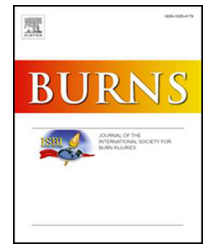


Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/burns

Burn mass casualty incidents in Europe: A European response plan within the European Union Civil Protection Mechanism

Stian Kreken Almeland^{a,b,c,*}, Evelyn Depoortere^d, Serge Jennes^e,
 Folke Sjöberg^f, J. Alfonso Lozano Basanta^d, Sofia Zanatta^d,
 Calin Alexandru^g, José Ramón Martínez-Mendez^h,
 Cornelis H. van der Vlies^{i,j}, Amy Hughes^{k,l,m}, Juan P. Barretⁿ,
 Naiem Moiemem^{o,p}, Thomas Leclerc^q

^a Norwegian National Burn Center, Department of Plastic, Hand, and Reconstructive Surgery, Haukeland University Hospital, Bergen, Norway

^b Department of Clinical Medicine, Faculty of Medicine, University of Bergen, Norway

^c Norwegian Directorate of Health, Department of Preparedness and Emergency Medical Services, Oslo, Norway

^d European Commission, Brussels, Belgium

^e Charleroi Burn Wound Center, Skin-burn-reconstruction Pole, Grand Hôpital de Charleroi, Charleroi, Belgium

^f Linköping Burn Center, Linköping University, Sweden

^g Department for Emergency Situations, Ministry of Internal Affairs, Bucharest, Romania

^h Burn Unit, Hospital Universitario La Paz, Madrid, Spain

ⁱ Department of Trauma and Burn Surgery, Maastad Hospital, Rotterdam, the Netherlands

^j Trauma Research Unit Department of Surgery, Erasmus MC, Rotterdam, the Netherlands

^k Interburns, International Network for Training, Education and Research in Burns, Swansea, Wales, UK

^l Bart's Health NHS Trust, London, UK

^m Essex and Herts Air Ambulance Charitable Trust, UK

ⁿ Department of Plastic Surgery and Burns, Vall d'Hebron Barcelona Hospital Campus, Universitat Autònoma de Barcelona, Barcelona, Spain

^o University Hospitals Birmingham Foundation Trust, Birmingham, UK

^p University of Birmingham, College of Medical and Dental Sciences, Birmingham, UK

^q Percy Military Teaching Hospital, Paris, France

Abbreviations: DG ECHO, Directorate General of Civil Protection and Humanitarian Aid Operations; EBA, European Burns Association; EU, European Union; UCPM, European Union Civil Protection Mechanism; WHO, World Health Organization

* Correspondence to: Norwegian National Burn Center, Department of Plastic, Hand, and Reconstructive Surgery, Haukeland University Hospital, Jonas Lies vei 65, 5021 Bergen, Norway.

E-mail address: stian.almeland@gmail.com (S.K. Almeland).

<https://doi.org/10.1016/j.burns.2022.07.008>

0305-4179/© 2022 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

ARTICLE INFO

Article history:

Accepted 19 July 2022

Keywords:

Burns

Mass casualty incident

Burn mass casualty

Disaster planning

Disaster medicine

European Union

ABSTRACT

Background: Burn care is centralized in highly specialized burn centers in Europe. These centers are of limited capacity and may be overwhelmed by a sudden surge in case of a burn mass casualty incident. Prior incidents in Europe and abroad have sustained high standards of care through well-orchestrated responses to share the burden of care in several burn centers. A burn mass casualty incident in Romania in 2015 sparked an initiative to strengthen the existing EU mechanisms. This paper aims to provide insight into developing a response plan for burn mass casualties within the EU Civil Protection Mechanism.

Methods: The European Burns Association drafted medical guidelines for burn mass casualty incidents based on a literature review and an in-depth analysis of the Romanian incident. An online questionnaire surveyed European burn centers and EU States for burn mass casualty preparedness.

Results: The Romanian burn mass casualty in 2015 highlighted the lack of a burn-specific mechanism, leading to the late onset of international transfers. In Europe, 71% of respondents had existing mass casualty response plans, though only 35% reported having a burn-specific plan. A burns response plan for burn mass casualties was developed and adopted as a Commission staff working document in preparation for further implementation. The plan builds on the existing Union Civil Protection Mechanism framework and the standards of the WHO Emergency Medical Teams initiative to provide 1) burn assessment teams for specialized in-hospital triage of patients, 2) specialized burn care across European burn centers, and 3) medevac capacities from participating states.

