Disaster management training in the euregio-meuse-rhine: What can we learn from each other to improve cross-border practices?

Peer-reviewed author version

Paquay, Méryl; Chevalier, Sabrina; Sommer, Anja; Ledoux, Céline; Gontariuk, Marie; Beckers, Stefan K.; VAN DER AUWERMEULEN, Loth; Krafft, Thomas & Ghuysen, Alexandre (2021) Disaster management training in the euregio-meuse-rhine: What can we learn from each other to improve cross-border practices?. In: International Journal of Disaster Risk Reduction, 56 (Art N° 102134).

DOI: 10.1016/j.ijdrr.2021.102134
Handle: http://hdl.handle.net/1942/33677

Training for cross-border disaster management: A scoping review taking the Euregio-Meuse-Rhine as a case in point

Méryl Paquay[1*], Anja Sommer[2,3], Céline Ledoux[4], Marie Gontariuk[4], Stefan K. Beckers[2], Loth Van Der Auwermeulen[5], Thomas Krafft[4], Alexandre Ghuysen[1,6]

1) Public Health Department, Faculty of Medicine, University of Liege, Belgium
2) Aachen Institute for Rescue management and public safety, University Hospital RWTH Aachen and City of Aachen, Aachen, Germany
3) Care and Public Health Research Institute, Maastricht University, Maastricht, Netherlands
4) Department of Health, Ethics and Society, Faculty of Health Medicine and Life Sciences, Maastricht University, Maastricht, Netherlands
5) Centre for Government and Law, Hasselt University, Hasselt, Belgium
6) Emergency Department, Liege University Hospital Centre, Liège, Belgium

*** Corresponding Author:**

Meryl PAQUAY

Email: meryl.hajaoui@uliege.be

Telephone: +32 43664508

Abstract

Introduction: Increasing numbers of extreme events, emerging and re-emerging infectious diseases and/or complex hazardous incidents require comprehensive preparedness and reliable and tested response strategies. Border regions are vulnerable as disasters might not halt at administrative borders and at the same time, due to the peripheral location of border regions (viewed from the center of the respective member state), resources to respond are often quite limited. Cross-border collaboration and coordination is therefore required based on mandatory strategy plans addressing the border region's specific needs and characteristics. As integral part of cross-border collaborations initiative in the Meuse–Rhine Euregio (EMR), under the Interreg project "International Information and Knowledge Centre in public safety" (IKIC) we reviewed published evidence informing on the current existing initiatives dedicated to disaster management training in the EMR.

Material and Methods: A search based on the PRISMA guidelines for scoping reviews was conducted to retrieve articles of interest in the following databases: Medline, PsychInfo and Scopus. The searches were limited to English, French, Dutch and German language articles and the period between January 2010 and June 2019. No restrictions were set for the study design or the type of methodology used.

Results: A total of 18 articles met the inclusion criteria out of a total of 1771 publications. Training development was found in two studies while nine studies focused more on the state of knowledge in disaster management. Seven articles referred only to technical skills, three only to non-technical skills and eight combined both types of skills. For the technical nature, Knowledge was found seven times, Skills five times and Attitudes twice. On the non-technical side, Knowledge was found three and both Skills twice and Attitudes three times. Five studies trained and assessed all the Knowledge, skills and attitudes elements.

Conclusions: The current available literature provides little scientific evidence to guide disaster education initiatives for cross-border collaboration among the EMR countries. Most of the studies

constitute inventories with descriptive reporting and very few experimental studies of quality have been carried out to date. At the same time, non-technical skills for disaster preparedness and management have been well considered among the articles included in our analysis. International recommendations do not appear to be harmoniously implemented. Cross-border collaboration needs to be further investigated.

Keywords: Disaster medicine, Mass casualty incidents, Disaster education, Disaster planning,

Introduction

Disaster management has become crucial in Public Health practice. Not only do disasters have undeniable human consequences, they also cause significant financial, environmental and social losses (Sever, Remuzzi, & Vanholder, 2018). Disaster has been defined as a *serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts*[1]. Disasters are often classified according to their natural or man-made nature, or be specified as Mass Casualty Incident (MCI) when *the event overwhelms the local healthcare system, where the number of casualties vastly exceeds the local resources and capabilities in a short period of time* (DeNolf & Kahwaji, 2020). The continuous increase in crises worldwide has persistently challenged the scientific community to contribute with sound evidence to concepts for disaster preparedness and management (Challen et al., 2012). The concept of disaster management in this context is indeed multifaceted, including the organization, anticipation and planning (preparedness) as well as the response to and recovering from a disaster. These considerations led to a shift in strategies, prioritising disaster preparedness over response (Rose, Murthy, Brooks, & Bryant, 2017). Disaster preparedness includes multiple activities for anticipating any type of disaster by considering various aspects such as the early identification and assessment of risks, the identification of any available resources, skills assessment and education (Ryan, 2005). This preparation phase is one of the four phases defined in the disaster management cycle from the American National Governors' Association (NGA) work (National Governors' Association, 1979): mitigation, preparedness, response and recovery.

In 2010 and then in 2019, the European Union (EU) warmly recommended its member countries to strengthen their security policy considering the disaster management cycle and to particularly focus on

[1] United Nations Office for Disaster Risk Reduction,2017

mitigation and preparedness (Poljanšek et al., 2019). However, the focus was rather set on a national level than a regional level. The EU border regions need a particular focus as they are convoluted and more vulnerable due to legal and administrative barriers, language barriers or economic disparities. Regarding cross-border management in the EU, a study has reported a lack of interest from the respecting authorities in collaborating together (Kamel, 2016). Cross-border collaborations, like the Meuse–Rhine Euregio (EMR), were born out of the hopes to reducing those issues. One of the most effective actions would be the development of joint prevention initiatives, such as education, in these regions. Studies demonstrate that individuals who suffer from severe stress, who are at higher risk of developing post-traumatic stress disorder or burnout later on, are the least trained to react to disaster situations (Ron & Shamai, 2014). Disaster education is therefore becoming a necessity. However, very little is known about disaster education in the EMR: Who is targeted? What is the current level of training? What are the existing training programs? How are they delivered? What is their content?

