

Cardiopulmonary complications and critical care in scorpion envenomation: a bibliometric analysis

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ABSTRACT

Aims: This study aimed to characterize publication and citation patterns in the literature on cardiopulmonary complications and critical care in scorpion envenomation and to map its thematic and intellectual structure.

Methods: The Web of Science Core Collection was searched on September 24, 2026. Records were screened against predefined eligibility criteria. Descriptive bibliometric indicators were calculated, and author-keyword co-occurrence (minimum three occurrences) and cited-reference co-citation (cited by at least 20 included records) networks were mapped using VOSviewer version 1.6.21.

Results: Of 462 retrieved records, 239 published between 1982 and 2026 were included; the 2026 count was partial. The records had received 5,346 citations (median, 10; h-Index, 41). Toxicon was the leading source (n=37), and India was the most frequently represented affiliation country (n=44). The author-keyword map, based on 162 records with author keywords, contained 28 terms in eight clusters. The co-citation map included 38 cited references in three clusters: foundational cardiovascular toxicity, myocardial injury and severity, and treatment and syntheses.

Conclusion: The literature is organized around acute cardiac and pulmonary injury, pediatric envenomation, and treatment-related themes. Combined keyword and co-citation mapping provides clinicians and researchers with a structured entry point to mechanistic, severity, assessment, and treatment literature and can guide focused evidence synthesis, without estimating complication incidence or comparative treatment effectiveness.

Keywords: Shock, cardiogenic, pulmonary edema, scorpion stings, critical care, bibliometrics

INTRODUCTION

Scorpion envenomation is an important public health problem, particularly in tropical and subtropical regions. Chippaux and Goffon estimated approximately 1.2 million stings and more than 3,250 deaths annually, while noting that surveillance and burden estimates vary across regions.¹ Most stings cause local symptoms; a smaller subset progresses to systemic toxicity. In severe cases, autonomic disturbance and catecholamine excess can accompany myocardial injury, ventricular dysfunction, pulmonary edema, cardiogenic shock, and respiratory failure.²⁻⁷ These complications can evolve rapidly, are especially consequential in children, and may require coordinated toxicology, emergency, pediatric, cardiology, and intensive care management.

The clinical literature is difficult to interpret as a single evidence base. A systematic review of scorpion-associated myocarditis assembled 703 patients from 30 case reports and 34 case series, illustrating the substantial contribution of small observational reports. These selected myocarditis cases cannot establish complication rates among all patients with scorpion stings.⁸ Controlled treatment studies address different envenomation syndromes and clinical settings, which complicates comparison across publications.⁹⁻¹¹ This

heterogeneity provides a rationale for examining how the literature is organized before undertaking a focused clinical evidence synthesis.

Recent clinical studies have examined bedside cardiac assessment, candidate biomarkers, hemodynamic monitoring, and prediction of transfer to the intensive care unit (ICU) in scorpion envenomation.¹²⁻¹⁶ These studies illustrate the range of clinical questions currently being addressed in scorpion envenomation. Earlier bibliometric analyses have addressed broader scorpionism epidemiology and venom and antivenom research rather than the cardiopulmonary and critical care focus considered here.^{17,18} A scoping review would characterize the breadth and nature of available clinical evidence, whereas bibliometric analysis maps indexed metadata and citation relationships to describe thematic and intellectual structure; the latter therefore better fits the present aim of characterizing field structure rather than synthesizing study-level findings.¹⁹⁻²¹

Accordingly, this study analyzed Web of Science Core Collection records on cardiopulmonary complications and critical care management in scorpion envenomation. The objectives were to characterize publication output and citation

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activity, describe source and geographic representation, and map the field's thematic and intellectual structure using author-keyword co-occurrence and cited-reference co-citation analyses.

METHODS

Ethics

The study analyzed bibliographic records and did not involve human participants, animals, or identifiable patient-level data. Ethics committee approval and informed consent were not applicable. The study was conducted in accordance with the relevant ethical principles and publication ethics standards.

