ORIGINAL RESEARCH

Disaster Medicine: A Comprehensive Review of the Literature From 2016

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ABSTRACT

Objective: The Society of Academic Emergency Medicine Disaster Medicine Interest Group, the Office of the Assistant Secretary for Preparedness and Response – Technical Resources, Assistance Center, and Information Exchange (ASPR TRACIE) team, and the National Institutes of Health Library searched disaster medicine peer-reviewed and gray literature to identify, review, and disseminate the most important new research in this field for academics and practitioners.

Methods: MEDLINE/PubMed and Scopus databases were searched with key words. Additional gray literature and focused hand search were performed. A Level I review of titles and abstracts with inclusion criteria of disaster medicine, health care system, and disaster type concepts was performed. Eight reviewers performed Level II full-text review and formal scoring for overall quality, impact, clarity, and importance, with scoring ranging from 0 to 20. Reviewers summarized and critiqued articles scoring 16.5 and above.

Results: Articles totaling 1176 were identified, and 347 were screened in a Level II review. Of these, 193 (56%) were Original Research, 117 (34%) Case Report or other, and 37 (11%) were Review/Meta-Analysis. The average final score after a Level II review was 11.34. Eighteen articles scored 16.5 or higher. Of the 18 articles, 9 (50%) were Case Report or other, 7 (39%) were Original Research, and 2 (11%) were Review/Meta-Analysis.

Conclusions: This first review highlighted the breadth of disaster medicine, including emerging infectious disease outbreaks, terror attacks, and natural disasters. We hope this review becomes an annual source of actionable, pertinent literature for the emerging field of disaster medicine.

Key Words: health education, literature review, disaster education.

The global incidence of natural and man-made disasters remains persistently high, and, because of the growing body of evidence supporting the positive impact of an efficient and effective medical response on victim outcomes, both the academic and operational fields of disaster medicine are growing.[1] As the academic field of disaster medicine develops, the movement toward professional specialization has progressed in multiple sectors. For example, the World Health Organization (WHO) has published formal recommendations on the use of emergency medical teams (EMTs), domestic and international organizations are moving toward developing a consensus-driven curriculum for disaster medicine, and work is being done to standardize data collection in the field and subsequent reporting and publication of associated research.[2,3] Federally funded programs, including the prior Metropolitan Medical Response System and the current Hospital Preparedness Program and Public Health Emergency Preparedness (PHEP) program, supported the unprecedented development of medical response systems and served as the impetus to search for and identify best practices and evidence of effectiveness.[4-6] However, as the field of disaster medicine is professionalized and grows, the available volume of information increases greatly. There are 24 disaster medicine and emergency preparedness journals and 35 emergency medicine related journals indexed in PubMed/MEDLINE, creating a large annual database of published research that varies significantly in quality and relevance for individuals who review literature in the field. The question of what the most important articles are to read within one's limited time becomes important. Thus, to address this issue, we performed a comprehensive literature review on disaster medicine modeled on the annual *Global Emergency Medicine Literature Review* (*GEMLR*).

In 2005, the *GEMLR* working group developed a process to annually consolidate the most relevant literature in global emergency medicine.[7,8] However,

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there is a large body of work related to domestic and international disaster medicine in the areas of preparedness, planning, and recovery that is not directly relevant to *GEMLR*'s scope and where we chose to focus.

A working group consisting of representatives of the Society of Academic Emergency Medicine (SAEM) Disaster Medicine Interest Group, the Office of the Assistant Secretary for Preparedness and Response Technical Resources, Assistance Center and Information Exchange (ASPR TRACIE), and the National Institutes of Health (NIH) Library developed a process based on *GEMLR* to identify the most current, relevant, and applicable research in disaster medicine, with the goal of conducting this search and analysis annually.

This analysis includes both gray literature and peer-reviewed publications to identify key documents published by academic, government, and non-governmental organizations. The authors hope that identifying the key contributions to the field in an annual summary will help inform disaster planning, as well as guide further research and encourage the professionalization of the field of disaster medicine.