In the context of the project "International Information and Knowledge Centre in public safety" (IKIC) funded by Interreg EMR, the aim of this scoping review is to investigate the current state of the art of disaster management training in the EMR through a scoping review. This study further aims to determine topics that have already been considered from specific topics that require in-depth examination in the EMR disaster management and education process. As an early achiever in cross-border collaboration, the experience and evidence from EMR would inform on the possible achievements, the pit-falls and the success factors to develop relevant disaster training modules and shape future researches.

Materials and methods

Literature search strategy and selection criteria

This study uses a scoping review approach, which is intended to allow the breadth of knowledge and practice in an emerging domain to be explored and documented. Indeed, due to the multitude of disciplines, institutions and stakeholders engaging in this field an overview on sound and reliable scientific evidence can only be provided by an approach like a scoping review.

A search of studies, based on the PRISMA guidelines for scoping reviews (Moher et al., 2009), was conducted to retrieve relevant articles in the following medical and transversal databases: Medline, PsychInfo and Scopus. The searches were limited to EMR languages (English, French, Dutch and German) and the period between January 2010 and June 2019. No restrictions were set for the study design or the type of methodology used. Additional relevant studies were identified by reviewing references of included studies. The literature search was conducted between April 2019 and June 2019.

The search strategy was developed using the Patient, Intervention, Comparator, Outcome (PICO) (Eriksen & Frandsen, 2018) approach and included thesaurus terms and free terms relating (Appendix A,B and C) to or describing disaster management process. An inclusion and exclusion criteria table is provided in Appendix D.

Study selection

Study selection was carried out by two researchers for the different stages of the research (IB, MP). In the first stage, publication titles and abstracts were all screened by the two investigators. Publications were included if the studies met the inclusion criteria as well as studies for which exclusion or inclusion could not be determined based on title and abstract alone. Secondly, the full text of potentially eligible studies was retrieved and assessed for eligibility and the duplicates deleted. For Dutch and German articles, two other researchers, independent of the first ones, provided translation for data extraction.

Any disagreement between the reviewers about study eligibility was settled by consensus among the researchers.

Data were extracted from the final selection of studies and completed by four researchers. The following data were extracted for each relevant article: study ID (first author and date), title, research object, country(ies) involved, study design, disaster type, target group, initiative type (evaluation or training), Characteristics of the initiative (Bloom skills classification (Bloom, 1956); Teaching method; Training assessment; Evaluation type) and main conclusions. Concerning “Initiative type”, “Evaluation” is referring to studies performing an assessment of knowledge and skills while “Training” covers studies developing a particular training in disaster management. Bloom skills classification differentiates three levels of expertise: Knowledge, Skills and Attitudes (KSA). Knowledge refers to the cognitive abilities, facts and concepts we are conscious of. Skills represent the psychomotor sphere. These are the physical abilities used during a performance. Attitudes constitute the affective domain with emotions and feelings. It reflects life skills more accurately. Each KSA that was evaluated or taught within the articles was then graded according to its technical or non-technical nature. Technical skills in general are defined as subject-specific knowledge and hence competencies while on the other hand, non-technical skills are skills which are generic in nature and are relevant across various jobs or professions (Ghouse, Chaudhary, & Garg, 2018). Conditions for evaluating these KSA and their technical or non-technical nature were also collected. Finally, for the "Training" modality, teaching methods have been specified.

