, Kalenka A, Alb M, Schmid-Bindert G, Bartling S, Schoepf JU, Schoenberg SO, Fink C. Image findings of patients with H1N1 virus pneumonia and acute respiratory failure. *Acad Radiol*. 2010; 17(6):681-685. [PubMed ID: 20457412]	H1N1 influenza outbreak, 2009 (worldwide)	1.97 (13)
44	Raja AS, Propper BW, Vandenberg SL, Matchette MW, Rasmussen TE, Johannigman JA, Davidson SB. Imaging utilization during explosive multiple casualty incidents. *J Trauma*. 2010; 68(6):1421-1424. [PubMed ID: 20539185]	Iraq War, 2003-2011 (Iraq)	1.97 (13)
44	Cho WH, Kim YS, Jeon DS, Kim JE, Kim KI, Seol HY, Kim KU, Park HK, Lee MK, Park SK, Jeong YJ. Outcome of pandemic H1N1 pneumonia: clinical and radiological findings for severity assessment. *Korean J Intern Med*. 2011; 26(2):160-167. [PubMed ID: 21716592]	H1N1 influenza outbreak, 2009 (worldwide)	1.97 (11)

TABLE 2

(Continued)

Rank	Article	Disaster	Average Yearly Citation (Total Citation)
47	Smith JE, Midwinter M, Lambert AW. Avoiding cavity surgery in penetrating torso trauma: the role of the computed tomography scan. *Ann R Coll Surg Engl*. 2010; 92(6):486-488. [PubMed ID: 20519069]	War in Afghanistan, 2001-2014 (Afghanistan)	1.89 (12)
48	Karadeli E, Koc Z, Ulusan S, Erbay G, Demiroglu YZ, Sen N. Chest radiography and CT findings in patients with the 2009 pandemic (H1N1) influenza. *Diagn Interv Radiol*. 2011; 17(3):216-222. [PubMed ID: 20703994]	H1N1 influenza outbreak, 2009 (worldwide)	1.88 (10)
49	Dong ZH, Yang ZG, Chen TW, Feng YC, Chu ZG, Yu JQ, Bai HL, Wang QL. Crush thoracic trauma in the massive Sichuan earthquake: evaluation with multidetector CT of 215 cases. *Radiology*. 2010; 254(1):285-291. [PubMed ID: 20019132]	Sichuan earthquake, 2008 (China)	1.86 (13)
50	Tham KY. An emergency department response to severe acute respiratory syndrome: a prototype response to bioterrorism. *Ann Emerg Med*. 2004; 43(1):6-14. [PubMed ID: 14707933]	SARS outbreak, 2003 (37 countries)	1.85 (24)
51	Wang CH, Liu CY, Wan YL, Chou CL, Huang KH, Lin HC, Lin SM, Lin TY, Chung KF, Kuo HP. Persistence of lung inflammation and lung cytokines with high-resolution CT abnormalities during recovery from SARS. *Respir Res*. 2005; 6:42. [PubMed ID: 15888207]	SARS outbreak, 2003 (37 countries)	1.80 (21)
51	Rodrigues RS, Marchiori E, Bozza FA, Pitrowsky MT, Velasco E, Soares M, Salluh JI. Chest computed tomography findings in severe influenza pneumonia occurring in neutropenic cancer patients. *Clinics (Sao Paulo)*. 2012; 67(4):313-318. [PubMed ID: 22522755]	H1N1 influenza outbreak, 2009 (worldwide)	1.80 (9)
53	Ooi GC, Khong PL, Muller NL, Yiu WC, Zhou LJ, Ho JC, Lam B, Nicolaou S, Tsang KW. Severe acute respiratory syndrome: temporal lung changes at thin-section CT in 30 patients. *Radiology*. 2004; 230(3):836-844. [PubMed ID: 14990845]	SARS outbreak, 2003 (37 countries)	1.79 (23)
54	Bagheri MH, Hosseini SK, Mostafavi SH, Alavi SA. High-resolution CT in chronic pulmonary changes after mustard gas exposure. *Acta Radiol*. 2003; 44(3):241-245. [PubMed ID: 12751992]	Iran-Iraq war, 1980-1988 (Iran, Iraq)	1.68 (23)
55	Marti M, Parron M, Baudraxler F, Royo A, Gomez Leon N, Alvarez-Sala R. Blast injuries from Madrid terrorist bombing attacks on March 11, 2004. *Emerg Radiol*. 2006; 13(3):113-122. [PubMed ID: 17103009]	Madrid train bombings, 2004 (Spain)	1.59 (16)
56	Hui DS, Wong KT, Antonio GE, Lee N, Wu A, Wong V, Lau W, Wu JC, Tam LS, Yu LM, Joynt GM, Chung SS, Ahuja AT, Sung JJ. Severe acute respiratory syndrome: correlation between clinical outcome and radiologic features. *Radiology*. 2004; 233(2):579-585. [PubMed ID: 15375225]	SARS outbreak, 2003 (37 countries)	1.56 (19)
57	Hong N, Du X, Nie Z, Li S. Diffusion-weighted MR study of femoral head avascular necrosis in severe acute respiratory syndrome patients. *J Magn Reson Imaging*. 2005; 22(5):661-664. [PubMed ID: 16193472]	SARS outbreak, 2003 (37 countries)	1.52 (17)