Study Design and Data Source

This descriptive bibliometric study used records retrieved from the Web of Science (WoS) Core Collection. The search was run on September 24, 2026, in the topic (TS) field. A WoS Topic search covers titles, abstracts, author keywords, and keywords plus. Because keywords plus terms are generated from cited-reference titles, they may retrieve records with only tangential relevance to the clinical question; eligibility screening was used to exclude such records. The search was conducted in the Web of Science Core Collection, with all indexes available through the institutional subscription enabled. No publication-year, language, or document-type limits were applied at retrieval. The search covered the full available WoS record range; the included publications span 1982 (the earliest eligible record retrieved) through September 24, 2026 (the search date), with 2026 therefore representing a partial year. The complete search strategy was:

TS=[("scorpion sting*" OR "scorpion envenom*" OR scorpionism) AND (cardiac OR cardiovascular OR cardiopulmonary OR myocardial OR myocarditis OR cardiomyopathy OR "myocardial dysfunction" OR "cardiac dysfunction" OR "heart failure" OR "left ventricular dysfunction" OR "ventricular dysfunction" OR "pulmonary edema" OR "pulmonary oedema" OR "cardiogenic shock" OR "circulatory shock" OR "respiratory failure" OR "acute respiratory distress syndrome" OR ARDS OR "mechanical ventilation" OR "noninvasive ventilation" OR "non-invasive ventilation" OR intubation OR "intensive care" OR "critical care" OR ICU OR vasopressor* OR inotrope* OR prazosin OR dobutamine OR ECMO OR "extracorporeal membrane oxygenation")]

The search returned 462 records. All 462 WoS accession numbers were unique, so no duplicate records were removed. Full Record and Cited References data were exported for the final included set. The data export was retrieved on September 24, 2026, coinciding with the search date. Citation counts are those present in this export snapshot and may change as WoS records are updated.

Eligibility and Screening

The target literature comprised human clinical publications on scorpion envenomation that substantively addressed cardiopulmonary manifestations, critical care management, or directly relevant diagnostic or therapeutic topics. Original clinical studies, case reports and series, and substantive topic-specific reviews were eligible. Letters were retained when they reported independent patient data or provided substantial topic-specific analysis. Animal, in vitro, and basic venom

studies; taxonomy-focused reports; records unrelated to scorpion envenomation; and publications without substantive relevance to the target clinical topics were excluded. For the mutually exclusive **Figure 1** categories, "no substantive cardiopulmonary/critical care focus" denoted clinical scorpion records whose primary clinical subject was outside the target manifestations or management; "insufficient relevance" denoted records that mentioned a target topic only tangentially, without analyzable clinical content; and "local or epidemiological focus only" denoted geographic, surveillance, or burden reports without eligible cardiopulmonary or critical care findings. "Ineligible format or no eligible clinical data" covered publication types or records lacking eligible human clinical data.

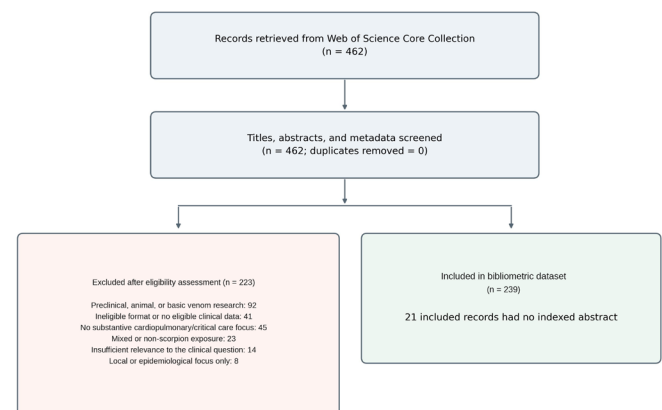


Figure 1. Record selection from the Web of Science Core Collection. Exclusion reasons are mutually exclusive and represent the primary eligibility reason for each record. Of the 239 included records, 21 had no abstract in the WoS export

The author screened titles, abstracts, and available WoS metadata for all retrieved records against predefined eligibility criteria. Records with uncertain eligibility were flagged for discussion with an independent research colleague; both rechecked these records against the eligibility criteria and resolved uncertainties by consensus. Full texts were consulted when available and needed to clarify eligibility. Full-text availability alone was not an exclusion criterion: records were included when relevance was clear from the title, abstract, or bibliographic metadata. No formal methodological quality or risk-of-bias appraisal of the included clinical publications was undertaken.

Data Items and Bibliometric Analysis

The extracted WoS fields included publication year, document type, source title, author names, affiliation addresses, author keywords, keywords plus, cited references, and times cited. Publication counts were summarized by year, source, document type, language, and affiliation country. Countries were counted once per record for each country represented. "Turkey" and "Türkiye" were harmonized as Türkiye; United States address forms ending in "USA" were grouped as United States, and capitalization variants were standardized. Records without affiliation data were excluded from country tabulations. Publication year was taken from the WoS PY field as indexed in the September 24, 2026 export; records tagged early access were not reassigned to a later final-issue year. Citation counts were treated as a database snapshot rather than as a time-independent measure. The h-Index was calculated for the 239-record set from the WoS times-cited values.