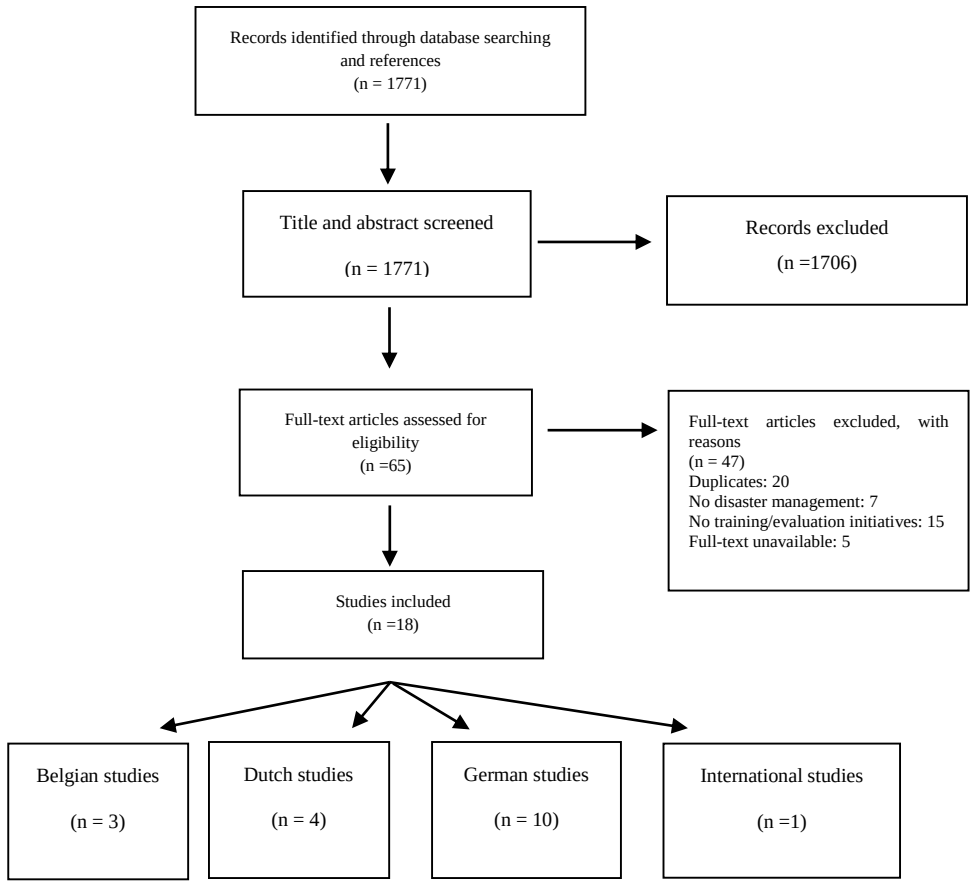

Figure 1. Study selection process

Results

A total of eighteen relevant articles were identified out of 1771. Three articles focused on Belgian territory, ten on German territory, four on Dutch territory and one on the three territories. Thirteen articles focused on descriptive studies, two articles were about experimental studies, two articles adopted a qualitative approach and one was a literature review. For the target groups, five studies targeted a student population while thirteen other studies targeted professionals. Regarding disaster type, nine articles discussed interventions applied to MCI, six articles on all types of disasters, two studies focused on CBRNs and one study focused only on natural disasters. Training development was found in two studies while nine studies focused more on the state of knowledge in disaster management. Of these eighteen articles, seven referred only to technical skills, three only to non-technical skills and eight combined both types of skills. For the technical nature, Knowledge was found seven times, Skills five and Attitudes twice. On the non-technical side, Knowledge was found in three articles, Skills in two articles and Attitudes in three articles. Five studies trained and assessed all the KSA. Table 1 summarizes all the characteristics of the relevant studies.

174 **Table 1: Characteristics of the studies reporting training initiatives in the EMR**

References	Study design	Research object	Country(ies) involved	Target group	Disaster type	Type of initiative (Training or Evaluation)	Characteristics of the initiative	Main conclusions
1. (M. L. Verheul, Dückers, Visser, Beerens, & Bierens, 2018)	Retrospective descriptive study	Evaluation of the impact of MCI exercises in Netherlands among Strategic Crisis Team (SCT) members	Netherlands	SCT members and their hospital organizations	MCI	Training	**KSA** Non-technical skills and attitudes (decision making, workload, communication, situation awareness, leadership, planification) **Teaching method** Large scale simulation **Training's assessment** Assessment of self-administered reports by two independent investigators on validated categories.	The authors could not establish that team members participating in MCI exercises in the Netherlands learn from their participation. More time and effort must be spent on the development of a validated evaluation system for these simulations, and more research into the role of the evaluator is needed.

2. (Dittmar, Wolf, Bigalke, Graf, & Birkholz, 2018)	Experimental study	Assessment of the decline in triage skills indicating a minimum time interval for re-training.	Germany	Members of professional Emergency Medical Service (EMS) staff	MCI	Training	**KSA** Technical skills, knowledge and attitude (triage time, triage algorithm adequacy, bleeding control) Non-technical Knowledge, skills and attitudes (role clarity/leadership, communication) **Teaching method** Lecture and practical sessions **Training's assessment** Simulation observed by two independent investigators measuring the performance according to predefined validated criteria.	To improve disaster preparedness, triage skills should be refreshed yearly by a brief re-education of all EMS providers.

3. (Wunderlich et al., 2017)	Prospective, cross-sectional, observational study	Assessment of the self-perception of medical students' knowledge and interest in disaster medicine nine years after the implementation of a standardized disaster medicine curriculum in German medical schools.	Germany	Medical students	All hazards	Evaluation	**KSA** Technical knowledge (disaster theory, triage algorithm...) Non-technical knowledge (leadership, planification) **Evaluation's type** Validated self-administered questionnaire	German students are still largely not well-educated regarding disaster medicine, despite their high motivation. The curriculum of 2006 was not implemented as originally planned and the number of trained students still remains low as the self-perception of knowledge.
4. (Luc J M Mortelmans, Gaakeer, Dieltiens, Anseeuw, & Sabbe, 2017)	Descriptive, cross-sectional study	Preparedness evaluation of Dutch hospitals to deal with a large-scale CBRN incident.	Netherlands	Dutch hospitals	CBRN incidents	Evaluation	**KSA** Technical skills (decontamination practices, drugs supply...) **Evaluation's type** Self-administered questionnaire	Despite a high-risk perception of threats, there are serious gaps in the preparedness of Dutch hospitals for treating patients involved in CBRN incidents.

5. (Luc J M Mortelmans, Lievers, Dieltiens, & Sabbe, 2016)	Descriptive cross-sectional study	Evaluation of the impact of basic military training on disaster management education and knowledge, compared with civilian senior medical student colleagues.	Belgium	Senior military and civilian medical students	All hazards	Evaluation	**KSA** Technical knowledge (theoretical disaster knowledge) **Evaluation's type** Self-administered questionnaire	Basic military training and its associated background make the military population better educated and prepared for disaster situations than their civilian counterparts.
6. (Luc J. M. Mortelmans et al., 2015)	Descriptive cross-sectional study	Preparedness evaluation of senior medical students for direct patient care or other tasks during mass casualty incidents in Netherlands.	Netherlands	Dutch senior medical students	All hazards	Evaluation	**KSA** Technical knowledge (theorical disaster knowledge) **Evaluations' type** Self-administered questionnaire	Despite a high willingness to respond, the students are not educated for disaster situations.
7. (Van Ruijven, Mayer and	Comparative study	Evaluation of on-scene command teams' coordination on	Netherlands	On-scene command teams comprising	All hazards	Evaluation	**KSA** Non-technical skills and attitudes (communication,	Emergency management performance and coordination patterns