METHODS

A project team was established in March 2017, composed of SAEM Disaster Medicine Interest Group co-chairs, an NIH Library medical librarian, and HHS/ASPR/TRACIE and HHS/ASPR/TRACIE/ICF staff. The team developed a protocol by outlining the methodology and participant roles. There was no external funding source for this study.

For the purposes of limiting the scope of the review, disaster medicine was defined by consensus as the area of medical specialization serving the dual purposes of providing health care to disaster survivors and providing medically related disaster preparation, planning, response, and recovery support and leadership regardless of the causative hazard.

A medical librarian searched the MEDLINE/PubMed and Scopus databases in June and July 2017 to find peer-reviewed literature with at least 1 "disaster medicine" search term and at least 1 "health care system" search term. Key words were searched in both databases and Medical Subject Headings (MeSH) terms were also searched in MEDLINE/PubMed (see Data Supplement S1 for search strategies). Nine journals that publish disaster medicine literature were each individually searched by 1 project team member to further identify relevant articles. Issues published in 2016 from the following journals were individually searched: *Academic Emergency Medicine*, *Annals of Emergency Medicine*, *Disaster Medicine and Public Health Preparedness*, *European Journal of Emergency Medicine*, *Journal of Emergency Management*, *Journal of Emergency Medical Services*, *PLoS Currents: Disasters*, *Prehospital and Disaster Medicine*, and *Prehospital Emergency Care*. Inclusion criteria included articles published in English and human studies. News articles, book chapters, and letters were excluded. Articles that had been e-published ahead of print in 2016, but with a print publication date of 2017, were included.

Gray Literature Search

A pre-identified list of 21 governmental, non-governmental, academic, and professional association websites was searched by 1 project team member for disaster-related publications published in 2016 in English (Table 1). After-action reports, evaluation reports, needs assessments, program monitoring reports, technical reports, topic reviews, white papers, and other types of articles that were consistent with the search strategy defined for the peer-reviewed literature search were included.

Screening of Publications

Articles identified by the literature search were screened by 5 project team members at the title and abstract levels (Level Iaand abstract levels (Level Ia review). Articles meeting all 3 of the following inclusion criteria were selected: disaster medicine concept AND health care systems/hospitals concept AND disaster type concept. Each article was independently reviewed by 2 members, and disagreements were sent to another for resolution. Publications identified through the gray literature and individual journal searches were screened by the project team member who conducted the searches, using the same 3 inclusion criteria. The set of screened articles proceeded to a second review of the title and abstract by the 3

TABLE 1

Gray Literature Sources

1	American Burn Association
2	American College of Chest Physicians
3	American College of Emergency Physicians
4	American Red Cross
5	Assistant Secretary for Preparedness and Response
6	Association of State and Territorial Health Officials
7	Center for Health Security
8	Centers for Disease Control and Prevention
9	DisasterLit
10	European Society for Emergency Medicine
11	Federal Emergency Management Agency
12	Mediterranean Emergency Medicine Congress
13	National Association of County and City Health Officials
14	National Center for Disaster Medicine and Public Health
15	Pan American Health Organization
16	Society for Academic Emergency Medicine
17	Society for Critical Care Medicine
18	Technical Resources, Assistance Center, and Information Exchange (ASPR TRACIE)
19	World Association for Disaster and Emergency Medicine
20	World Health Organization
21	Yale New Haven Center for Emergency Preparedness and Disaster Response

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project leads to further ensure relevance (Level Ib review). The final set of articles from the Levels Ia and Ib reviews proceeded to full-text review (Level II review).

The full-text of each included article was obtained and classified by publication type as either Original Research, Case Report/Other, or Review/Meta-Analysis. The Level II screening criteria were based on the *GEMLR* scoring but adjusted to the types of articles included in this review and interests of the project team. The Level II screening criteria were piloted by 2 project team members using a convenience sample of included articles. The criteria were adjusted to address difficulty with scoring different types of articles (eg, review vs primary research), and points allotted to each category were adjusted due to a perceived skew based on methods rather than results.