The author-keyword co-occurrence analysis was conducted using VOSviewer (version 1.6.21; Centre for Science and Technology Studies, Leiden University, Leiden, the Netherlands), with full counting and a minimum occurrence threshold of three. A thesaurus file harmonized selected spelling and synonym variants, including “scorpion envenoming” and “scorpionism” with “scorpion envenomation,” “pulmonary oedema” with “pulmonary edema,” “scorpion stings” with “scorpion sting,” and “scorpion venoms” with “scorpion venom.” The singular/plural variants of each term were harmonized, whereas “scorpion sting” and “scorpion envenomation” were retained as separate author-keyword concepts to preserve the distinction between the exposure event and the clinical consequences of venom inoculation. “Tityus” and “Tityus serrulatus” were retained as distinct concepts. The overlay visualization displays average publication year on a 2000-2025 scale. Cited-reference co-citation was analyzed in VOSviewer using full counting and a minimum threshold of 20 citations per cited reference (that is, cited by at least 20 of the 239 included records). No inferential tests were used. Author keywords were used for thematic mapping because they represent terminology explicitly assigned by the authors; Keywords Plus were not incorporated into the co-occurrence network to avoid combining author-assigned terms with algorithmically generated indexing terms. The thresholds were selected pragmatically to retain recurrent items while maintaining interpretable network sizes and were not intended as statistical significance criteria.

RESULTS

Selection and Publication Profile

Of 462 records screened, 239 were included in the bibliometric dataset and 223 were excluded after eligibility assessment (Figure 1). Preclinical, animal, or basic venom research was the largest exclusion category (92/223; 41.3%). Publications ranged from 1982 to 2026. Annual output was uneven, with the highest number of included records in 2015 (n=16), followed by 2025 (n=14) and 2014 (n=13). Eleven records were published in each of 2013 and 2018. Seven records were dated 2026 in the export; this year was incomplete at the time of retrieval (Figure 2).

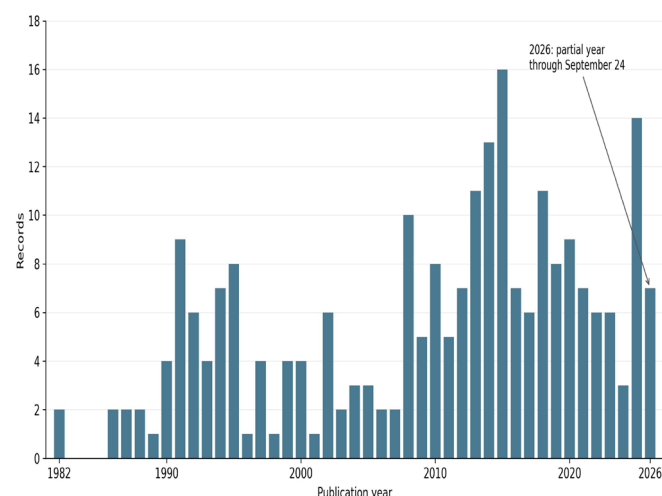


Figure 2. Annual publication output in the included dataset. The 2026 value is partial because the search was conducted on September 24, 2026

The dataset contained 196 records classified as articles, including two records also tagged as early access and one

record also tagged as a book chapter; 27 reviews, including one record also tagged as early access; 9 letters; 6 notes; and 1 editorial material record. English was the indexed language for 224 records, with French (n=7), Turkish (n=4), Spanish (n=2), and Portuguese (n=2) accounting for the remainder. Abstracts were available for 218 records (Table 1).

Table 1. Bibliometric characteristics of the included records

Characteristic	Value
Records included	239
Publication years	1982-2026*
WoS citations in export snapshot	5,346
Mean citations per record	22.4
Median citations per record	10
Uncited records	24
Set-level h-Index	41
Source titles	113
Records with affiliation data	214 (89.5%)
Records with abstract	218 (91.2%)
Article records**	196 (82.0%)
Reviews	27 (11.3%)
Letters	9 (3.8%)
Notes	6 (2.5%)
Editorial material	1 (0.4%)
Records with author keywords	162 (67.8%)

*2026 is partial through September 24, 2026. Publication year follows the WoS PY field as indexed at retrieval; an early access record was not reassigned when a final issue year became available.
 **The article group includes two records also tagged early access and one also tagged book chapter; the review group includes one record also tagged early access

Sources and Geographic Distribution

The 239 records were distributed across 113 source titles. Toxicon published the largest number (n=37), followed by Clinical Toxicology and Wilderness & Environmental Medicine (n=9 each), Human & Experimental Toxicology and Journal of Clinical and Diagnostic Research (n=7 each), and Annals of Tropical Paediatrics and the American Journal of Tropical Medicine and Hygiene (n=6 each; Table 2). WoS affiliation data were present for 214 records (89.5%). Under record-level full counting, India was most frequently represented (n=44), followed by Türkiye and Tunisia (n=30 each), Brazil (n=21), Israel (n=17), and the United States (n=14). A record could contribute to more than one country count; country totals are reported in Table 3.