Conclusion: The European burn mass casualty response plan could enable the delivery of high-level burn care in the face of an overwhelming incident in an affected European country. Further steps for integration and implementation of the plan within the Union Civil Protection Mechanism framework are needed.

© 2022 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Burn patients require highly specialized and centralized burn care, which has been shown to increase survival and improve outcomes [1]. Maintaining a resilient burn care

system with adequately funded and verified centers that provide high care standards, and can confidently respond to mass casualty surges, is the foundation of burn mass casualty preparedness [2,3]. Burn mass casualty incidents are rare events that lead to a sudden surge of victims that overwhelm local burn care capacities and capabilities [4,5]. Preparedness should include robust local major incident plans describing the system, space, staff, and supplies needed for a timely response [6]. Historically, burn mass casualties have posed significant

challenges that have elicited ad-hoc mutual aid in different ways to support local, regional, and even national burn care capacities [4,7].

One of the most challenging features of a disaster is the enormous gap between usual care standards and the availability of care capabilities and capacities amid an overwhelming surge [6]. The resource gap may result in a discrepancy between public expectations for standard care and the real-time contextual care capacities. This gap has led to a mitigation strategy of claiming “a situation of crisis” where “anything is better than nothing,” proclaiming that

normal standards of care are therefore not applicable [8]. The aftermath of the medical response to the Haiti earthquake in 2010 truly challenged this paradigm [9]. In the past decade, the WHO Emergency Medical Teams initiative established minimal care standards for all medical teams in disasters [10,11]. Even in a crisis, the WHO Emergency Medical Teams initiative has raised the standards for acceptable care, aiming to convert strategy from the lowest acceptable standards to the highest achievable ones. Lessons learned from burn mass casualty incidents have resulted in the development of management strategies and plans for burn-specific responses to mass casualties in different regions of the world [5,12–15]. In a large-scale burn mass casualty incident in Taiwan in 2016, impressive logistics and a well-organized medical response proved near-normal care standards achievable in well-resourced environments [16]. Recently, worldwide recommendations encouraging such structured disaster responses were issued by the WHO Emergency Medical Teams Technical Working Group on Burns [7]. They support organizing both the triage and expert assessment of burns and initial burn care in first receiving hospitals with the support of burns rapid response teams. These recommendations set minimal standards to be applied worldwide with locally adjusted implementations.

Most previous large-scale burn mass casualties, both in Europe and across the globe, have involved victim numbers that would be problematic for any European country to deal