Each Level II article was independently reviewed by 2 volunteers from the SAEM Disaster Medicine Interest Group and scored using an Excel scoring spreadsheet; there were 8 Level II reviewers. A predefined scale assessing clarity, design, ethics, importance, and impact was used; not all categories were applicable to each publication type. The score for each criteria category ranged from 0 to 5 points; the maximum score for each category varied (Table 2). The maximum overall score for each article was 20 points. The reviewers had discretionary points to allot per article based on their professional expertise. The average of the 2 scores was used as the final score. Articles with a final score of 16.5 or higher proceeded to the formal review where a summary and critique of each article were written by a reviewer.

To account for scoring outliers, articles that 1 Level II reviewer scored at 16.5 or higher and the second Level II reviewer scored 4 or more points lower were identified. The 3 project leads independently scored these identified articles (Level IIb). For these articles, the average of the 2 highest scores from the 2 Level II reviewers and 1 Level IIb reviewer was used as the final score. Those articles with an average score of 16.5 or higher also proceeded to the formal summary and critique.

This was not a research study, and thus no prior ethical or institutional review board approval was sought for this article. Reviewers did not score or summarize articles that they coauthored.

RESULTS

The number of articles retrieved from MEDLINE/PubMed and Scopus databases for 2016 was 1590; from the individual journal search, 62; and from the gray literature search, 67 publications. A total of 1175 articles/publications were identified after removing duplicates.

After the Level Ia screening, 565 articles met all 3 screening criteria and proceeded to Level Ib review. Upon full-text review, 22 book chapters, editorials, news articles, and non-English articles were further excluded because they did not meet the screening criteria. Of the remaining 347 articles selected for Level II review, 193 (56%) were Original Research, 117 (34%) Case Report or other, and 37 (11%) Review/Meta-Analysis. The average final score for all articles after a Level II and Level IIb review was 11.34, with a median of 11.5 and a range of 1 to 18. The average score by publication type ranged from 10.8 (Original Research) to 11.7 (Review/Meta-Analysis).

Of these 347, 18 articles met the 16.5 cutoff after completion of Level II and Level IIb scoring (Table 3). Half (9) were Case Report or other, 7 (39%) were Original Research, and 2 (11%) were Review/Meta-Analysis. Nine reviewers participated in the writing of the summaries and critiques. Of the 18 selected articles, 61% (11) were identified by the database searches, 28% (5) by the gray literature search, and 11% (2) by the individual journal search. Of the final 18 articles, 13 were journal articles represented in 10 different journals; 3 were published in *Prehospital and Disaster Medicine*, 2 in *Disaster Medicine and Public Health Preparedness*, and 1 each in *Annals of Surgery*, *Connecticut Medicine*, *European Journal of Emergency Medicine*, *Frontiers in Public Health*, *Journal of Epidemiology and Community Health*, *Journal of Trauma and Acute Care Surgery*, *New England Journal of Medicine*, and *Preventive Medicine*.

The complete list of all 347 articles scored in Level II review, as well as full summaries and critiques of the 18 top scoring articles, are included in Data Supplements S2 and S3.

Limitations

We limited our search to English language journals and other literature sources, which likely caused us to miss other relevant articles. Additionally, we used a broad definition of disaster medicine, which, in some cases, may have been too broad yet still omitted some potentially relevant literature. Our review and scoring process may have inappropriately rewarded structure over conclusions, even though, prior to article analysis, adjustments were made to score articles on operational impact, implementation potential, and cost-effectiveness. In addition, the points awarded to overall importance are subjective, and some reviewers may have inherent bias toward certain subjects that were not adjusted for by our multi-reviewer process. Finally, we understand that importance is in the eye of the beholder in many cases. Our reviewers may have overlooked significant contributions in niche areas where our knowledge of current practice and/or the impact of the findings is minimal or lacking.