57	Shim SS, Kim Y, Ryu YJ. Novel influenza A (H1N1) infection: chest CT findings from 21 cases in Seoul, Korea. *Clin Radiol*. 2011; 66(2): 118-124. [PubMed ID: 21216327]	H1N1 influenza outbreak, 2009 (worldwide)	1.52 (9)
57	Dan D, Mingsong L, Jie T, Xiaobo W, Zhong C, Yan L, Xiaojin L, Ming C. Ultrasonographic applications after mass casualty incident caused by Wenchuan earthquake. *J Trauma*. 2010; 68(6):1417-1420. [PubMed ID: 20234325]	Sichuan earthquake, 2008 (China)	1.52 (10)
60	Zhao C, Gan Y, Sun J. Radiographic study of severe Influenza-A (H1N1) disease in children. *Eur J Radiol*. 2011; 79(3):447-451. [PubMed ID: 20965678]	H1N1 influenza outbreak, 2009 (worldwide)	1.50 (8)
61	Valente T, Lassandro F, Marino M, Squillante F, Aliperta M, Muto R. H1N1 pneumonia: our experience in 50 patients with a severe clinical course of novel swine-origin influenza A (H1N1) virus (S-OIV). *Radiol Med*. 2012; 117(2):165-184. [PubMed ID: 22020427]	H1N1 influenza outbreak, 2009 (worldwide)	1.45 (7)
62	White PW, Gillespie DL, Feurstein I, Aidinian G, Phinney S, Cox MW, Adams E, Fox CJ. Sixty-four slice multidetector computed tomographic angiography in the evaluation of vascular trauma. *J Trauma*. 2010; 68(1):96-102. [PubMed ID: 19779310]	Unspecified armed conflicts	1.43 (10)
63	Dean AJ, Ku BS, Zeserson EM. The utility of handheld ultrasound in an austere medical setting in Guatemala after a natural disaster. *Am J Disaster Med*. 2007; 2(5):249-256. [PubMed ID: 18491840]	Guatemala landslide, 2015 (Guatemala)	1.39 (13)
64	Amorim VB, Rodrigues RS, Barreto MM, Zanetti G, Hochhegger B, Marchiori E. Influenza A (H1N1) pneumonia: HRCT findings. *J Bras Pneumol*. 2013; 39(3):323-329. [PubMed ID: 23857688]	H1N1 influenza outbreak, 2009 (worldwide)	1.36 (5)
65	Wong CK, Lai V, Wong YC. Comparison of initial high-resolution computed tomography features in viral pneumonia between metapneumovirus infection and severe acute respiratory syndrome. *Eur J Radiol*. 2012; 81(5):1083-1087. [PubMed ID: 21439753]	SARS outbreak, 2003 (37 countries)	1.29 (6)
66	Chen TW, Yang ZG, Wang QL, Dong ZH, Yu JQ, Zhuang ZP, Hou CL, Li ZL. Crush extremity fractures associated with the 2008 Sichuan earthquake: anatomic sites, numbers and statuses evaluated with digital radiography and multidetector computed tomography. *Skeletal Radiol*. 2009; 38(11):1089-1097. [PubMed ID: 19554326]	Sichuan earthquake, 2008 (China)	1.26 (9)
67	Ng CK, Chan JW, Kwan TL, To TS, Chan YH, Ng FY, Mok TY. Six month radiological and physiological outcomes in severe acute respiratory syndrome (SARS) survivors. *Thorax*. 2004; 59(10):889-891. [PubMed ID: 15454656]	SARS outbreak, 2003 (37 countries)	1.22 (15)
68	Chau TN, Lee PO, Choi KW, Lee CM, Ma KF, Tsang TY, Tso YK, Chiu MC, Tong WL, Yu WC, Lai ST. Value of initial chest radiographs for predicting clinical outcomes in patients with severe acute respiratory syndrome. *Am J Med*. 2004; 117(4):249-254. [PubMed ID: 15308434]	SARS outbreak, 2003 (37 countries)	1.13 (14)
69	Pinilla I, de Gracia MM, Quintana-Diaz M, Figueira JC. Radiological prognostic factors in patients with pandemic H1N1 (pH1N1) infection requiring hospital admission. *Emerg Radiol*. 2011; 18(4):313-319. [PubMed ID: 21617935]	H1N1 influenza outbreak, 2009 (worldwide)	1.11 (6)
70	Singh AK, Sodickson A, Abujudeh H. Imaging of abdominal and pelvic injuries from the Boston Marathon bombing. *Emerg Radiol*. 2016; 23(1):35-39. [PubMed ID: 26445949]	Boston Marathon bombing, 2013 (USA)	1.09 (1)
71	Muller NL, Ooi GC, Khong PL, Zhou LJ, Tsang KW, Nicolaou S. High-resolution CT findings of severe acute respiratory syndrome at presentation and after admission. *AJR Am J Roentgenol*. 2004; 182(1):39-44. [PubMed ID: 14684509]	SARS outbreak, 2003 (37 countries)	1.08 (14)