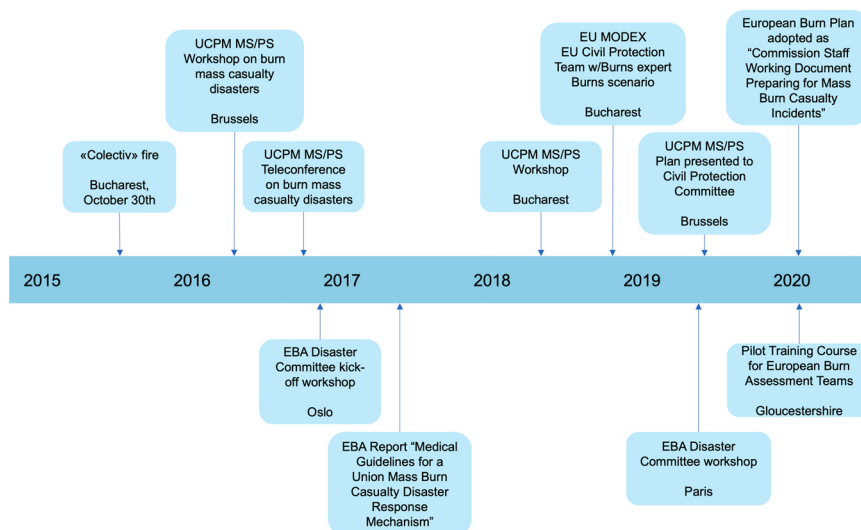


Fig. 1 – Timeline for progress on developing a European response plan for burn mass casualty incidents. The DG ECHO invited all European Union Civil Protection Mechanism Member and Participating States to join a workshop on burn mass casualties in response to a request from Romanian authorities. The workshop was held in May 2016 and started the process of developing a response mechanism for European burns disasters. A follow-up teleconference in September 2016 led to the involvement of EBA to prepare medical guidelines for a proposed mechanism. Draft response plans were made with contributions from Member and Participating States and in collaboration with the European Burns Association. Member and Participating States were again invited to a follow-up workshop in Bucharest in October 2018, after which the EBA expert panel revised and validated the plan in May 2019 before the plan was presented to the Civil Protection Committee. Internal procedures and revisions within DG ECHO processed the plan towards its final adopted version of January 2020. UCPM: European Union Civil Protection Mechanism. MS: Member States of the EU. PS: Participating States in the Union Civil Protection Mechanism.

with singlehandedly [4,7]. However, Europe is a high-resource environment with extensive cumulative specialized burn care capabilities and would thus be able to deal with the typical burn mass casualties and still abide by high standards of care, though only if responding collectively in a structured way. In the past decades, lessons learned from burn mass casualties have been the primary fuel for developing new disaster management plans in individual European countries. For instance, the Volendam incident in 2001 sparked preparedness plan revisions in the Netherlands and Belgium [14,17]. Nevertheless, a pan-European response mechanism has not been available until now. In other areas of crisis management, the EU has long developed a common framework to aid its member states through the Union Civil Protection Mechanism (UCPM). This system has made it possible to request, accept, and offer pre-verified assets for assistance, both within Europe and worldwide [18,19]. Though plans were in the pipeline to expand the UCPM with medical teams, no such mechanism was implemented when the “Colectiv” nightclub fire occurred in Bucharest in October 2015. At the time, Romania was left without the option of a UCPM activation for burns clinical care support. The incident became a grim example of how unprepared Europe was to support a Member or Participating State expeditiously when overwhelmed with burn victims. Though an international response was present and cross-border transfers were

eventually possible; there was a lack of means, tools, and protocols to activate and organize the response. Romania and involved partners spent precious time creating ad-hoc deals and solutions. The incident in Romania highlighted the need for pre-arranged established protocols for international collaboration to achieve proper access to specialized burn care for victims in large-scale burn mass casualties in Europe. Post-incident, Romanian authorities brought the incident to the attention of the European Commission, asking for a burn mass casualty response to be included under the UCPM. The European Commission responded by initiating the first steps toward developing a European response plan for burn mass casualty incidents. Mass casualty planning and preparedness requires training, resources, and maintaining an updated stockpile of supply [3]. Fortunately, large-scale burn mass casualties are not common, making it difficult for an individual country, let alone any single hospital, to provide enough funding for such comprehensive programs. [14]. However, structuring a robust pan-European plan for burn mass casualty incidents may mitigate the financial burden on individual countries by establishing a cross-border mutual aid program. In addition, this emergency response could be utilized in other parts of the world when needed.

This article aims to provide detailed insight into the development of a European response plan for burns mass casualty incidents within the framework of the UCPM.

2. Methods

The Directorate General of Civil Protection and Humanitarian Aid Operations (DG ECHO) of the European Commission invited the European Burns Association (EBA) in September 2016 to provide medical guidelines that could be integrated into a European response mechanism for burn mass casualty incidents. The EBA disaster committee led this work, which consisted of a literature review, an in-depth case analysis of the “Colectiv” mass casualty in Romania in 2015, and a consensus report. Moreover, to further investigate the level of burn mass casualty preparedness across Europe, a questionnaire was developed to map national preparedness plans in the UCPM States and burn centers across Europe. The questionnaire was distributed to the UCPM States by the DG ECHO and through the EBA Secretariat to all 90 burn centers in Europe registered with the EBA. The survey accepted responses from May through December 2019 using Google Forms™.

The initial consensus report from the EBA became the point of reference for further developments of the European response plan within the existing EU framework, led by the DG ECHO and supported by the EBA, ready for sharing with Member and Participating States of the UCPM. A timeline of the work and progress is presented in Fig. 1. The burns response plan was presented to the UCPM Member and Participating States’ civil protection authorities in June 2019 and adopted as a Commission staff working document in preparation for implementation into the UCPM on January 7th, 2020 [20].