Table 2. Most productive source titles

Source title	Records
Toxicon	37
Clinical Toxicology	9
Wilderness & Environmental Medicine	9
Human & Experimental Toxicology	7
Journal of Clinical and Diagnostic Research	7
Annals of Tropical Paediatrics	6
American Journal of Tropical Medicine and Hygiene	6
Chest	5
Intensive Care Medicine	5
Journal of Tropical Pediatrics	4

Table 3. Most frequently represented affiliation countries

Country	Records	% of records with affiliation data
India	44	20.6
Turkiye	30	14.0
Tunisia	30	14.0
Brazil	21	9.8
Israel	17	7.9
United States	14	6.5
Egypt	12	5.6
Morocco	10	4.7
Iran	7	3.3
Saudi Arabia	6	2.8
France	6	2.8

Country counts use record-level full counting. Records with affiliations in multiple countries contribute once to each represented country. Percentages use the 214 records with affiliation data as the denominator

Citation Profile

The included records had received 5,346 citations in the WoS export snapshot (mean, 22,4; median, 10). Twenty-four records had no citations; the h-Index of the included set was 41. The most cited record was Ismail’s 1995 description of the scorpion envenoming syndrome (245 citations), followed by the 2014 New England Journal of Medicine review by Isbister and Bawaskar (211) and Chippaux’s 2012 review of management options (174). The ten most cited records are listed in Table 4.

Table 4. Ten most cited records in the included dataset

First author	Year	Title	Source	Citations
Ismail	1995	The scorpion envenoming syndrome	Toxicon	245
Isbister	2014	Scorpion envenomation	New England Journal of Medicine	211
Chippaux	2012	Emerging options for the management of scorpion stings	Drug Design Development and Therapy	174
Abroug	1999	Serotherapy in scorpion envenomation: a randomised controlled trial	Lancet	132
Freire-Maia	1994	Approaches to the treatment of scorpion envenoming	Toxicon	130
Boyer	2009	Antivenom for critically ill children with neurotoxicity from scorpion stings	New England Journal Of Medicine	126
Gueron	1992	The cardiovascular-system after scorpion envenomation-a review	Journal Of Toxicology-Clinical Toxicology	126
Santos	2016	Clinical and epidemiological aspects of scorpionism in the world: a systematic review	Wilderness & Environmental Medicine	103
Ghalim	2000	Scorpion envenomation and serotherapy in morocco	American Journal of Tropical Medicine and Hygiene	97
Sofer	1988	Respiratory-failure in children following envenomation by the scorpion Leiurus-quinquestriatus-hemodynamic and neurological aspects	Toxicon	95

Citation counts reflect the WoS export retrieved on September 24, 2026 (5,346 citations across the included set)

Keyword and Co-citation Networks

After thesaurus-based harmonization, the author-keyword co-occurrence map, based on the 162 records with author keywords, included 28 terms in eight clusters, with 117 links and a total link strength of 262 (Figure 3 and 4; Table 5). “Scorpion envenomation” had the highest occurrence count (68) and total link strength (90), followed by “scorpion sting” (47 and 75). “Children” and “pulmonary edema” each occurred 26 times, with total link strengths of 38 and 36, respectively. “Myocarditis” occurred 20 times (total link strength, 35), while “echocardiography” and “prazosin” each occurred 14 times (27 and 26, respectively). In the overlay visualization, pulmonary edema had an earlier mean publication year (2009,3) than myocarditis (2016,3) and echocardiography (2016,9). The cited-reference co-citation network included

38 references in three co-citation clusters: foundational cardiovascular toxicity (18 references), myocardial injury and severity (7 references), and treatment and syntheses (13 references), with 671 links and a total link strength of 3,812 (Figure 5; Table 6). These clusters spanned 1970-2000 (median, 1990,5), 1998-2007 (median, 2003), and 1999-2014 (median, 2010), respectively. No reference published after 2014 met the 20-citation threshold. Chippaux and Goyffon’s¹ 2008 paper had the highest total link strength (399) and was cited by 69 included records, followed by Gueron’s 1970 paper (307; cited by 51), Bahloul et al.’s³ 2004 paper (301; cited by 35), and Abroug et al.’s⁴ 1995 paper (304; cited by 37).