DISCUSSION

This first annual disaster medicine literature review revealed that most literature in the field of disaster medicine during 2016 was anecdotal, primarily consisting of single site, case

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TABLE 2

Scoring Criteria

	Original Research	Points	Review/Meta-Analysis	Points	Case Reports/Other	Points
Clarity	Criteria scored below		There is a clearly stated hypothesis/ purpose.	1	There is a clearly stated hypothesis/ purpose.	1
	Criteria scored below		The authors provide sufficient background to put the results of the review into context.	1	The authors provide sufficient background to put the results of the case report/other into context.	1
			The review can be understood by someone with general medical or public health training.	1	The case report/ other can be understood by someone with general medical or public health training.	1
					The authors use appropriate graphs, tables, and figures and clear language throughout the article.	2
Design	There is a clearly stated hypothesis/ purpose.	1	This is a formal meta-analysis or systematic review that only includes studies with a control group and/ or grades the evidence included in the review.	1	There is sufficient information provided on their methodology or procedure used to determine whether it was appropriate.	1
	The study is randomized or uses a control group or other appropriate criterion standard for comparison.	2	There is a clear reproducible method for the selection of the studies included in the review/meta-analysis.	1	N/A	
	There is no obvious bias in selection of subjects or setting, or the authors discuss attempts to limit bias.	1	The data analyses and statistical tests used were appropriate.	1	N/A	
	The appropriate/ correct analyses of data and results including statistical tests were used.	1	N/A		N/A	
Ethics	The authors declare that they have no significant conflicts of interest.	1	N/A		N/A	
Importance	The results of the study are generalizable.	2	The results of the review/meta-analysis are generalizable.	2	The results of the study are generalizable.	2

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TABLE 2

Scoring Criteria (continued)

	Original Research	Points	Review/Meta-Analysis	Points	Case Reports/Other	Points
	The study is clearly relevant to the realm of disaster medicine.	2	The review is clearly relevant to the realm of disaster medicine.	2	The review/case report/other is clearly relevant to the realm of disaster medicine.	2
	The authors raise questions for further research that may stimulate future research, but these must be stated/discussed in the article at least briefly.	1	The authors raise questions for further research that may stimulate future research, but these must be stated/discussed in the article at least briefly.	1	The authors raise questions for further research that may stimulate future research, but these must be stated/discussed in the article at least briefly.	1
Impact	The findings are original or suggestive with impact on practice.	2	The findings are original or suggestive with impact on practice.	2	The findings are original or suggestive with impact on practice.	2
	The findings can be implemented.	2	The findings can be implemented.	2	The findings can be implemented.	2
	The findings can be implemented without major expenditures.	1	The findings can be implemented without major expenditures.	1	The findings can be implemented without major expenditures.	1
Overall	Reviewer can apply based on their professional expertise and opinion on the merits of the paper.	4	Reviewer can apply based on their professional expertise and opinion on the merits of the paper.	4	Reviewer can apply based on their professional expertise and opinion on the merits of the paper.	4

reports, or narratives. Although many fields of science begin with anecdotes, an essential next step in the development of the field of disaster medicine will be a commitment to support original research in the form of randomized controlled trials, meta-analyses, interventional studies, cohort analyses, epidemiological assessments, cost-effective analyses, and others.[9]

This review also highlighted that *disaster medicine* is a broad, poorly defined term with overlap in multiple specialties, particularly global/international medicine, emergency management, and emergency medicine. Improved definitions and clarity of scope of the disaster medicine field may help improve future investigations and innovations.

Many of the reviewed articles used sophisticated mathematical modeling to anticipate disaster outcomes, but, in many of them, the clinical assumptions used were inappropriate for the situation. Greater engagement between knowledgeable clinical staff and modelers is critical if data obtained from modeling and potentially used for planning and response are to be meaningful and not harmful.