2.1. Data analysis

The data for this paper was derived from a non-systematic literature review and expert consensus, further processed through thorough integrative cooperation with the DG ECHO staff to adapt to European Commission standards. The national survey data are presented as counts and percentages. Due to a low response rate, no further analyses or

generalizations from the data were apt. The complete questionnaire is provided as supplementary material (Appendix A).

3. Designing a European response plan

3.1. Analysis of the burn mass casualty incident in Romania

On October 30th, 2015, Bucharest, Romania, experienced a tragic mass burn casualty incident. During an indoor rock concert in the “Colectiv” nightclub, pyrotechnics caused flammable materials in the ceiling to catch fire. It resulted in an overwhelming mass casualty with a sudden surge of 162 burn victims that required immediate attendance. Patients were distributed to eleven different hospitals in the Bucharest area. In the days following the incident, the Romanian authorities dealt with a confusing situation with conflicting demands and advice to manage the overwhelming medical situation. An immense public pressure grew on the Romanian government to acknowledge an inability to handle the medical disaster. The political turmoil resulted in a change in government amidst the medical crisis [21]. Thus, the Romanian authorities were dealing with the pressure to handle the ongoing surge, assess the medical situation at hand, and organize international assistance. At the time, the European Member States had no existing framework for burn care assistance. Romanian authorities resolved to bilateral communications with European states who were offering aid. Though with late onset and not a straightforward operation, the resulting ad-hoc solution led specialized burn teams from Israel, Belgium, Finland, the UK, and Norway to support burn assessments and transfer priorities. An early and prominent effort was conducted by the Belgian Burn Team, who reported to find victims impressively well-managed in the intensive care environment but reported an evident lack of capacity and capability to provide high-level surgical care in the face of the massive surge. The burn teams found overworked surgical staff and overbooked surgical

Table 1 – International transfers following the “Colectiv” fire incident in 2015.

No. of patients transferred per day per country	Post accident day of transfer														Total No. of patients transferred
	1	4	5	6	7	8	9	10	11	12	13	17	30		
Austria					2						1	1	1	5	
Belgium					8									8	
France									1					1	
Germany			1*	1*	1*		1*	2						5	
Israel		1*	1*		1*									3	
The Netherlands					8									8	
Norway							1							1	
United Kingdom							9							9	
Total No. of patients transferred	0	1	1	1	19	11	1	2	1	0	1	1	1	40	

* Privately funded.

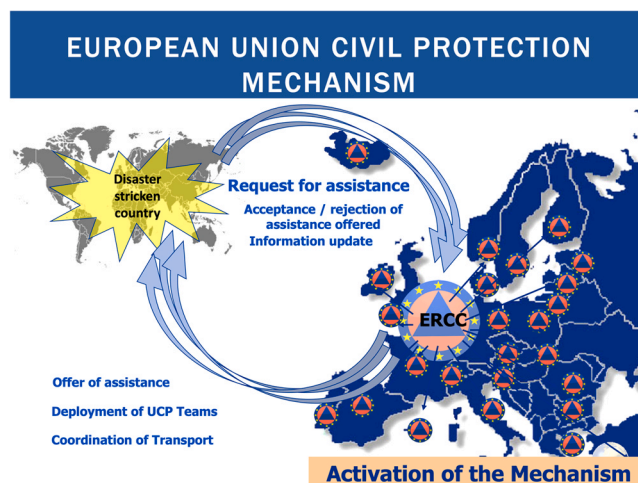


Fig. 2 – Schematic presentation of the European Union Civil Protection Mechanism. ERCC: Emergency Response Coordination Centre.

theaters, making surgery a significant bottleneck for care. Local hospitals and authorities agreed that international transfers would be needed to increase survivability and outcomes for burn patients. However, the situation was further complicated by the severe clinical presentation of the burn victims. Due to the indoor nature of the incident with melting, burning acoustic foam running from the ceiling and immersing the victims from the top downwards, most patients had burns in their head and neck area combined with other injuries and had sustained inhalation injuries. These circumstances complicated transportation and international transfers. Even though some international transfers were made in the first few days, most international transfers were delayed until a week or more after the incident. Due to the late onset of many possible transfers, many patients had developed respiratory complications, such as ARDS, and severe sepsis complications rendering them unfit for aeromedical transportation. Eventually, 40 patients were transferred internationally. An overview of international transfers from the “Colectiv” incident is presented in Table 1.