de Bruijne, 2015)		multidisciplinary objectives and tasks, and impact of their performance.		various actors (police, etc)			coordination, role attribution) **Evaluation's type** Virtual reality simulation, observation of performance indicators	within and among on-scene command teams have considerable variation.
8. (L J M Mortelmans, Van Boxstael, De Cauwer, & Sabbe, 2014)	Descriptive cross-sectional study	Preparedness assessment of local hospitals to deal with CBRN incidents.	Belgium	Hospitals in Belgium with an emergency department (ED)	CBRN incidents	Evaluation	**KSA** Technical skills (decontamination practices, drugs supply...) **Evaluation's type** Self-administered questionnaire	There are serious gaps in hospital preparedness for CBRN incidents in Belgium. Lack of financial resources is a major obstacle in achieving sufficient preparedness.
9. (L J M Mortelmans, Dieltiens, Anseeuw, & Sabbe, 2014)	Descriptive cross-sectional study	Preparedness assessment of Belgian senior medical students for disaster medicine in their curriculum	Belgium	Belgian senior medical students	All hazards	Evaluation	**KSA** Technical knowledge (theoretical disaster knowledge) **Evaluation's type** Self-administered questionnaire	Belgian medical students do believe in the usefulness of teaching disaster medicine in the regular curriculum. Although knowledge and estimated capability are limited, there is a high willingness to

								assist. European guidelines could help to establish a basic training in preparing them for a real incident.
10. (Ingrassia et al., 2014)	Qualitative study	Assessment of the prevailing preferences and characteristics of disaster management educational and training initiatives (ETIs) at a postgraduate level that currently exist in the EU countries	Europe (Belgium, Germany and Netherlands)	Postgraduate level	All hazards	Evaluation	**KSA** Technical knowledge, skills and attitudes (training/education type developed) Non-technical knowledge, skills and attitudes **Evaluation's type** Validated standardized online survey instrument	Although ETIs currently exist, they are not broadly available in all 27 EU countries. Also, the curricula do not cover all key elements of disaster management in a standardized and competency-based structure.
11. (Haferkamp, Kraemer, Linehan, & Schembri, 2011)	Experimental study	Evaluation of the impact of the DREAD-ED game on two different target groups with different expertise	Germany	Students of a large German university as well as members of the	Natural hazards	Evaluation	**KSA** Non-technical skills and attitudes (communication, decision making, leadership, stress control)	In conclusion, the DREAD-ED game provides an engaging environment for training group decision making processes. However, it must also

		on crisis management		Academy of Crisis Management and Civil Defense			**Evaluation's type** Serious game	be noted that further work is needed to validate the effectiveness of this training methodology
12. (Brauner, Stiehl, Lechleuthner, & Mudimu, 2014)	Literature review	Evaluation of training in mass casualty events: - Aspects of quality of emergency care for patients and - Comparison of mass casualty concepts	Germany	Emergency staff	MCI	Evaluation	**KSA** Technical knowledge, skills and attitudes (training/education performance) Non-technical knowledge, skills and attitudes **Evaluation's type** Evaluation by training observer (qualitative evaluation) and by analyzing certain measurement values (time of triage and triage categorization) (quantitative evaluation)	An evaluation has to be universal and independent of staff behavior. Patient care needs to be measured.

13. (Ellebrecht, 2013)	Descriptive, cross-sectional study	MCI experiences and education in triage	Germany	Paramedics and emergency physicians	MCI	Evaluation	**KSA** Technical knowledge (training/education evaluated in these 3 aspects; MCI Triage experience/ Incidence and types of triage emergencies/Training and self-assessment) **Evaluation's type** Survey about MCI and triage for paramedics and emergency physicians	Only 56% of Professional EMS staff is experienced in triage. Triage needs to be more integrated into education and training for both target groups.
14. (Mück et al., 2016)	Comparative study	Comparison of training simulations of MCI in two high	Germany	Ambulance services, emergency department	MCI	Training	**KSA** Technical skills (triage)	As the personnel did not know about the training beforehand, the simulation was

		level trauma centers		s in involved hospitals			Non-technical skills and attitudes (decision making, workload, communication, situation awareness, leadership, planification) **Teaching method** MCI simulation in a city tunnel (live including fire services, EMS, police and trauma centers) **Training's assessment** Comparing of on-site triage, time intervals for reaching milestones (such as availability of x-ray images in the emergency department)	adequate to train staff and to identify possibilities for improvement

15. (Brodauf, Heßing, Hoffmann, & Friemert, 2015)	Descriptive, cross-sectional study	Evaluation of the preparedness for MCI in trauma centers	Germany	Head physicians and department managers	MCI	Evaluation	**KSA** Technical knowledge (clinical setting, physician qualification and education, conditions in emergency department) Non-technical knowledge (opinion about changed education for specialized medical training / residency concerning polytraumatized patients; collaboration with other hospitals) **Evaluation's type** Online survey with head physicians and department managers	Almost all included hospitals do have preparations in place for MCI. Examples are emergency plans for incidents such as fire, evacuation, earth quakes, natural disasters, train or plain disasters Well organized cooperation between trauma centers of different categories. However, less than 60% have logistical resources or materials in stock for MCI.

16. (Schneider et al., 2015)	Qualitative study	Development of MCI training concept, their evaluation criteria and their test.	Germany	EMS personnel	MCI	Training	**KSA** Technical knowledge, skills and attitudes (triage of patients, number of EMS units, analysis of danger, evacuation measures) **Teaching method** Not mentioned **Training's assessment** Evaluation criteria such as - Time until last patient is transported to hospital - Time until all critical triaged patients left the scene	Good preparation of training scenarios is necessary for a succesful training. Adequate registration of personnel and patient actors is important as well as the collection of predefined data. Further, electronic data analyses is essential for timely results.

							- Ratio EMS units / patient and observer during training	
17. (Fischer et al., 2013)	Descriptive, cross-sectional study	Assessment of the level of preparation of hospital physicians for MCI	Germany	Hospital physicians	MCI and terror attacks	Evaluation	**KSA** Technical knowledge (location, hospital setting, medical expertise of physician concerning injury patterns and treatment of explosion victims and CBRN, base knowledge about MCI) Non-technical knowledge (personal opinion about the need of further education about MCI, terrorism for physicians and EMS staff) **Evaluation's type**	Hospital physicians are insufficiently prepared for a MCI. Standardized training programs about MCI management as well as triage and care of NBC contaminated patients are needed and should be integrated into the continuous education of physicians.