Disaster medicine does not lend itself well to randomized studies, but we believe that there is a significant role for defining which datasets may be most helpful to collect in disaster situations, as well as the potential for development and use of comparative metrics based on standardized exercises, and other tools that could help define the effects of preparedness interventions such as training.

Overly broad conclusions based on the results or information available in the reviewed articles were common. These can lead to recommendations that are not supported by the actual event data or study outcomes. Case reports support and are important for operational learning, but knowledge from 1 event does not necessarily translate to all events of similar etiology. For example, mass shooting events have different characteristics such as range, caliber, and number of victims that are unique, and may affect the tactics of the response, though the strategies used may be commonly applicable.

In some cases, there is no substitute for descriptive learning from novel events, and a balance must be struck in the scoring

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TABLE 3

Disaster Medicine Literature Review 2016 Articles by Article Type

Type	First Author	Title	Journal	Summary
Case Report/Other	Agua-Agum[12]	After Ebola in West Africa – unpredictable risks, preventable epidemics	*NEJM*	A high level review of the 2013–2016 Ebola viral disease outbreak reveals that effective management of the next outbreak will require committing resources to both strengthen national health systems and sustain investment in the next generation of vaccines, drugs, and diagnostics.
	ASPR TRACIE[24]	CMS and disasters: Resources at your fingertips		This document highlights several different methods by which organizations can meet the Centers for Medicare and Medicaid Services Emergency Preparedness Requirements for Medicare and Medicaid Participating Providers and Suppliers Final Rule.
	Birnbaum[10]	Research and evaluations of the health aspects of disasters, Part VII: the relief/ recovery framework	*Prehosp Disaster Med*	The disaster logic model (DLM) can provide a framework to guide research efforts that study the effects, outcomes, costs, and impacts of disaster interventions.
	Birnbaum[11]	Research and evaluations of the health aspects of disasters, Part VI: interventional research and the disaster logic model	*Prehosp Disaster Med*	This article describes a detailed process to initiate and evaluate interventional research studies in the disaster field.
	Healthcare Ready[25]	Access denied: delivery of critical health care products and personnel to disaster sites		This report offers a review of emergency site access challenges experienced by the private sector, as well as summaries of programs and legislation by state. Potential solutions and program recommendations are provided.
	Jacobs[16]	The Hartford Consensus IV: a call for increased national resilience	*Conn Med*	This article is a summary and call to action for response to active shooter and intentional mass casualty events. It discusses training and implementation of a plan to increase the ability of bystanders and professional rescuers to respond to such events, focusing most notably on hemorrhage control.
	Schoch-Spana[26]	How to steward medical countermeasures and public trust in an emergency: a		This is a resource document and casebook developed for the FDA providing guidance on communicating medical

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TABLE 3

Disaster Medicine Literature Review 2016 Articles by Article Type (continued)

Type	First Author	Title	Journal	Summary
		communication casebook for FDA and its public health partners		countermeasures to the public in an emergency.
	World Health Organization[27]	Emergency medical teams: minimum technical standards and recommendations		This is a guidance document produced by a WHO–convened working group on minimum standards and requirements for emergency medical teams (EMTs) on providing rehabilitation after large-scale disasters.
	World Health Organization[28]	Noncommunicable diseases (NCD) in emergencies		This brief is intended primarily for emergency planners, emergency professionals, and policy-makers tasked with emergency preparedness and response. It provides a brief overview of the impact of emergencies on people with NCDs and describes the minimum standard and emergency actions to be adopted in relation to NCD emergencies.
Original Research	Caspers[20]	Observation services linked with an urgent care center in the absence of an emergency department: an innovative mechanism to initiate efficient health care delivery in the aftermath of a natural disaster	*Disaster Med Public Health Prep*	This article demonstrates the usefulness and diverse population base that can be cared for by an ED Observation Unit in the absence of an ED through a retrospective review of such a model created after the destruction of the ED at NYU Langone Medical Center during Hurricane Sandy.
	Heid[23]	Vulnerable, but why? Posttraumatic stress symptoms in older adults exposed to Hurricane Sandy	*Disaster Med Public Health Prep*	Posttraumatic stress disorder (PTSD) symptoms were much more likely in elderly persons affected by Hurricane Sandy who had lower levels of income, positive affect, employment, and other factors that may allow for targeted interventions to increase pre-event resilience and promote post-event recovery.
	Heldenberg[14]	Civilian casualties of terror-related explosions: the impact of vascular trauma on treatment and prognosis	*J Trauma Acute Care Surg*	Vascular casualties from improvised explosive devices (IEDs) cause more complex casualties who have a poorer prognosis. This has implications for the triage of victims with such