Overall, several obstacles to international transfers were identified and agreed upon: 1) Lack of a specific response mechanism to activate 2) Late onset of international transfers 3) Lack of predefined economic and legal structures for hospitals in European countries to accept patients by 4) Lack of a centralized communication structure for request and offers of assistance in sudden onset health incidents 5) Lack of medical transportation capacities and capabilities 6) No common European framework identifying burn care facilities in Europe.

3.2. Survey of national preparedness

Ninety burn centers across Europe and national authorities in 34 UCPM Member and Participating States (at the time, there were 28 EU Member States and six additional Participating States as the survey was conducted before the UK left the EU) received the questionnaire. Responses were accepted from

May through December 2019. Only 9/34 (26%) national authorities responded to the survey, and 8/90 burn centers (9%) replied. Thereby, the overall response rate for the survey was as low as 14% (17/124). Since many responding burn centers and authorities were the single respondents from their country, there were replies from 17 different countries altogether. Twelve respondents (71%) indicated that they had an existing national preparedness plan for mass casualty incidents. However, only six (35%) stated that they had a plan that included specific responses in case of burn-related incidents.

The UCPM relies on the communication between national civil protection authorities in all Member and Participating States through the Emergency Response Coordination Center. However, still, in all states where the respondents indicated they had a national preparedness plan for mass casualty incidents, national health authorities were responsible for coordinating their plan's activation. Fourteen respondents (82%) said they were interested in being able to request and offer assistance through the UCPM in a possible future burn mass casualty response plan.

3.3. Existing framework – the European Union Civil Protection Mechanism (UCPM)

Since its establishment in 2001, the overall objective of the UCPM has been to strengthen the cooperation among Member and Participating States in the field of civil protection and to facilitate the coordination and effectiveness of systems for preventing, preparing for, and responding to disasters [19]. Currently, thirty-three states - the 27 EU member states and six other countries (Norway, Iceland, Montenegro, North Macedonia, Serbia, and Turkey) participate, collectively referred to as “Member and Participating States.” The Mechanism can activate support upon the request of a Member or Participating State, or indeed any other affected country in the world overwhelmed by a disaster. By pooling the capacities and capabilities of the Member and

Table 2 – The first hours of a disaster response in an affected country. Typical timeline and responses mobilized within the disaster-stricken country before international assistance is requested.

Step	Typical time frame
First emergency response	< 1 h
Initial rescue to safe environment and early support (trauma assessment, early ABC)	< 1 h
Primary on scene triage	< 2 h
Activation of local or national plans	< 2 h
Early stabilization at or close to the scene (i.e. hemorrhage control, fluid resuscitation)	< 2 h
Primary evacuation to first-receiving hospital	< 2–4 h

Participating States, the Mechanism can ensure better protection. An activation is coordinated by the Emergency Response Coordination Center through its 24/7 hub in Brussels [22]. The Emergency Response Coordination Center communicates resource needs, requests, and offers through the civil protection focal points in every Member and Participating State (Fig. 2).

These permanent and well-established lines of communication ensure a swift and coordinated response to disasters. The European Commission established the European Medical Corps as part of the UCPM in response to the Ebola Crisis in West Africa in 2014 [23]. The tragic incident in Romania brought attention to the vulnerability of Member and Participating States to burn mass casualty incidents, and Romania subsequently asked the European Commission to consider integrating the response to such disasters under the European Medical Corps. The civil protection and health authorities in participating states were invited to join a workshop in Brussels in May 2016 to initiate work on a burn-specific response plan (Fig. 1).