TABLE 2

(Continued)

Rank	Article	Disaster	Average Yearly Citation (Total Citation)
71	Yun TJ, Kwon GJ, Oh MK, Woo SK, Park SH, Choi SH, Lee HJ, Goo JM, Yim JJ, Kim JS, Park CM. Radiological and clinical characteristics of a military outbreak of pandemic H1N1 2009 influenza virus infection. *Korean J Radiol*. 2010; 11(4):417-424. [PubMed ID: 20592925]	H1N1 influenza outbreak, 2009 (worldwide)	1.08 (7)
73	Nicolini A, Ferrera L, Rao F, Senarega R, Ferrari-Bravo M. Chest radiological findings of influenza A H1N1 pneumonia. *Rev Port Pneumol*. 2012; 18(3):120-127. [PubMed ID: 22483844]	H1N1 influenza outbreak, 2009 (worldwide)	1.07 (5)
74	Postma IL, Beenen LF, Bijlsma TS, Berger FH, Heetveld MJ, Bloemers FW, Goslings JC. Radiological work-up after mass casualty incidents: are ATLS guidelines applicable? *Eur Radiol*. 2014; 24(3):785-791. [PubMed ID: 24306424]	Turkish Airlines Flight 1951 crash, 2009 (Netherlands)	1.06 (3)
75	Choi MJ, Lee YS, Lee JY, Lee KS. Novel influenza A (H1N1) virus infection in children: chest radiographic and CT evaluation. *Korean J Radiol*. 2010; 11(6):656-664. [PubMed ID: 21076592]	H1N1 influenza outbreak, 2009 (worldwide)	0.97 (6)
75	Breeze J, Leason J, Gibb I, Allanson-Bailey L, Hunt N, Hepper A, Spencer P, Clasper J. Characterisation of explosive fragments injuring the neck. *Br J Oral Maxillofac Surg*. 2013; 51(8):e263- e266. [PubMed ID: 24012051]	War in Afghanistan, 2001-2014 (Afghanistan)	0.97 (3)
77	Yuan Y, Tao XF, Shi YX, Liu SY, Chen JQ. Initial HRCT findings of novel influenza A (H1N1) infection. *Influenza Other Respir Viruses*. 2012; 6(6):e114- e119. [PubMed ID: 22551111]	H1N1 influenza outbreak, 2009 (worldwide)	0.96 (4)
78	Wang TL, Jang TN, Huang CH, Kao SJ, Lin CM, Lee FN, Liu CY, Chong CF, Dorji H, Teng HJ, Chang H. Establishing a clinical decision rule of severe acute respiratory syndrome at the emergency department. *Ann Emerg Med*. 2004; 43(1):17-22. [PubMed ID: 14707935]	SARS outbreak, 2003 (37 countries)	0.92 (12)
79	Wong KT, Antonio GE, Hui DS, Ho C, Chan PN, Ng WH, Shing KK, Wu A, Lee N, Yap F, Joynt GM, Sung JJ, Ahuja AT. Severe acute respiratory syndrome: thin-section computed tomography features, temporal changes, and clinicoradiologic correlation during the convalescent period. *J Comput Assist Tomogr*. 2004; 28(6):790-795. [PubMed ID: 15538152]	SARS outbreak, 2003 (37 countries)	0.90 (11)
80	Chang YC, Yu CJ, Chang SC, Galvin JR, Liu HM, Hsiao CH, Kuo PH, Chen KY, Franks TJ, Huang KM, Yang PC. Pulmonary sequelae in convalescent patients after severe acute respiratory syndrome: evaluation with thin-section CT. *Radiology*. 2005; 236(3):1067-1075. [PubMed ID: 16055695]	SARS outbreak, 2003 (37 countries)	0.88 (10)
81	Meghoo CA, Dennis JW, Tuman C, Fang R. Diagnosis and management of evacuated casualties with cervical vascular injuries resulting from combat-related explosive blasts. *J Vasc Surg*. 2012; 55(5):1329-1336; discussion 36-7. [PubMed ID: 22325667]	Unspecified armed conflicts	0.86 (4)