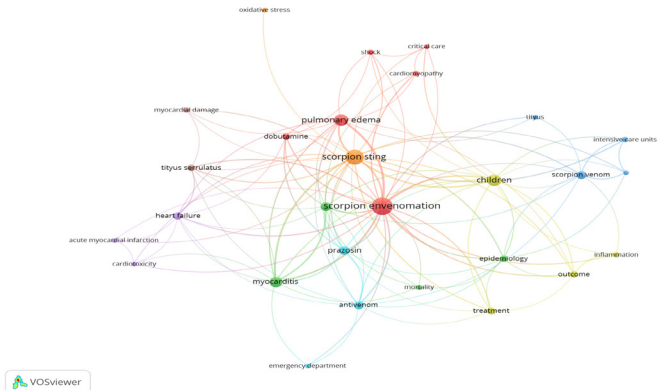


Figure 3. VOSviewer author-keyword co-occurrence network based on the 162 records with author keywords within the 239-record dataset. Node size represents keyword occurrence, node color represents cluster assignment, and links represent co-occurrence strength. The map contains 28 terms in eight clusters, 117 links, and a total link strength of 262

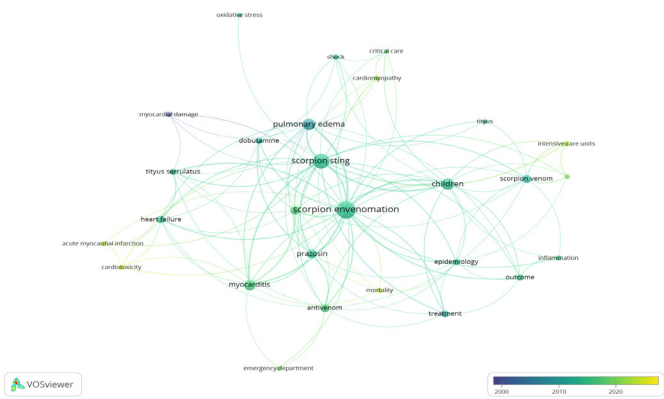


Figure 4. VOSviewer overlay visualization of the author-keyword co-occurrence network. Node color represents average publication year on the displayed 2000-2025 scale; node sizes and links match Figure 3

Table 5. Author-keyword clusters in the VOSviewer co-occurrence map

Cluster	Interpretive label	Author keyword	Occurrences	Links	Total link strength	Mean publication year
1	Cardiopulmonary and critical care	Scorpion envenomation	68	24	90	2014,3
		Pulmonary edema	26	14	36	2009,3
		Dobutamine	7	7	13	2012,1
		Cardiomyopathy	4	4	6	2020,3
		Shock	4	6	7	2015,3
		Critical care	3	5	6	2018,0
2	Cardiac assessment and epidemiology	Myocarditis	20	11	35	2016,3
		Echocardiography	14	13	27	2016,9
		Epidemiology	7	10	15	2014,1
		Mortality	3	5	5	2022,0
3	Species, venom, and health-system terms	Scorpion venom	11	10	15	2012,5
		Intensive care units	4	4	10	2021,5
		Public health	3	5	9	2019,0
		Tityus	3	3	4	2012,3
4	Pediatric outcomes and treatment	Children	26	15	38	2014,1
		Treatment	8	7	12	2010,4
		Outcome	6	7	13	2015,2
		Inflammation	4	4	7	2015,8
5	Cardiac complications	Heart failure	9	10	18	2014,6
		Acute myocardial infarction	3	4	5	2021,7
		Cardiotoxicity	3	5	7	2024,0
6	Acute treatment and care setting	Prazosin	14	10	26	2013,3
		Antivenom	11	12	20	2016,5
		Emergency department	3	3	4	2019,3
7	No interpretive label assigned	Scorpion sting	47	23	75	2013,6
		Oxidative stress	3	1	1	2015,7
8	No interpretive label assigned	Tityus serrulatus	6	8	15	2013,0
		Myocardial damage	4	4	5	2001,5

Based on the 162 records with author keywords within the fixed 239-record dataset; full counting; minimum occurrence threshold: 3; thesaurus harmonization as described in methods. This table provides the cluster membership and term-level metrics underlying Figures 3 and 4. Cluster numbers are VOSviewer assignments; labels are interpretive summaries used in the discussion. Clusters 7 and 8 each contain only two terms and were not assigned separate interpretive labels. Occurrences are the number of records containing the keyword. Links and total link strength are counted from each term's perspective; across all terms they sum to twice the network totals (117 links; total link strength 262). Mean publication year is the average WoS publication year of records containing the term and corresponds to the node colors in Figure 4