3.4. Existing global framework – the WHO Emergency Medical Teams initiative

While drafting the European response plan for burns, there was a simultaneously ongoing process within the WHO Emergency Medical Teams initiative to generate worldwide recommendations for the management of burn mass casualty incidents [7]. The EBA was actively engaged in this work. Additionally, the European Commission has been a critical WHO partner in implementing Emergency Medical Teams standards, performing conjoined verifications of European Emergency Medical Teams [23]. Recommendations from the WHO Emergency Medical Teams Technical Working Group on Burns have been essential foundations in developing a European response [7]. One of the key recommendations from the WHO working group was to strengthen national planning for burn mass casualty incidents.

3.5. The European response plan

3.5.1. Objectives

The overall aim of implementing a burns-specific plan within the UCPM is to ensure specialized burn care for all victims suffering severe burns following a mass casualty incident in any Member and Participating State in Europe. In the agreed

template for UCPM activation for burn mass casualties, a request for assistance to the Emergency Response Coordination Center will typically consist of one or all of three elements:

- 1) Burn assessment teams to aid specialized in-hospital triage of patients and preparations for patient distribution
- 2) Specialized burn care bed capacities in European burn centers
- 3) Medevac capacities from participating states

3.5.2. Basic premises and rationale

The EBA's guidance to the European Commission underlined the importance of timing if wanting to respond meaningfully. The central presumption for any international response revolves around the practicalities dependent on timing. Firstly, when analyzing the typical timeframes of UCPM responses, one would find that activation, capacity selection, and acceptance/rejection typically take days to achieve. Indeed, it seems impossible to activate and deploy an international response within the first 24 h, even in a well-prepared and sped-up process. Secondly, provided that initial management was appropriate, severely burned patients typically achieve relative stability and remain fit for transportation in a short window during the first four days [24]. A UCPM activation for burn mass casualties will need to aim for patient assessment and transfer between 24 and 96 h post-burn.

Since an international deployment of resources is not instantly organized, there will always be a time frame within which any disaster-stricken country would have to manage the local situation unassisted until international assistance becomes available. The affected country will have to handle much of the disaster management efforts and initial logistics according to their local or national mass casualty response mechanism. This temporary capability to sustain a local capacity increase might be referred to as the response-dependent surge capacity [3,4,14,25]. Considering typical time frames, Table 2 presents a core rationale of presumptions for burn mass casualties that will have to be addressed by the disaster-stricken country's surge capacity in their national planning. With this timeline in mind, the national disaster management plans will be the only foreseeable guidance to rely on for primary triage, transport to hospitals, and initial stabilization at the local first receiving hospitals.

A burns response activation of the UCPM would rely on a clear national leadership in an emergency response to burns. Thus, if needed, an early and coherent request for external support creates the basis for any UCPM activation [20].

Table 3 – Key recommendations for national preparedness planning for burn mass casualty incidents in coordination with a European response.

Early request and offer for assistance	Prepare national management plans with clear thresholds for activation and communication
Expert assessment by burn assessment teams	National or international burn assessment teams to primary hospitals
Prioritize burn patients for transfer	In-hospital/secondary triage targeted at final care decision, including evaluation of possibility for safe transportation
MEDEVAC to definitive care facility	Timely and safe transportation in the preferred care level

Successful UCPM activation for burn mass casualties would depend on a well-integrated response at the national and EU levels. Therefore, key recommendations for burn mass casualties were developed to guide Member and Participating States in mass burn preparedness planning with an efficient UCPM activation and coordination for such incidents (Table 3).

There are few available burn specialists in each European country since European burn care is highly centralized in specialized burn centers. This scarcity of specialists makes deployable teams a practical solution to enable reinforcement to affected countries' national experts in the critical assessment phase. Learning from existing burn mass casualty plans in other countries and the WHO recommendations, the development of burn assessment teams was the suggested mechanism to aid affected countries in a European context [5,7,12–15].

3.5.3. Structure and activation

The burn assessment teams may be deployed from within the affected country or from other Member and Participating States. The standard composition of EU burn assessment teams is outlined in Table 4. These expert teams should be trained to be familiarized with UCPM activations. Upon request and acceptance from the local authorities, their mission is to be of assistance to the disaster-stricken country in providing a specialized assessment of burn patients (“secondary” or “in-hospital” triage) and guidance on needed level of care. Burn assessment teams should always perform their patient assessments within a hospital environment. Their evaluation of the patients' condition in a burn mass casualty setting has two deeply interrelated goals:

1) Burn severity must be assessed based on standardized criteria. This expert assessment dictates which level of specialized burn care the patient requires and is best performed by a trained burn surgeon.