82	Babyn PS, Chu WC, Tsou IY, Wansaicheong GK, Allen U, Bitnun A, Chee TS, Cheng FW, Chiu MC, Fok TF, Hon EK, Gahunia HK, Kaw GJ, Khong PL, Leung CW, Li AM, Manson D, Metreweli C, Ng PC, Read S, Stringer DA. Severe acute respiratory syndrome (SARS): chest radiographic features in children. *Pediatr Radiol*. 2004; 34(1):47-58. [PubMed ID: 14624321]	SARS outbreak, 2003 (37 countries)	0.85 (11)
83	Engel A, Soudack M, Ofer A, Nitecki SS, Ghersin E, Fischer D, Gaitini DE. Coping with war mass casualties in a hospital under fire: the radiology experience. *AJR Am J Roentgenol*. 2009; 193(5):1212-1221. [PubMed ID: 19843733]	Lebanon War, 2006 (Lebanon, Israel, and the Golan Heights)	0.84 (6)
84	Grosse AB, Grosse CA, Steinbach LS, Zimmermann H, Anderson S. Imaging findings of avalanche victims. *Skeletal Radiol*. 2007; 36(6): 515-521. [PubMed ID: 17410358]	Unspecified avalanche	0.83 (8)
84	Johnson ON, Fox CJ, O'Donnell S, Weber M, Adams E, Cox M, Quan R, Rich N, Gillespie DL. Arteriography in the delayed evaluation of wartime extremity injuries. *Vasc Endovascular Surg*. 2007; 41(3):217-224. [PubMed ID: 17595388]	Unspecified armed conflicts	0.83 (8)
84	Lai EK, Deif H, LaMere EA, Pham DH, Wolff B, Ward S, Mederski B, Loutfy MR. Severe acute respiratory syndrome: quantitative assessment from chest radiographs with clinical and prognostic correlation. *AJR Am J Roentgenol*. 2005; 184(1):255-263. [PubMed ID: 15615985]	SARS outbreak, 2003 (37 countries)	0.83 (10)
84	Antonio GE, Ooi CG, Wong KT, Tsui EL, Wong JS, Sy AN, Hui JY, Chan CY, Huang HY, Chan YF, Wong TP, Leong LL, Chan JC, Ahuja AT. Radiographic-clinical correlation in severe acute respiratory syndrome: study of 1373 patients in Hong Kong. *Radiology*. 2005; 237(3): 1081-1090. [PubMed ID: 16304120]	SARS outbreak, 2003 (37 countries)	0.83 (10)
84	Li AM, So HK, Chu W, Ng PC, Hon KL, Chiu WK, Leung CW, Yau YS, Mo WK, Fok TF. Radiological and pulmonary function outcomes of children with SARS. *Pediatr Pulmonol*. 2004; 38(6):427-433. [PubMed ID: 15514972]	SARS outbreak, 2003 (37 countries)	0.83 (10)
89	Tanaka N, Emoto T, Suda H, Kunihiro Y, Matsunaga N, Hasegawa S, Ichiyama T. High-resolution computed tomography findings of influenza virus pneumonia: a comparative study between seasonal and novel (H1N1) influenza virus pneumonia. *Jpn J Radiol*. 2012; 30(2):154-161. [PubMed ID: 22180185]	H1N1 influenza outbreak, 2009 (worldwide)	0.81 (4)
90	Nitecki SS, Karram T, Hoffman A, Bass A. Venous trauma in the Lebanon War–2006. *Interact Cardiovasc Thorac Surg*. 2007; 6(5):647-650. [PubMed ID: 17670724]	Lebanon War, 2006 (Lebanon, Israel, and the Golan Heights)	0.76 (7)
91	Chandler TM, Leipsic J, Nicolaou S, Quiney B, Romney M, Muller NL, Ajlan AM. Confirmed swine-origin influenza A(H1N1) viral pneumonia: computed tomographic findings in the immunocompetent and the immunocompromised. *J Comput Assist Tomogr*. 2011; 35(5):602-607. [PubMed ID: 21926856]	H1N1 influenza outbreak, 2009 (worldwide)	0.75 (4)
92	Folio LR, Fischer T, Shogan P, Frew M, Dwyer A, Provenzale JM. Blast and ballistic trajectories in combat casualties: a preliminary analysis using a cartesian positioning system with MDCT. *AJR Am J Roentgenol*. 2011; 197(2):W233-W240. [PubMed ID: 21785047]	Iraq War, 2003-2011 (Iraq)	0.74 (4)