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TABLE 3

Disaster Medicine Literature Review 2016 Articles by Article Type (continued)

Type	First Author	Title	Journal	Summary
				injuries and selection of receiving hospitals.
	Nomura[19]	Post-nuclear disaster evacuation and survival amongst elderly people in Fukushima: a comparative analysis between evacuees and non-evacuees	*Prev Med*	Elderly residents of care facilities evacuated after a disaster experienced a 3-fold increase in mortality compared with baseline mortality in a control group. This potential impact should be considered in evacuation decision-making.
	Rozenfeld[15]	A new paradigm of injuries from terrorist explosions as a function of explosion setting type	*Ann Surg*	This article is a retrospective review of terrorist-related blast injuries from the Israeli national trauma registry over the time period of the second intifada 2000–2005, comparing injury patterns with the setting of the blast, specifically inside buildings, near buildings, inside buses, near buses, and in open spaces.
	Sasabuchi[18]	Increase in avoidable hospital admissions after the Great East Japan earthquake	*J Epidemiol Community Health*	Early intervention may reduce avoidable hospital admissions for new acute conditions in the months following an area impacted by a natural disaster.
	Van Berlaer[17]	Disaster preparedness and response improvement: comparison of the 2010 Haiti earthquake-related diagnoses with baseline medical data	*Eur J Emerg Med*	This article provides a comparison of pre-event and the 2 years post-event diagnosis with diagnosis of patients seen up to 1 month post-earthquake in the same location.
Review/Meta-Analysis	Brolin Ribacke[13]	Effects of the West Africa Ebola virus disease on health-care utilization – a systematic review	*Front Public Health*	A review of the literature indicates non-Ebola-related increases in morbidity and mortality in West Africa due to both a decrease in services available and a decrease in utilization of these services.
	Garbern[22]	A systematic review of health outcomes among disaster and humanitarian responders	*Prehosp Disaster Med*	This study is a meta-analysis of research on the physical and mental health effects to the responders to major disasters. It concludes that responders' health, both mental and physical, needs to be better assessed after disaster work.

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systems to account for this tension between clinical value and academic rigor.

Interestingly, several articles reviewed did not appear to take into account substantial contributions from the literature in the same area. This may reflect a lack of rigor in searching for literature, not selecting multiple databases to search (many journals publish articles on disaster medicine topics and all are not found in one database), or problems with the terminology used (eg, that knowledge of specific strategies within case reports are not reflected in the titles or abstracts, among other potential issues). The authors cannot draw firm conclusions but strongly encourage authors to be diligent when writing to access and use literature and research to deepen the understanding of context and allow richer comparisons and distinctions to be made. However, several common themes were identified from the 18 most highly scored articles.

Two articles by Birnbaum et al.[10,11] both provided frameworks to address the gap in structured reproducible research to an environment where changes are being implemented at a rapid pace in unique situations. Both the Disaster Logic Model and the Relief/Recovery Framework focus on a standardized approach to data acquisition.