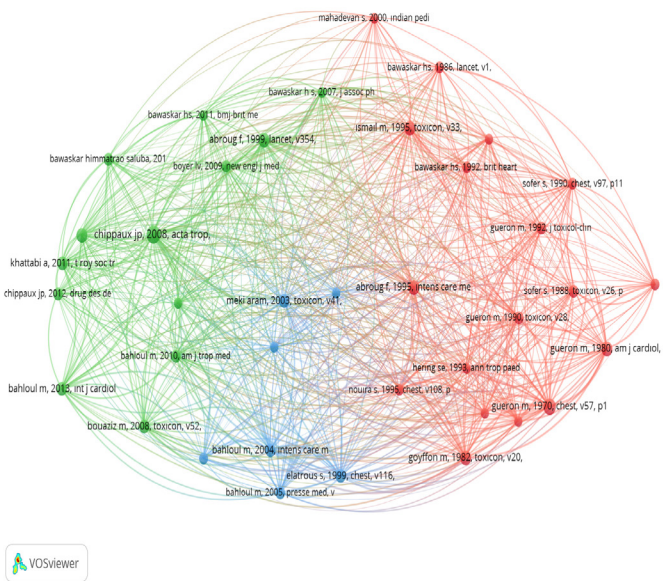


Figure 5. Cited-reference co-citation network generated in VOSviewer from the 239-record WoS export. Node size represents the number of included records citing each reference, node color represents cluster assignment, and links represent co-citation strength. The map contains 38 cited references in three clusters, 671 links, and a total link strength of 3,812

DISCUSSION

The present bibliometric analysis reveals a clinically coherent body of literature centered on acute cardiac and pulmonary injury, pediatric envenomation, and treatment-related themes. Its intellectual structure is further defined by three interconnected co-citation clusters representing foundational cardiovascular toxicity, myocardial injury and severity, and treatment and syntheses (Figure 5; Table 6). Notably, no cited reference published after 2014 reached the selected co-citation threshold, indicating that the most strongly shared reference base remains anchored in earlier literature. By integrating keyword co-occurrence with co-citation analysis, this study extends broader bibliometric work on scorpionism epidemiology and venom science by focusing specifically on cardiopulmonary complications and critical care.^{17,18} Annual publication output fluctuated over time rather than showing uninterrupted growth, and the partial 2026 count should therefore be interpreted cautiously.

The co-citation structure reflects successive but overlapping layers of the field. The foundational cardiovascular toxicity cluster includes early descriptions of cardiovascular effects and