TABLE 2

(Continued)

Rank	Article	Disaster	Average Yearly Citation (Total Citation)
93	Flint JH, Wade AM, Stocker DJ, Pasquina PF, Howard RS, Potter BK. Bone mineral density loss after combat-related lower extremity amputation. *J Orthop Trauma*. 2014; 28(4):238-244. [PubMed ID: 23912861]	Iraq War, 2003-2011 (Iraq); War in Afghanistan, 2001-2014 (Afghanistan)	0.73 (2)
94	Dong ZH, Yang ZG, Chen TW, Chu ZG, Wang QL, Deng W, Denor JC. Earthquake-related versus non-earthquake-related injuries in spinal injury patients: differentiation with multidetector computed tomography. *Crit Care*. 2010; 14(6):R236. [PubMed ID: 21190568]	Sichuan earthquake, 2008 (China)	0.71 (5)
94	Cellarier GR, Bordes J, Karkowski L, Gagnon N, Billhot M, Cournac JM, Rousseau C, De Greslan T, Mac Nab C, Dubrous P, Duron S, Moroge S, Quentin B. Safety, feasibility, and interest of transthoracic echocardiography in a deployed French military Ebola virus disease treatment center in Guinea. *Intensive Care Med*. 2015; 41(8):1491-1492. [PubMed ID: 25952824]	Ebola outbreak, 2014-2016 (West Africa)	0.71 (1)
96	Chen SY, Chiang WC, Ma MH, Su CP, Hsu CY, Ko PC, Tsai KC, Yen ZS, Shih FY, Chen SC, Lin SJ, Wang JL, Chang SC, Chen WJ. Sequential symptomatic analysis in probable severe acute respiratory syndrome cases. *Ann Emerg Med*. 2004; 43(1):27-33. [PubMed ID: 14707937]	SARS outbreak, 2003 (37 countries)	0.69 (9)
96	Hui JY, Hon TY, Yang MK, Cho DH, Luk WH, Chan RY, Chan KS, Loke TK, Chan JC. High-resolution computed tomography is useful for early diagnosis of severe acute respiratory syndrome-associated coronavirus pneumonia in patients with normal chest radiographs. *J Comput Assist Tomogr*. 2004; 28(1):1-9. [PubMed ID: 14716225]	SARS outbreak, 2003 (37 countries)	0.69 (9)
98	Chen TW, Yang ZG, Dong ZH, Tang SS, Chu ZG, Shao H. Earthquake-related pelvic crush fracture vs. non-earthquake fracture on digital radiography and MDCT: a comparative study. *Clinics (Sao Paulo)*. 2011; 66(4):629-634. [PubMed ID: 21655758]	Sichuan earthquake, 2008 (China)	0.67 (4)
98	El-Badrawy A, Zeidan A, Ebrahim MA. 64 multidetector CT findings of influenza A (H1N1) virus in patients with hematologic malignancies. *Acta Radiol*. 2012; 53(6):662-667. [PubMed ID: 22734081]	H1N1 influenza outbreak, 2009 (worldwide)	0.67 (3)
100	Splavski B, Sisljagic V, Peric L, Vrankovic D, Ebling Z. Intracranial infection as a common complication following war missile skull base injury. *Injury*. 2000; 31(4):233-237. [PubMed ID: 10719101]	Unspecified armed conflicts	0.66 (11)

Abbreviations: SARS, Severe Acute Respiratory Syndrome; MERS, Middle East Respiratory Syndrome.

TABLE 3

Types of Disaster Studied in the 100 Most Highly Cited Articles

Disaster Type	Article Count
Natural	
Disease outbreak	55
Earthquake	7
Avalanche	2
Landslide	1
Human-made	
Armed conflict	23
Terrorist incident	10
Aviation accident	1
Nuclear disaster	1

TABLE 4

Individual Disasters, When Specified, and the Number of Articles Where They Were Studied

Individual Disaster	Article Count
H1N1 influenza outbreak, 2009 (worldwide)	28
SARS outbreak, 2003 (37 countries)	24
War in Afghanistan, 2001-2014 (Afghanistan)	8
Iraq War, 2003-2011 (Iraq)	6
Sichuan earthquake, 2008 (China)	6
Boston Marathon bombing, 2013 (USA)	4
9/11 World Trade Center attack, 2001 (USA)	3
Lebanon War, 2006 (Lebanon, Israel, and the Golan Heights)	3
Iran-Iraq war, 1980-1988 (Iran, Iraq)	2
MERS outbreak, 2012-2015 (29 countries)	2
Ebola outbreak, 2014-2016 (West Africa)	1
Fukushima Daiichi nuclear disaster, 2011 (Japan)	1
Guatemala landslide, 2015 (Guatemala)	1
Haiti earthquake, 2010 (Haiti)	1
Madrid train bombings, 2004 (Spain)	1
Turkish Airlines Flight 1951 crash, 2009 (The Netherlands)	1
Utøya shooting attacks, 2011 (Norway)	1

Abbreviations: SARS, Severe Acute Respiratory Syndrome; MERS, Middle East Respiratory Syndrome.

Ophthalmology (1). For 1 article, no departmental affiliation was given for the first author.

Journal

These 100 most highly cited articles were published in 56 journals, including 18 Radiology journals. Other than radiology, these journals covered a wide range of topics, such as emergency medicine, surgery, military medicine, critical care, and respirology. The journal *Radiology* published the most highly cited articles (11 articles), followed by the *American Journal of Roentgenology* (12 articles) Table 6 lists the journals

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FIGURE 1

Distribution of the 100 Most Highly Cited Articles Since 2000 Depicting the Roles of Diagnostic Imaging in Disaster Management by Year of Publication.

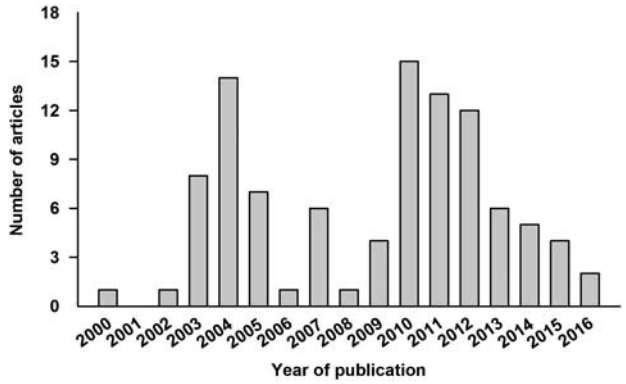

TABLE 5

Countries of Origin of the 100 Most Highly Cited Articles Since 2000 Depicting the Roles of Diagnostic Imaging in Disaster Management

Country of the 1st Author	Article Count
United States of America	25
China (People's Republic of)	24
Canada	6
Israel	5
United Kingdom	5
China (Republic of)	4
Korea	4
Brazil	3
Germany	3
Iran	3
Italy	3
France	2
Japan	2
Spain	2
Croatia	1
Egypt	1
Finland	1
The Netherlands	1
Norway	1
Saudi Arabia	1
Singapore	1
Switzerland	1
Turkey	1

in which at least 2 highly cited articles were published, ranked in descending order of the number of articles published, and their corresponding impact factors for the year 2015, as obtained from the InCites Journal Citation Reports.