2) Fitness for transportation is equally important to assess. It is dictated by the severity of organ failures and the level of dependency on replacement therapies. This assessment is best performed by an anesthesiologist or critical care specialist trained in burn care. Designation of the correct level of care and expertise during air transfer is an integral part of this assessment to ensure the safety of secondary transfers [26,27].

The provided assessment helps establish the patients' priority for transfer to specialist care in burn centers, as available. Thereby, the end goal of burn assessment teams' deployment would be to support informed priority decisions for transferring burn patients to adequate specialized care.

Based on the offer of assistance by Member and Participating States of the UCPM, patients will finally be dispatched to appropriate specialized burn care facilities. For patients to safely reach their chosen destination, their transportations will be conducted by MEDEVAC capacities contributed by Member and Participating States or by specific MEDEVAC capacities developed under the newly established European reserve of resources (rescEU) within the UCPM [28]. During transport and at the intended destination, care level decisions should be informed by the care needs identified by burn assessment teams. Though, final decisions on priorities of care and transportation always remain with the responsible national authorities.

The proposed activation mechanism through a national request for assistance to the Emergency Response Coordination Center is outlined in Fig. 3. The Emergency Response Coordination Center may make these offers available to the disaster-stricken state by pooling all available offers. The affected country may then accept the offer(s) that best answers their request. The pooling of resources also enables the state needing assistance to combine offers to fit any evolving needs. The Emergency Response Coordination Center will coordinate the UCPM activation and distribute the

Table 4 – European Burn Assessment Team composition and profiles.

Function	No.	Profile	Organization
Burn Assessment Team coordinator	1	Coordination expert	Countries participating in the UCPM
Senior Burn Physician	1	Surgeon or anesthesiologist/ intensivist with high level of seniority	Countries participating in the UCPM
Second Burn Physician	1	Burn surgeon or intensivist	Countries participating in the UCPM
Burn nurse	1	Burn nurse	Countries participating in the UCPM

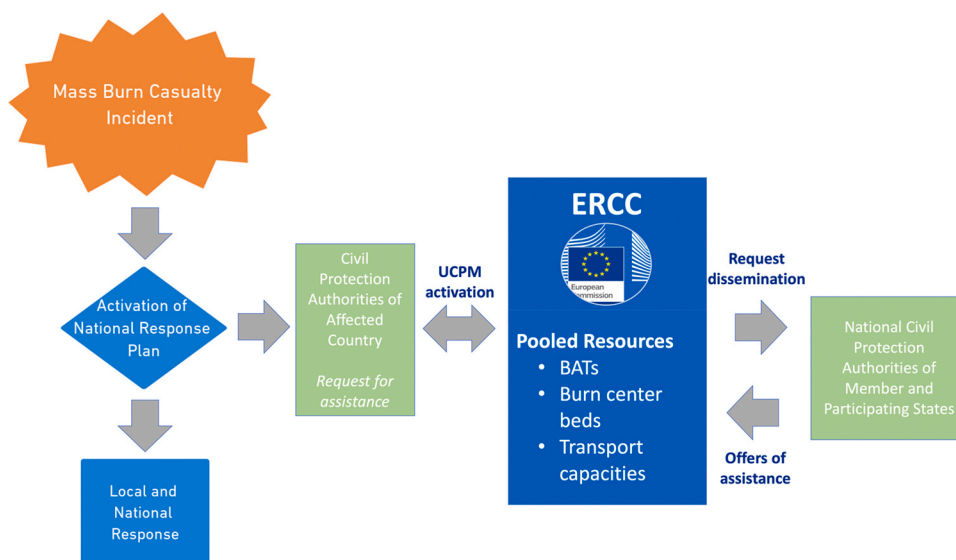


Fig. 3 – UCPM Burns Plan Activation. Activation of a national response plan in case of a burn mass casualty incident leading to UCPM activation through a request for assistance from the affected country. The Emergency Response Coordination Center will inform all civil protection authorities in Member and Participating States that will in turn explore their capacities, according to their national response plans, to provide support to the requesting country through an offer of assistance. Support is only put in effect once accepted by the requesting country.