Table 6. Cited references in the VOSviewer co-citation map

VOSviewer cited-reference label	Cluster	Year	Occurrences (citing records)	Links	Total link strength
Gueron M, Chest, 57:156	1: Foundational cardiovascular toxicity	1970	51	37	307
Gueron M, Am J Cardiol, 45:979	1: Foundational cardiovascular toxicity	1980	41	35	230
Goyffon M, Toxicon, 20:337	1: Foundational cardiovascular toxicity	1982	41	35	279
Bawaskar HS, Lancet, 1:510	1: Foundational cardiovascular toxicity	1986	23	34	134
Gueron M, Toxicon, 25:121	1: Foundational cardiovascular toxicity	1987	25	31	123
Sofer S, Toxicon, 26:931	1: Foundational cardiovascular toxicity	1988	27	36	204
Gueron M, Toxicon, 28:1005	1: Foundational cardiovascular toxicity	1990	29	36	253
Rahav G, Chest, 97:1478	1: Foundational cardiovascular toxicity	1990	21	36	165
Sofer S, Chest, 97:118	1: Foundational cardiovascular toxicity	1990	23	36	181
Abroug F, Chest, 100:1057	1: Foundational cardiovascular toxicity	1991	20	34	182
Bawaskar HS, Brit Heart J, 68:478	1: Foundational cardiovascular toxicity	1992	25	35	145
Gueron M, J Toxicol-Clin Toxic, 30:245	1: Foundational cardiovascular toxicity	1992	29	36	159
Hering SE, Ann Trop Paediatr, 13:173	1: Foundational cardiovascular toxicity	1993	20	37	169
Sofer S, J Pediatr-Us, 124:973	1: Foundational cardiovascular toxicity	1994	20	34	154
Abroug F, Intens Care Med, 21:629	1: Foundational cardiovascular toxicity	1995	37	37	304
Ismail M, Toxicon, 33:825	1: Foundational cardiovascular toxicity	1995	39	37	238
Nouira S, Chest, 108:682	1: Foundational cardiovascular toxicity	1995	22	36	200
Mahadevan S, Indian Pediatr, 37:504	1: Foundational cardiovascular toxicity	2000	21	27	100
Abroug F, Lancet, 354:906	2: Treatment and syntheses	1999	39	37	266
Bouaziz M, Clin Toxicol, 44:293	2: Treatment and syntheses	2006	21	36	159
Bawaskar H S, J Assoc Physicians India, 55:14	2: Treatment and syntheses	2007	20	36	156
Bouaziz M, Toxicon, 52:918	2: Treatment and syntheses	2008	31	35	209
Chippaux JP, Acta Trop, 107:71	2: Treatment and syntheses	2008	69	37	399
Boyer LV, New Engl J Med, 360:2090	2: Treatment and syntheses	2009	24	37	193
Bahloul M, Am J Trop Med Hyg, 83:1084	2: Treatment and syntheses	2010	30	37	226
Bawaskar HS, Bmj-Brit Med J, 342	2: Treatment and syntheses	2011	20	36	152
Khattabi A, T Roy Soc Trop Med H, 105:364	2: Treatment and syntheses	2011	33	35	188
Bawaskar Himmatrao Saluba, J Assoc Physicians India, 60:46	2: Treatment and syntheses	2012	27	31	108
Chippaux JP, Drug Des Dev Ther, 6:165	2: Treatment and syntheses	2012	27	33	119
Bahloul M, Int J Cardiol, 162:86	2: Treatment and syntheses	2013	33	33	200
Isbister GK, Bawaskar HS, New Engl J Med, 371:457	2: Treatment and syntheses	2014	37	37	200
Karnad DR, Heart, 79:485	3: Myocardial injury and severity	1998	20	36	116
Elatrous S, Chest, 116:748	3: Myocardial injury and severity	1999	33	37	290
Cupo P, Toxicon, 40:823	3: Myocardial injury and severity	2002	20	37	183
Meki Aram, Toxicon, 41:129	3: Myocardial injury and severity	2003	36	36	270
Bahloul M, Intens Care Med, 30:461	3: Myocardial injury and severity	2004	35	37	301
Bahloul M, Presse Med, 34:115	3: Myocardial injury and severity	2005	27	36	207
Cupo P, Int J Cardiol, 116:98	3: Myocardial injury and severity	2007	25	34	155

Fixed 239-record dataset; full counting; minimum inclusion threshold: each cited reference had to be cited by at least 20 of the 239 included records. Cluster assignments and network values reproduce the retained VOSviewer map. Cluster labels are interpretive summaries. Cluster 1 (foundational cardiovascular toxicity) comprised 18 references published 1970-2000 (median year, 1990,5); cluster 3 (myocardial injury and severity) comprised 7 references published 1998-2007 (median, 2003); and cluster 2 (treatment and syntheses) comprised 13 references published 1999-2014 (median, 2010). "Occurrences (citing records)" is the number of records in the analyzed export citing that reference; "Links" is the number of co-citation links; total link strength is the sum of link weights. Reference labels are readable transcriptions of VOSviewer labels; network values were not recalculated or changed. VOSviewer: Visualization of similarities viewer

severe envenomation by Gueron, Sofer, Ismail, and Bawaskar. The myocardial injury and severity cluster brings together studies of myocardial dysfunction, hemodynamic assessment, and clinical severity, including work by Bahloul, Elatrous, Cupo, Karnad, and Meki. The treatment and syntheses cluster includes the Abroug and Boyer trials, Chippaux's management review, and the review by Isbister and Bawaskar.^{2,6,9,10} These cluster labels are interpretive summaries of the underlying co-citation structure. Their publication periods span 1970-2000 (median year, 1990,5), 1998-2007 (median, 2003), and 1999-

2014 (median, 2010), respectively, with substantial temporal overlap. The predominance of older references should not be interpreted as evidence that contemporary research has slowed, because more recent publications have had less time to accumulate citations. Co-citation patterns also depend on reference matching and the selected threshold.