TABLE 6

Journals That Published At Least 2 of the 100 Most Highly Cited Articles Since 2000 Depicting the Roles of Diagnostic Imaging in Disaster Management

Journals	Article Count	Impact Factor (2015)
Radiology	11	6.798
American Journal of Roentgenology	9	2.660
Journal of Trauma and Acute Care Surgery (previously *Journal of Trauma – Injury Infection and Critical Care)*	5	2.802
European Journal of Radiology	5	2.593
Emergency Radiology	5	Not indexed by JCR
New England Journal of Medicine	3	59.558
Annals of Emergency Medicine	3	5.008
Acta Radiologica	3	2.009
Journal of Computer Assisted Tomography	3	1.470
Critical Care	2	4.950
Clinical Radiology	2	2.151
British Journal of Radiology	2	1.840
Korean Journal of Radiology	2	1.592
Skeletal Radiology	2	1.527
Clinics	2	1.328

Abbreviation: JCR, Journal Citation Reports.

Study Design and Sample Size

Out of the 100 most highly cited articles, 81 studies were retrospective, and 19 studies were prospective. Many of the prospective articles were follow-up studies on the treatment outcomes. For example, 9 out of 24 articles (37.5%) about the SARS outbreak were prospective. Seven of these 9 articles were specifically about treatment outcomes.

The range of sample sizes was 7-4365, with an average of 197.8 and a median of 72. These results are summarized in Table 7.

Imaging Modality

Several major imaging modalities, such as conventional radiography, angiography, ultrasound, computed tomography (CT), and magnetic resonance imaging were utilized in these 100 highly cited studies. A total of 64 articles involved only 1 modality (on average 1.4 modalities per article). CT was the most reported modality (52.8%), followed by conventional radiography (33.3%) and ultrasound (9.7%). Table 8 shows the number and breakdown of the modalities discussed in these articles.

Table 9 shows a further breakdown of the two most utilized imaging modalities in several major disaster types/events. Again, CT and conventional radiography were ranked consistently as the most utilized modalities in most cases, with the

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TABLE 7

Distribution of Study Design and Sample Size of the 100 Most Highly Cited Articles Since 2000 Depicting the Roles of Diagnostic Imaging in Disaster Management

Descriptors	Result	Article Count
Study design (n = 100)	Prospective	19
	Retrospective	81
Sample size (n = 100)	1-50	43
	51-100	18
	101-200	20
	201-500	9
	501-1000	7
	1001-5000	3
	(min = 7, max = 4365, mean = 197.8, median = 72)	

TABLE 8

Number and Breakdown of the Imaging Modalities Investigated in the 100 Most Highly Cited Articles Since 2000 Depicting the Roles of Diagnostic Imaging in Disaster Management

Descriptors	Results	Count
Number of articles (n = 100)	1 modality	64 articles
	2 modalities	29 articles
	3 modalities	6 articles
	4 modalities	1 article
Breakdown of imaging modalities (n = 144)	Conventional radiography	48 (33.3%)
	Including dual-energy X-ray absorptiometry	1 (0.7%)
	Angiography	2 (1.4%)
	Ultrasound	14 (9.7%)
	Computed tomography (CT)	76 (52.8%)
	Including high-resolution CT	19 (13.2%)
	Including CT angiography	6 (4.2%)
	Magnetic resonance imaging	4 (2.8%)

only exception of ultrasound being the second most investigated modality in armed conflicts.

Non-Patient-Centric Articles

Our literature selection and bibliometric analysis focused on original research articles that included patients in the study design. For readers' interest, we also compiled a list of 15 non-patient-centric articles (Table 10) that did not include patients in the study design, but nevertheless could provide important insights into the roles of imaging in disaster responses. These articles typically provide either a narrative description of the experience of imaging services in disasters, summaries of work-flow adjustments, or guidelines and recommendations based on real experience in disasters.

TABLE 9

Top 2 Most Investigated Imaging Modalities in Major Disaster Types or Events

Disaster Type/Event	Top 2 Imaging Modalities
Disease outbreak	
H1N1 influenza outbreak, 2009 (28 articles)	58% Computed tomography (CT)
	38% Conventional radiography
SARS outbreak, 2003 (24 articles)	50% Conventional radiography
	47% CT
Armed conflict (23 articles)	65% CT
	15% Ultrasound
Terrorist incident (10 articles)	45% Conventional radiography
	40% CT
Earthquake (7 articles)	56% CT
	22% Conventional radiography

Abbreviation: SARS, Severe Acute Respiratory Syndrome.