							Survey (7700 hospital physicians), descriptive statistics	
18. (Kupfer, Michalzik, & Lenz, 2013)	Descriptive, cross-sectional study	Evaluation of nurses' response readiness in hospital emergency exercises	Germany	Nurses in emergency departments	MCI	Evaluation	**KSA** Technical knowledge (hospital capacities, triage, patient care, materials management) Non-technical knowledge (own role, situational awareness, communication, ethics and law) **Evaluation's type** Creation of database and qualitative evaluation concept for literature review and field studies, later on: construction and qualitative evaluation of the process. The base of evaluation gives the potential to	The development of an adequate instrument to evaluate the response readiness is challenging. The resulting evaluation approach has the potential to substantiate education and training in the context of curriculum development. In the long run the focus of training and evaluation needs to be an interprofessional approach for all involved occupational groups.

							further concretize training and education	

Discussion

With the aim of investigating the current state of the art of disaster management initiatives in the EMR, eighteen relevant articles out of 1771 were identified. This clearly shows the limited scientific studies on disaster management preparedness in the countries of the EMR region. Indeed, many studies about disaster and health emergencies have investigated the human, economic and psychological impact of disasters. However, only a few actually addressed preventive measures. Among the studies adopting a preventive approach, it appears that a very limited percentage of them are dedicated to disaster management education even though European and international directives promote this approach (Wannous & Velasquez, 2017). This shows that despite being acknowledged as an important subject, disaster management has not been considered as a priority among curricula over other themes to date (Ingrassia et al., 2014). Exploring grey literature and fieldwork would also provide support for this hypothesis. Indeed, initiatives may have been taken without being reported or published.

In view of the study designs adopted, a majority of descriptive studies was found and only two studies have adopted an experimental design. Those results are in line with previous study showing a vast majority of descriptive studies in the field of disaster management (Smith, Burkle, Aitken, & Leggatt, 2018). This may be explained by the lack of standardized assessment tools or suitable training context in this very specific research area. Yet, experimental studies are required to ascertain if any learning impact is to be observed as the result of any training implemented.

The authors noticed that the scientific concern for disaster management appears to be quite heterogeneous among the countries of interest. Indeed, there were more studies conducted on the German region than on Belgian and Dutch regions. It is hypothesized that this heterogeneity could be lessened by exploring grey literature. Besides, no article addressing the cross-border aspect was found, while European directives strongly stimulate cross-borders initiatives, such as hence the emergence of collaboration such as EMR. In this context, it would be valuable to investigate the reasons for this lack of interest for research on cross-borders and the barriers.

Regarding the target audience, undergraduate students and relief professionals tend to be the most frequent target group. No study, however, took into consideration citizens' education about disaster management, either in terms of disaster management competencies evaluation or training. Citizens are the first to be affected and directly on the spot when a disaster strikes and it has been demonstrated that its consequences tended to be reduced when communities were acknowledged, motivated to create a culture of prevention and resilience to disaster (Torani, Majd, Maroufi, Dowlati, & Sheikhi, 2019). In this context, raising awareness on risk reduction, individuals capacities and empowering the communities should be prioritized (Rundmo & Nordfjærn, 2017). Furthermore, there is evidence that primary and secondary schools are the most conducive environment for learning disaster management (A. Johnson, R. Ronan, M. Johnston, & Peace, 2014). It would therefore be interesting to investigate whether schools actually train their students, and how this training is designed for the development of initiatives that promote compliance with international guidelines.

Besides, it is worth noting that although some study focused on precise themes such as CBRNs, most initiatives appear to have a "global hazards" or "MCI" approach. Further a lack of common acceptation for rather ubiquitous themes or vocabulary shared between the different authors was noticed, which may lead to some confusion. While some studies indifferently employ MCI to refer to an "all hazards" approach, other studies distinguished both terms. The same applies to the words "disaster" and "crisis", for which there does not seem to be a consensus. This could be explained by the lack of international consensus on the definitions and the legal specificities applicable within each country. However, defining clear concept could help their operationalization and guide future interventions (M. L. M. I. Verheul & Dückers, 2020).

Most of these initiatives aimed to assess knowledge and skills rather than developing and evaluating training that will enable expertise improvement. Moreover, knowledge about disaster management is first assessed and taught among the developed initiatives, rather than skills and attitudes. However, more focus on competence-based than knowledge-based training would be needed to meet both professional and field-level requirements. This study found very interesting results with regard to the two

experimental studies which incorporated simulation education within their programs. At this point, numerous studies have suggested that simulation as a teaching tool may play a key role in technical and non-technical skills training (Morgan, Kurrek, Bertram, LeBlanc, & Przybyszewski, 2011). Indeed, simulation is important in critical care and disaster medicine training as simulation offers the potential to replicate high-risk, but infrequent disaster environments, without harming any patients or learners (Pucher et al., 2014). Using simulation as an evaluation method, might be of more limited interest. Although this is one of the rare processes by which all KSA modalities can be measured, limitations come from the potential difficulty encountered in validating a simulation-based evaluation process. Less than half of the studies actually used validated tools to assess state-of-the-art knowledge or training program developed. Besides technical skills, non-technical skills have proved to be highly valuable when a disaster strikes but the authors found data about non-technical skills in only six of the studies reported. Of interest and great hope is that the skills most commonly taught in these studies, namely leadership, communication and coordination, seem to reflect the gaps identified among relief professionals in post-disaster reports (Goralnick, Van Trimpont, & Carli, 2017).

In the light of these results, different perspectives may be considered, from both scientific as well as pedagogical aspect.