The 2013–2016 West Africa Ebola viral disease (EVD) epidemic was highlighted in 2 articles. The largest epidemic of EVD to date generated more than 28 000 cases and more than 11 000 deaths in the large, mobile populations of Guinea, Liberia, and Sierra Leone. Members of the WHO Ebola response team reviewed the natural history of the epidemic, effects of interventions, and critical recommendations to prepare for future outbreaks.[12] The second article, by Brolin et al.,[13] focused on the indirect effects of the EVD outbreak on health systems, including increased maternal morbidity and mortality, a reduction in human immunodeficiency virus (HIV)-infected patients receiving antiretroviral treatment, an increase in malaria cases due to the termination of intermittent preventive treatment programs, fewer children being treated for diarrhea and acute respiratory infections, and reductions in hospital in-patient admittance and essential surgery.

Man-made, intentional events including shootings, bombings, and other trauma were also a key subject across 3 of the highest scored articles. Two were retrospective reviews from the Israeli Trauma Registry. Heldenberg et al.[14] conducted a retrospective analysis between September 2000 and December 2005 to compare injuries and other data from patients with and without vascular trauma (VT) from improvised explosive devices (IEDs). The authors demonstrated that patients with VT after IED detonation had higher injury severity scores and required more resources in their care than patients without VT. Rozenfeld et al.[15] examined the setting of IEDs as compared with injury severity of victims of trauma during the second intifada (2000–2005). Their data demonstrated more severe injuries when the explosion occurred either inside of a building or a bus, as opposed to open areas. Both studies demonstrate the importance of a national data registry to collect, analyze, and report actionable findings to improve preparedness planning. The Hartford Consensus IV, focused on intentional events, was a consensus conference summary that discussed training and implementation of a plan to increase the ability of bystanders and professional rescuers to respond, focusing most notably on hemorrhage control.[16] While the concept is important and highlights an opportunity to reduce preventable deaths due to uncontrolled bleeding, further prospective and retrospective analysis is critical to demonstrate the effectiveness of this prehospital initiative. These 3 articles highlight that utilization of existing databases and not novel disaster-focused ones is a practical, reproducible methodology for future disaster medicine inquiry.

Three of the 18 articles were retrospective reviews of earthquakes: Haiti in 2010 and the Great Eastern Japan in 2011. Van Berlaer et al.[17] nicely summarized initial diagnoses by the Belgian First Aid and Support Team in the immediate aftermath of the Haiti earthquake and follow-up diagnoses from the Médecins Sans Frontières (Doctors Without Borders) clinics operating in the same location during the same time of the year in 2009, 2011, and 2012, in order to compare short-term outcomes. Sasabuchi et al.[18] reviewed the Great Eastern Japan earthquake's impact on hospital admissions and investigated possible utilization reduction strategies in the wake of such a disaster. Both incorporated novel retrospective analysis: 1 merged 2 electronic medical record databases for follow-up, whereas Sasabuchi et al.[18] used a national data registry as the data source for their investigations. A comparative analysis was conducted by Nomura et al.[19] to aid in evacuation decision-making between elderly evacuees and non-evacuees after the F*ukushima* Daiichi nuclear disaster, which was a result of the Great Eastern Japan earthquake in 2011. Elderly residents of care facilities evacuated after the disaster experienced a 3-fold increase in mortality as compared with a baseline mortality in a control group.

Caspers et al.[20] demonstrated the usefulness and diverse population base that can be cared for by an emergency department (ED) observation unit in the absence of an ED through a retrospective review of such a model developed and used after the destruction of the ED at New York University Langone Medical Center during Hurricane Sandy. In 2017, the National Academies of Science, Engineering, and Medicine hosted a forum, Translating the Results of Hurricane Sandy Research Grants into Policy and Operations,[21] which summarized key findings from Caspers et al.[20] and others.