DISCUSSION

In this study, we conducted a bibliometric analysis of the top 100 most highly cited articles published since 2000 that depicted roles of diagnostic imaging in clinical diagnosis, treatment, and follow-up management of patients in response to disasters. By illustrating the diversity of medical practitioners from different subspecialties as well as the varied disaster management strategies and research strategies depicted in these publications, we revealed the trends of utility of imaging in this field that may guide future research and aid disaster management planning.

In our analysis, disease outbreaks, armed conflicts, terrorist incidents, and earthquakes were the most commonly studied disasters. A few reasons could explain why certain disasters were more highly represented than others. First, disasters such as disease outbreaks, earthquakes, and armed conflicts typically cause morbidity and mortality of a larger number of people, and consequently result in a higher number of medical care encounters.[25] Second, research on certain types of disasters, such as armed conflicts or terrorist incidents, may have received prioritized support from national governments, in the form of research infrastructure and research funding. This may explain the large number of articles studying armed conflicts in our analysis.[26] Third, the research output in disaster medicine research may reflect the research capacity or interest of local hospitals or institutions that are in geographic proximity to the disaster location. For example, Wenchuan County, the epicenter of the 2008 Sichuan earthquake in China, was only 80 km away from Chengdu, a major city with a population over 10 million.[27] In our analysis, we identified 6 articles that studied this earthquake, 5 of which were conducted in the West China Hospital, the largest hospital in Chengdu. Fourth, the relative numbers of publications reflect

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TABLE 10

The 15 Most Highly Cited Non-Patient-Centric Articles Since 2000 Discussing Diagnostic Imaging in Disasters, Ranked by Yearly Average Citation

Ranks	Article	Disaster	Average Yearly Citation (Total Citation)
1	Auffermann WF, Kraft CS, Vanairsdale S, Lyon GM, 3rd, Tridandapani S. Radiographic imaging for patients with contagious infectious diseases: how to acquire chest radiographs of patients infected with the Ebola virus. *AJR Am J Roentgenol*. 2015; 204(1):44-48. [PubMed ID: 25402496]	Ebola outbreak, 2014-2016 (West Africa)	4.50 (9)
2	Bluemke DA, Meltzer CC. Ebola virus disease: radiology preparedness. *Radiology*. 2015; 274(2):527-531. [PubMed ID: 25405643]	Ebola outbreak, 2014-2016 (West Africa)	2.61 (5)
3	Moreno CC, Kraft CS, Vanairsdale S, Kandiah P, Klopman MA, Ribner BS, Tridandapani S. Performance of bedside diagnostic ultrasound in an Ebola isolation unit: the Emory University Hospital experience. *AJR Am J Roentgenol*. 2015; 204(6): 1157-1159. [PubMed ID: 25730332]	Ebola outbreak, 2014-2016 (West Africa)	1.89 (3)
4	Gogna A, Tay KH, Tan BS. Severe acute respiratory syndrome: 11 years later–a radiology perspective. *AJR Am J Roentgenol*. 2014; 203(4):746-748. [PubMed ID: 25247939]	SARS outbreak, 2003 (37 countries)	1.33 (3)
5	Mollura DJ, Palmore TN, Folio LR, Bluemke DA. Radiology preparedness in ebola virus disease: guidelines and challenges for disinfection of medical imaging equipment for the protection of staff and patients. *Radiology*. 2015; 275(2):538-544. [PubMed ID: 25654616]	Ebola outbreak, 2014-2016 (West Africa)	1.20 (2)
6	Harcke HT, Statler JD, Montilla J. Radiology in a hostile environment: experience in Afghanistan. *Mil Med*. 2006; 171(3): 194-199. [PubMed ID: 16602513]	War in Afghanistan, 2001-2014 (Afghanistan)	1.02 (11)
7	Shah S, Dalal A, Smith RM, Joseph G, Rogers S, Dyer GS. Impact of portable ultrasound in trauma care after the Haitian earthquake of 2010. *Am J Emerg Med*. 2010; 28(8):970-971. [PubMed ID: 20708876]	Haiti earthquake, 2010 (Haiti)	0.96 (6)
8	Ho SS, Chan PL, Wong PK, Antonio GE, Wong KT, Lyon DJ, Fung KS, Li CK, Cheng AF, Ahuja AT. Eye of the storm: the roles of a radiology department in the outbreak of severe acute respiratory syndrome. *AJR Am J Roentgenol*. 2003; 181(1):19-24. [PubMed ID: 12818823]	SARS outbreak, 2003 (37 countries)	0.89 (12)
9	Ehara S. In a radiology department during the earthquake, tsunami, and nuclear power plant accident. *AJR Am J Roentgenol*. 2011; 197(4):W549-W550. [PubMed ID: 21940524]	Great East Japan earthquake, 2011 (Japan)	0.57 (3)
10	Mazur SM, Rippey J. Transport and use of point-of-care ultrasound by a disaster medical assistance team. *Prehosp Disaster Med*. 2009; 24(2):140-144. [PubMed ID: 19591309]	Unspecified cyclone	0.51 (4)
11	Tsou IY, Goh JS, Kaw GJ, Chee TS. Severe acute respiratory syndrome: management and reconfiguration of a radiology department in an infectious disease situation. *Radiology*. 2003; 229(1):21-26. [PubMed ID: 12853656]	SARS outbreak, 2003 (37 countries)	0.45 (6)
12	Lin YC, Dong SL, Yeh YH, Wu YS, Lan GY, Liu CM, Chu TC. Emergency management and infection control in a radiology department during an outbreak of severe acute respiratory syndrome. *Br J Radiol*. 2005; 78(931):606-611. [PubMed ID: 15961842]	SARS outbreak, 2003 (37 countries)	0.43 (5)
13	Heffernan TEt, Alle S, Matthews CC. Weathering the storm: maintaining an operational radiology department at Ochsner Medical Center throughout Hurricane Katrina. *Radiology*. 2007; 242(2):334-337. [PubMed ID: 17255404]	Hurricane Katrina, 2005 (USA)	0.30 (3)
14	Long J. Combat radiology: a unique opportunity for patient-centered radiology. *J Am Coll Radiol*. 2010; 7(12):915-917. [PubMed ID: 21129680]	Iraq War, 2003-2011 (Iraq)	0.16 (1)
15	Bluth EI, Kay D, Smetherman D, DeVun D, Eick J, Matthews C, Sullivan M. Managing in a catastrophe: radiology during Hurricane Katrina. *AJR Am J Roentgenol*. 2007; 188(3):630-632. [PubMed ID: 17312046]	Hurricane Katrina, 2005 (USA)	0.10 (1)