Scientifically, by adding articles from the grey literature, the authors could observe whether they follow the same tendencies as the chosen scientific articles. Similarly, by applying the same research question to multiple relief agencies, its training facilities, and professionals involved in training and education, a more meaningful understanding of the field initiatives could be generated. As previously mentioned, more experimental protocols are needed to really witness the impact of disaster management training within the EMR. Research and training efforts must also be focused on citizens, particularly primary and secondary school students.

From the pedagogical point of view, there would be merit in developing and validating educational curricula incorporating simulation. This should help to lead to more a competency-based approach rather than a knowledge-based approach.

Conclusions

The current available literature provides little scientific evidence to guide disaster education initiatives within EMR countries. Most of the elements reported have descriptive purposes and very few experimental studies of quality have been carried out to date. However, non-technical skills seem well considered among the analyzed articles.

As a conclusion, international recommendations do not appear to be harmoniously implemented and, finally, the cross-border collaboration needs to be further investigated.

Declaration of Interest

The authors declare no conflict of interest

Declaration of Financial Support

This work was supported by the International Information and Knowledge Centre in Public Safety (IKIC) (EMR77/2018-2021) project and Interreg-EMR program.

Acknowledgments

The authors warmly acknowledge all the IKIC Public Safety partners and Interreg-EMR organization: Maastricht University, RWTH Aachen University, Order of Malta, School of the Landassociation North-Rhine e.V. (German Red Cross), Fire department of the City of Aachen, South Limburg Security Region, Research Centre Jülich, Technical and Pedagogical Cooperation Centre and Hasselt University.

References

A. Johnson, V., R. Ronan, K., M. Johnston, D., & Peace, R. (2014). Implementing disaster preparedness education in New Zealand primary schools. *Disaster Prevention and Management: An International Journal*, *23*(4), 370–380. https://doi.org/10.1108/DPM-09-2013-0151

Brauner, F., Stiehl, M., Lechleuthner, A., & Mudimu, O. A. (2014). Evaluation of mass casualty incident (MCI) exercises. Requirements for scientific assessment of MCI exercises . Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84899476781&doi=10.1007%2Fs10049-013-1722-x&partnerID=40&md5=af50162fe596bc36ccb74853a83a9531

Brodauf, L., Heßing, K., Hoffmann, R., & Friemert, B. (2015). Current state of medical care of polytrauma and mass casualty incidents in Germany: Are we well-prepared? . Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84942980790&doi=10.1007%2Fs00113-015-0063-2&partnerID=40&md5=0e3f433b08ad86734ab55a7b6433aedf

Challen, K., Lee, A. C., Booth, A., Gardois, P., Woods, H. B., & Goodacre, S. W. (2012). Where is the evidence for emergency planning: A scoping review. *BMC Public Health*. https://doi.org/10.1186/1471-2458-12-542

DeNolf, R. L., & Kahwaji, C. I. (2020). *EMS, Mass Casualty Management*. *StatPearls*. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/29493995

Dittmar, M. S., Wolf, P., Bigalke, M., Graf, B. M., & Birkholz, T. (2018). Primary mass casualty incident triage: evidence for the benefit of yearly brief re-training from a simulation study. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, *26*(1), 35. https://doi.org/10.1186/s13049-018-0501-6

Ellebrecht, N. (2013). The reality of triage: Results of a questionnaire on triage training and MCI experience of emergency physicians and paramedics . Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84881474237&doi=10.1007%2Fs10049-

013-1726-6&partnerID=40&md5=5057feea370592326b266229f7b20025

Eriksen, M. B., & Frandsen, T. F. (2018). The impact of patient, intervention, comparison, outcome (Pico) as a search strategy tool on literature search quality: A systematic review. *Journal of the Medical Library Association*, *106*(4), 420–431. https://doi.org/10.5195/jmla.2018.345

Fischer, P., Wafaisade, A., Neugebauer, E. A. M., Kees, T., Bail, H., Weber, O., … Kabir, K. (2013). Preparedness of hospital physicians for a mass casualty incident: A German survey amongst 7,700 physicians . Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84872677861&doi=10.1007%2Fs00113-011-2035-5&partnerID=40&md5=89b1b4ceb4fba4eca9ee69347e1df62f

Ghouse, S. M., Chaudhary, M., & Garg, S. (2018). Importance of Non-Technical Skills for Employment Opportunities: A Gap Analysis of Students and Employers Perception Importance of Non-Technical Skills. In *2018 Eleventh International Conference on Contemporary Computing (IC3)* (pp. 1–6). IEEE. https://doi.org/10.1109/IC3.2018.8530663

Goralnick, E., Van Trimpont, F., & Carli, P. (2017). Preparing for the Next Terrorism Attack. *JAMA Surgery*, *152*(5), 419. https://doi.org/10.1001/jamasurg.2016.4990

Haferkamp, N., Kraemer, N. C., Linehan, C., & Schembri, M. (2011). Training disaster communication by means of serious games in virtual environments. *Entertainment Computing*, *2*(2), 81–88. https://doi.org/10.1016/J.ENTCOM.2010.12.009

Ingrassia, P. L., Foletti, M., Djalali, A., Scarone, P., Ragazzoni, L., Corte, F. Della, … Fisher, P. (2014). Education and Training Initiatives for Crisis Management in the European Union: A Web-based Analysis of Available Programs. *Prehospital and Disaster Medicine*, *29*(02), 115–126. https://doi.org/10.1017/S1049023X14000235

Kamel, N. (2016, December 1). European reference networks: Moving towards a tangible outcome of the European Union's cross-border healthcare directive? *European Respiratory Journal*. European

Respiratory Society. https://doi.org/10.1183/13993003.01385-2016

Kupfer, R., Michalzik, E., & Lenz, M. (2013). Preparedness - Decisions in the face of uncertainty. Evaluation of nurses' response readiness in hospital emergency exercises . Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84890239582&doi=10.1016%2Fj.zefq.2013.10.023&partnerID=40&md5=92c541cd9573aeeb2a2e9737b0d7ce63