Document-level citation counts provide a related but distinct perspective on scholarly influence. The citation profile was led by Ismail's 1995 syndrome description, followed by the

2014 New England Journal of Medicine review by Isbister and Bawaskar and Chippaux's 2012 management review. These publications represent syndrome description, clinical synthesis, and management-oriented literature, respectively. Citation counts indicate scholarly visibility rather than current guideline status or clinical effectiveness; for example, the Boyer trial focused on neurotoxicity in critically ill children rather than specifically on cardiopulmonary outcomes.¹⁰

The author-keyword network provides a complementary view of the field's thematic structure. Eight clusters were identified, with complete membership and term-level metrics provided in [Table 5](#). The largest clusters grouped cardiopulmonary and critical care terms, cardiac assessment and epidemiology, species/venom and health-system terms, and pediatric outcomes and treatment. Smaller clusters represented cardiac complications, acute treatment and care setting, and two two-term groupings that were not assigned separate interpretive labels. Pulmonary edema, myocarditis, and echocardiography link major cardiopulmonary complications with their clinical assessment, whereas antivenom, prazosin, and dobutamine represent recurrent management topics. In the overlay visualization, myocarditis and echocardiography appeared later on average than pulmonary edema. This pattern reflects the timing of indexed author-keyword use and should not be interpreted as a change in disease incidence or clinical practice. Critical care-specific terminology was less prominent in the author-keyword network than cardiopulmonary manifestations: "critical care" and "intensive care units" occurred three and four times, respectively, whereas several management-related search terms, including mechanical ventilation, intubation, vasopressors, and ECMO, did not meet the three-occurrence threshold. Thus, critical care management was less frequently represented as an explicit author-keyword theme, although this should not be interpreted as an absence of critical care content in the underlying literature.

The mapped themes are consistent with the range of questions addressed in the contemporary clinical literature. A meta-analysis of controlled trials and the Brazilian clinical protocol show that treatment evidence and guidance are organized according to syndrome, species, and care setting.^{11,22} Studies in the corpus also address point-of-care ultrasound, candidate cardiac biomarkers, noninvasive cardiac output monitoring, prediction of intensive care unit transfer, and extracorporeal support.¹²⁻¹⁶ These examples illustrate the types of focused clinical questions represented in the literature rather than their prevalence or relative clinical importance. For clinicians, the bibliometric maps can serve as an entry point to the evidence by identifying mechanistic and severity studies, treatment trials, and clinical syntheses that can subsequently be appraised within the relevant species and care setting.

The geographic distribution of the literature also reflects established centers of research activity. India, Türkiye, Tunisia, and Brazil were among the most frequently represented affiliation countries, alongside Israel and the United States. These counts represent WoS-Indexed institutional addresses and should not be interpreted as measures of disease burden or the total research contribution of endemic countries. Costa et al.'s¹⁷ Scopus-based bibliometric analysis of scorpionism likewise identified Brazil and Iran among leading contributors, although its broader epidemiological scope precludes direct rank comparison. Brazil contributed 21 records in the present

dataset, and all six records using *Tityus serrulatus* as an author keyword included at least one Brazilian affiliation. This concentration is consistent with the major role of *Tityus serrulatus* in Brazilian scorpion accidents.²³

The bibliometric findings also point to several areas where further clinical research could be valuable. The co-citation clusters provide a structured basis for focused evidence syntheses on cardiopulmonary mechanisms, treatment strategies, myocardial dysfunction, and clinical severity. Greater consistency in clinical definitions and more complete use of author keywords would improve comparability across specialties. The cited clinical literature also supports further prospective multicenter evaluation and external validation of diagnostic and prognostic tools.^{8,11-14,22} Questions concerning treatment benefit, certainty of evidence, and unmet clinical need, however, require dedicated clinical synthesis rather than bibliometric analysis.

Limitations

This study has several limitations. Restricting retrieval to the Web of Science Core Collection may omit relevant literature indexed elsewhere. Author-keyword and co-citation maps depend on metadata completeness, thesaurus harmonization, cited-reference matching, and selected thresholds; author keywords were available for 162 of 239 records. The 2026 publication count is partial, and citation-based indicators reflect scholarly visibility rather than study quality or clinical effectiveness.

CONCLUSION

The WoS-indexed literature on cardiopulmonary complications and critical care in scorpion envenomation is organized around acute cardiac and pulmonary injury, pediatric envenomation, and treatment-related themes. Keyword and co-citation mapping delineated a field that links foundational cardiovascular toxicity with subsequent work on myocardial injury, severity assessment, and treatment. Together, these maps provide clinicians and researchers with a structured overview of the literature and can help identify relevant mechanistic, diagnostic, prognostic, and therapeutic evidence for focused synthesis. As a bibliometric analysis, however, these findings describe the structure and scholarly visibility of the literature rather than complication incidence or comparative treatment effectiveness.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study analyzed bibliographic records and did not involve human participants, animals, or identifiable patient-level data. Ethics committee approval and informed consent were not applicable.

Informed Consent

Since the study was conducted without the participation of any living being, no written consent form was obtained.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The author declares no conflicts of interest related to this study.

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Author Contributions

The author is solely responsible for the entirety of conception, execution, analysis, and writing of the manuscript.

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