Abbreviation: SARS, Severe Acute Respiratory Syndrome.

the relative utility of diagnostic imaging in disasters. The recent Ebola outbreak in West Africa caused substantial mortality and generated public attention;[18,28] however, because of the limited role of diagnostic imaging in the direct diagnosis of Ebola virus disease,[28] our literature search only identified one highly cited research article on this topic.

It is reasonable to expect that these articles correlated with the disasters they studied, both spatially and temporally. Spatially, in our analysis, most articles originated from a country that was either the location of the disaster, or in the case of armed conflicts, a participant of the conflict, with a notable exception of an article discussing responses to the 2015 Guatemala landslide[29] that was published by a group in United States. Temporally, articles about a particular disaster typically clustered in a short period following the disaster occurrence, as illustrated in the Results section: compared with the Sichuan earthquake in 2008, the disaster-to-publication delay in the SARS and H1N1 influenza outbreaks was much shorter. This could be explained by the fact that disease outbreaks, unlike earthquakes, have a longer hazardous duration. Thus, faster publications could have been driven by the motivation to help end the disease outbreaks, with the information discussed and dispersed through the publications.

Limitations

Our study has its share of limitations. In our literature search, we only used the MEDLINE database developed by the National Library of Medicine. Our intention was to make extensive use of the highly sophisticated MeSH system,[17] as shown in our search methods. Because a disaster is a complex concept, the preindexation of references using the MeSH keywords can ensure we receive a comprehensive set of results. This may not be possible in many other databases, notably in the Web of Science. In addition, MEDLINE indexes more than 5600 journals and contains more than 23 million references in life sciences and medicine.[17] Although simultaneous use of other major databases could theoretically supplement the search results in many topics, MEDLINE is considered highly comprehensive in medical fields.[30-33] Further, because our focus was on the most highly cited articles, it was quite unlikely that a highly cited article would come from a journal that was not indexed by MEDLINE. It is our experience in bibliometric research that almost all highly cited articles come from an overlapping list of established journals that were generally indexed by most major literature search engines.[11-13,16]

The most utilized imaging modalities identified in our analysis are CT (52.8%), conventional radiography (33.3%), and ultrasound (9.7%). Because of potential selection bias based on the interests of researchers and journals, the utilization of these modalities in the published literature may not represent the actual utilization rate in the field. For example, the widespread use of chest X-ray and high-resolution CT in the SARS and H1N1 influenza outbreaks may have skewed our overall data. We have tried to mitigate this issue by providing a breakdown of the most investigated imaging modalities by the major disaster types/events. Further, the research literature may under-represent modalities that were more characterized and mature in disaster management. Nevertheless, the research interest in using these modalities as revealed in our analysis may, to some extent, reflect their particular value in disaster situations. For example, the rapid image acquisition and wealth of information generated by CT could explain its wide use in triaging patients, assessing and characterizing injuries, as well as in following up patients after the initial encounter.[34,35] The rapid point-of-care access of radiography and ultrasound, on the other hand, make these modalities ideal where diagnosis and treatment within the golden hour is critical.[36]

CONCLUSIONS

In conclusion, our study identified and analyzed the 100 most highly cited original research articles by average yearly citation published since 2000 that depicted the utility of diagnostic imaging in clinical diagnosis, treatment, and follow-up management of patients in response to a variety of disasters. These results offer an important insight into the utility of diagnostic imaging in response to various disasters and could help guide future research in developing disaster management plans.

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