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Altman, D., Antes, G., … Tugwell, P. (2009, July). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*. https://doi.org/10.1371/journal.pmed.1000097

Morgan, P. J., Kurrek, M. M., Bertram, S., LeBlanc, V., & Przybyszewski, T. (2011). Nontechnical Skills Assessment After Simulation-Based Continuing Medical Education. *Simulation in Healthcare: The Journal of the Society for Simulation in Healthcare*, *6*(5), 255–259. https://doi.org/10.1097/SIH.0b013e31821dfd05

Mortelmans, L J M, Dieltiens, G., Anseeuw, K., & Sabbe, M. B. (2014). Belgian senior medical students and disaster medicine, a real disaster? Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84891841716&doi=10.1097%2FMEJ.0b013e3283643874&partnerID=40&md5=0fc2b6174c776e9107c3824e5faa0934

Mortelmans, L J M, Van Boxstael, S., De Cauwer, H. G., & Sabbe, M. B. (2014). Preparedness of Belgian civil hospitals for chemical, biological, radiation, and nuclear incidents: Are we there yet? Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84903821450&doi=10.1097%2FMEJ.0000000000000072&partnerID=40&md5=f4f586dc479a5b41c7307beac1aadc33

Mortelmans, Luc J. M., Bouman, S. J. M., Gaakeer, M. I., Dieltiens, G., Anseeuw, K., & Sabbe, M. B.

(2015). Dutch senior medical students and disaster medicine: a national survey. *International Journal of Emergency Medicine*, *8*. https://doi.org/10.1186/S12245-015-0077-0

Mortelmans, Luc J M, Gaakeer, M. I., Dieltiens, G., Anseeuw, K., & Sabbe, M. B. (2017). Are Dutch Hospitals Prepared for Chemical, Biological, or Radionuclear Incidents? A Survey Study. *Prehospital and Disaster Medicine*, *32*(5), 483–491. https://doi.org/10.1017/S1049023X17006513

Mortelmans, Luc J M, Lievers, J., Dieltiens, G., & Sabbe, M. B. (2016). Are Belgian military students in medical sciences better educated in disaster medicine than their civilian colleagues? *Journal of the Royal Army Medical Corps*, *162*(5), 383–386. https://doi.org/10.1136/jramc-2015-000563

Mück, F., Wirth, K., Muggenthaler, M., Kanz, K. G., Kreimeier, U., Maxien, D., … Wirth, S. (2016). Pretreatment mass casualty incident workflow analysis: Comparison of two level 1 trauma centers . Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84976408065&doi=10.1007%2Fs00113-016-0200-6&partnerID=40&md5=adde408f2616db3215a0f07cf29de488

National Governors' Association. (1979). *Comprehensive Emergency Management: A Governor's Guide*. Retrieved from https://books.google.be/books?id=yMWy-GSQCYkC&printsec=frontcover&hl=fr&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

Poljanšek, K., Casajus Valles, A., Marín Ferrer, M., De Jager, A., Dottori, F., Galbusera, L., … Vogt, J. V. (2019). *Recommendations for National Risk Assessment for Disaster Risk Management in EU*. https://doi.org/10.2760/084707

Pucher, P. H., Batrick, N., Taylor, D., Chaudery, M., Cohen, D., & Darzi, A. (2014). Virtual-world hospital simulation for real-world disaster response. *Journal of Trauma and Acute Care Surgery*, *77*(2), 315–321. https://doi.org/10.1097/TA.0000000000000308

Ron, P., & Shamai, M. (2014). The impact of ongoing national terror on the community of hospital

nurses in israel. *Community Mental Health Journal*, *50*(3), 354–361. https://doi.org/10.1007/s10597-013-9645-z

Rose, D. A., Murthy, S., Brooks, J., & Bryant, J. (2017). The Evolution of Public Health Emergency Management as a Field of Practice. *American Journal of Public Health*, *107*(S2), S126–S133. https://doi.org/10.2105/AJPH.2017.303947

Rundmo, T., & Nordfjærn, T. (2017). Does risk perception really exist? *Safety Science*, *93*, 230–240. https://doi.org/10.1016/j.ssci.2016.12.014

Ryan, J. (2005). Environmental Health in Emergencies and Disasters: A Practical Guide. *Emergency Medicine Journal*, *22*(8), 610–610. https://doi.org/10.1136/emj.2003.011981

Schneider, F., Kippnich, U., Siebel, C., Sautter, J., Kippnich, M., & Sefrin, P. (2015). Recommendation on conducting and evaluating mass casualty exercises - A german red cross view . Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84929070910&doi=10.1055%2Fs-0034-1387584&partnerID=40&md5=f0965e26abb0450df24efcb124dd5a5f

Sever, M. S., Remuzzi, G., & Vanholder, R. (2018, September 1). Disaster medicine and response: Optimizing life-saving potential. *American Journal of Disaster Medicine*. NLM (Medline). https://doi.org/10.5055/ajdm.2018.0305

Smith, E. C., Burkle, F. M., Aitken, P., & Leggatt, P. (2018). Seven Decades of Disasters: A Systematic Review of the Literature. *Prehospital and Disaster Medicine*, *33*(4), 418–423. https://doi.org/10.1017/S1049023X18000638

Torani, S., Majd, P. M., Maroufi, S. S., Dowlati, M., & Sheikhi, R. A. (2019). The importance of education on disasters and emergencies: A review article. *Journal of Education and Health Promotion*, *8*, 85. https://doi.org/10.4103/jehp.jehp_262_18

van Ruijven, T., Mayer, I., & de Bruijne, M. (2015). Multidisciplinary coordination of on-scene command teams in virtual emergency exercises. Retrieved from

https://www.scopus.com/inward/record.uri?eid=2-s2.0-84929292549&doi=10.1016%2Fj.ijcip.2015.02.005&partnerID=40&md5=292f65b3a318066a9cfee5fd705b2575