The mental health impacts of disasters were the focus of 2 articles. Garbern et al.[22] focused on rates of posttraumatic stress disorder (PTSD) and depression in responders. In a meta-analysis of 2849 abstracts and 66 articles on the health sequelae of responding to various types of disasters, they found that PTSD had a reported prevalence of up to 34% in some studies,

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and depression was found in up to 53% of responders. Heid et al.[23] assessed factors associated with PTSD in 88 older adults exposed to Hurricane Sandy. They concluded that symptoms were much more likely in elderly persons affected by Hurricane Sandy who had lower levels of income, positive affect, employment, and other factors.

A significant regulatory change for many health care entities was summarized in the US Department of Health and Human Services document, "ASPR TRACIE's CMS Emergency Preparedness Rule: Resources at Your Fingertips 2016."[24] This resource reviewed the new Centers for Medicare and Medicaid Services (CMS) Emergency Preparedness Requirements for Medicare and Medicaid Participating Providers and Suppliers Final Rule, which aimed to establish consistent emergency preparedness requirements for facilities and agencies participating in Medicare and Medicaid. Providers and suppliers are required to meet 4 core elements including developing an emergency plan, implementing policies and procedures, having a communication plan, and having a training and testing program. Multiple tables and figures highlight several different methods by which organizations can meet the CMS Rule.

Finally, several white papers we scored highly were reviews of recommended best practices. Healthcare Ready's "Access Denied: Delivery of Critical Healthcare Products and Personnel to Disaster Sites" summarized recommendations to address delays in accessing areas impacted by disasters by private sector personnel and supplies, which comprise 90% of US critical health care resources.[25] Articles on the Northeastern Winter Storms (2015) and Hurricane Matthew (2016) addressed the negative impact of the events on our critical infrastructure and exposed systemic gaps in credentialing and logistics that prevented employees and supplies from getting to disaster-affected areas in a timely fashion. A medical countermeasures (MCM) document and casebook developed for the US Food and Drug Administration (FDA) by Schoch-Spana et al.[26] provided guidance on communicating MCM information to the public in an emergency. Additionally, the WHO Emergency Medical Teams: Minimum Technical Standards and Recommendations for Rehabilitation provided minimum standards and requirements for EMTs providing rehabilitation after large-scale disasters.[27] Last, a report by WHO and the United Nations Task Force on Noncommunicable Diseases (NCD) provided a brief overview of impact, minimum standards, and emergency actions to be adopted regarding care for NCDs during emergencies.[28]

Disaster medicine generates significant contributions to the literature each year with beneficial, but significant, crossover with global health, trauma care, emergency medical services, emergency management, and other disciplines. The disaster medicine literature is often case-based, which does not dilute the importance of learning from these experiences, but does limit most conclusions to process, rather than intervention/outcome findings. Substantial improvements in the disaster medicine literature are possible and involve the integration of knowledgeable clinicians and practitioners with educators, modelers, and researchers.

Our initial literature review demonstrated a reproducible review process that can be repeated to capture the most critical disaster medicine literature on an annual basis. In the year 2016, the most highly scored articles highlighted a variety of events including earthquakes, the recent Ebola epidemic, Hurricane Sandy, and trauma as a result of terrorism. Other articles focused on new suggestions for data collection and reviews of past literature or new guidance. While disasters and threats may change annually, common principles of disaster preparedness, mitigation, response, and recovery are exemplified throughout these articles and this review. Our aim is to highlight current high-quality literature, improve evidence-based practice, and advance care during these crises.

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Presentations

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Author Contributions

RS, EG, JH, and SB conceived the study and organized the study group. RS, EG, JH, SB, AL, JN, MT, and AM worked on developing the study design. AL, JN, MT, and AM conducted the initial literature search, performed the first round of screening, tracked the article database, and analyzed the data. RS, EG, JH, PB, JB, GC, SG, AM, and IN all performed subsequent rounds of screening and review of the literature, including summaries of the selected articles. RS, EG, JN, and AL drafted the manuscript, and all authors contributed substantially to its revision. RS takes responsibility for the paper as a whole.

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Supplementary material

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APPENDIX A: Disaster Medicine Literature Review Group (in alphabetical order)

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