Verheul, M. L., Dückers, M. LA, Visser, B. B., Beerens, R. J., & Bierens, J. J. (2018). Disaster Exercises to Prepare Hospitals for Mass-Casualty Incidents: Does it Contribute to Preparedness or is it Ritualism? *Prehospital and Disaster Medicine*, *33*(4), 387–393. https://doi.org/10.1017/S1049023X18000584

Verheul, M. L. M. I., & Dückers, M. L. A. (2020, February 1). Defining and Operationalizing Disaster Preparedness in Hospitals: A Systematic Literature Review. *Prehospital and Disaster Medicine*. Cambridge University Press. https://doi.org/10.1017/S1049023X19005181

Wannous, C., & Velasquez, G. (2017). United Nations Office for Disaster Risk Reduction (UNISDR)—UNISDR's Contribution to Science and Technology for Disaster Risk Reduction and the Role of the International Consortium on Landslides (ICL). In *Advancing Culture of Living with Landslides* (pp. 109–115). Springer International Publishing. https://doi.org/10.1007/978-3-319-59469-9_6

Wunderlich, R., Ragazzoni, L., Ingrassia, P. L., Corte, F. Della, Grundgeiger, J., Bickelmayer, J. W., & Domres, B. (2017). Self-Perception of Medical Students' Knowledge and Interest in Disaster Medicine: Nine Years After the Approval of the Curriculum in German Universities. *Prehospital and Disaster Medicine*, *32*(4), 374–381. https://doi.org/10.1017/S1049023X17000280

Appendix A : Reasearch Strategy for Medline

1	Disaster Planning/ (13461)
2	Strategic Stockpile/ (58)
3	Disaster Medicine/ (786)
4	1 or 2 or 3 (13999)
5	Disasters/ (18489)
6	Natural Disasters/ (70)
7	Terrorism/ (5049)
8	Chemical Terrorism/ (162)
9	Bioterrorism/ (4561)
10	5 or 6 or 7 or 8 or 9 (27663)
11	disaster*.ti,ab,kf. (23574)
12	(strategic adj2 stockpile*).ti,ab,kf. (86)
13	emergenc* preparedness.ti,ab,kf. (1654)
14	emergenc* management.ti,ab,kf. (2712)
15	11 or 12 or 13 or 14 (26866)
16	(mass adj2 casualt*).ti,ab,kf. (2257)
17	(mass adj2 murder*).ti,ab,kf. (157)
18	terrorism.ti,ab,kf. (3107)
19	(terror* adj2 attack*).ti,ab,kf. (2270)
20	16 or 17 or 18 or 19 (7035)
21	4 or 10 or 15 or 20 (52111)
22	belgium/ or germany/ or netherlands/ (188566)
23	(belgium or belgian or german* or netherlands or dutch or euregio* or meuse-rhine).ti,ab,kf. (218978)
24	22 or 23 (314183)
25	21 and 24 (964)
26	limit 25 to yr="2010 -Current" (410)
27	limit 26 to (dutch or english or flemish or french or german) (404)

Appendix B : Reasearch Strategy for PyschInfo

1. Emergency Preparedness/ (1079)
2 Emergency Management/ (641)
3 1 or 2 (1629)
4 disasters/ (3182)
5 Natural Disasters/ (3935)
6 Mass Murder/ (146)
7 Terrorism/ (6998)
8 Bioterrorism/ (111)
9 4 or 5 or 6 or 7 or 8 (13631)
10 emergenc* preparedness.ti,ab,id. (335)
11 emergenc* management.ti,ab,id. (600)
12 disaster*.ti,ab,id. (9150)
13 (strategic adj2 stockpile*).ti,ab,id. (4)
14 10 or 11 or 12 or 13 (9599)
15 (mass adj2 murder*).ti,ab,id. (293)
16 (mass adj2 casualt*).ti,ab,id. (142)
17 terrorism.ti,ab,id. (5606)
18 (terror* adj2 attack*).ti,ab,id. (2828)
19 15 or 16 or 17 or 18 (7736)
20 3 or 9 or 14 or 19 (19387)
21 (belgium or belgian or german* or netherlands or dutch or euregio* or meuse-rhine).ti,ab,id. (48945)
22 20 and 21 (362)
23 limit 22 to yr="2010 - 2019" (205)
24 limit 23 to (dutch or english or french or german) (193)

Appendix C : Reasearch Strategy for Scopus

(TITLE-ABS-KEY (("emergenc* preparedness") OR ("emergenc*management") OR disaster* OR (strategic W/2 stockpile*)) OR TITLE-ABS-KEY ((mass W/2 murder*) OR (mass W/2 casualt*) OR (terrorism) OR (terror* W/2 attack)) AND TITLE-ABS-KEY ((belgium OR belgian OR german* OR netherlands OR dutch OR euregio* OR meuse-rhine))) AND (LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010)) AND (LIMIT-TO (AFFILCOUNTRY , "Germany") OR LIMIT-TO (AFFILCOUNTRY , "Netherlands") OR LIMIT-TO (AFFILCOUNTRY , "Belgium")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "German") OR LIMIT-TO (LANGUAGE , "Dutch") OR LIMIT-TO (LANGUAGE , "French"))

Appendix D: Inclusion and Exclusion criteria

Inclusion	Exclusion
Disaster, terrorism, mass casualty incident	Financial crisis, demographic crisis (refugee), humanitarian crisis, non-acute disaster (heat wave, etc.), individual emergency
EMR countries	Non-EMR countries, crisis/disaster managed by an EMR country but outside the EMR country
Training interventions, assessment of knowledge and skills	Interventions during the crisis, post-crisis interventions, preventive interventions not part of training/education
Interventions from 2010	Articles relating to events prior to 2010