ERCC: Emergency Response Coordination Centre. **BAT:** Burn Assessment Team. **UCPM:** Union Civil Protection Mechanism.

request for assistance to all UCPM Member and Participating States. Each country's civil protection authorities will receive this request and coordinate with their health authorities and burn centers. The civil protection authorities will then communicate their offers of assistance back to the Emergency Response Coordination Center, which would coordinate the response and utilize the offered resources to support the affected country. The affected country requesting assistance can then choose where the patients will go. Accordingly, burn assessment teams can be invited by the affected country to assist locally in primary hospitals, and MEDEVAC capacities can be accepted to transport patients to burn centers in other Member or Participating States.

3.5.4. Implementation

A preliminary version of the European burn response plan was tested early at a UCPM exercise, and adaptations were made accordingly. The proposed plan received input from Member and Participating States through discussions in the European Commission's Civil Protection Committee and Health Security Committee. After resulting adjustments, it was adopted as a Commission staff working document, meaning the plan is among items in the process for further implementation [20]. Furthermore, the EBA endorsed the plan and its accompanying medical recommendations in the 2019 general assembly. A pilot training course for burn assessment teams was developed in response to an open call by the DG ECHO as an important first step of implementation. The course aimed at preparing burn assessment teams to fulfill their missions within the UCPM framework and included a practical simulation exercise to ensure assessment reliability and reproducibility. After evaluating the course

objectives, outline, content, and delivery, DG ECHO decided to implement an improved course program starting at the end of 2022. The European Commission also funded the EBA verification of 5 new European burn centers in 2021.

4. Discussion

The European burn mass casualty response plan is meant to develop a central European structure, creating a hub where the Member and Participating States of the UCPM may connect their national plans. By providing a centralized system for logistics and coordination in the Emergency Response Coordination Center, the plan may contribute to the overarching support goal by lowering the local burden and improving outcomes in burn mass casualties. Burn professionals participate in a very well-connected global community of burns experts. Historically, burn professionals have always been willing to support large-scale incidents, but they have lacked the tools to properly organize such support [29,30]. The most significant accomplishment of a European burn response plan within the UCPM would be to enable the European burns community to aid each other in disasters in a meaningful and organized way.

The European survey had a disappointingly low response rate, either reflecting a low interest or worryingly no real national preparedness for burn mass casualty incidents. Notably, the European burn mass casualty response relies on initial local and national response mechanisms to recognize the needs and then activate a coordinated response through the Emergency Response Coordination Center. National preparedness is the core of both the WHO Emergency Medical

Teams initiative and the UCPM. The UCPM mass casualty plan activation, like WHO Emergency Medical Teams activation, should be only in response to a formal request from the disaster-stricken state. Only through National leadership and organized response in the affected country can successful coordination of assistance be achieved [7,30]. At the national level, different actors could be involved in responding to mass casualty events. It is fundamental to streamline national coordination since any response requires strong logistics and communicational support offered by the UCPM and the Emergency Response Coordination Center. A vital feature of the burn plan activation within the UCPM is timely requests and offers. Successful UCPM activation is dependent on an early request from the affected country. This can sometimes be politically difficult but a critical decision, knowing that stepping down from a response is far more beneficial for the affected country than a late request for mutual aid. Hence, the UCPM plan activation relies on internal mechanisms and communication lines within each country, rendering the existence of local and national disaster plans a crucial asset.

4.1. Burn assessment teams

European countries differ significantly in the number of available burn beds and personnel and their geography. Some of the larger countries, with sufficiently staffed burn specialized bed capacity, might be able to manage over a hundred casualties properly. In contrast, the smaller countries would need outside help even with a low number. Smaller countries would probably also have a lower threshold at which outside mutual expert help would be required for the in-hospital assessment and triage. Importantly, even if an affected country will indeed be self-sufficient with burn assessment teams, the need for cross-border transfer logistics to definitive burn centers in other countries could remain. Therefore, the European burn response plan must include all combinations of the above options of requesting experts, transportation, and final care in burn centers.

The burn assessment team comprises four members: A coordination expert, two Burn Physicians (one intensivist/anesthetist and one surgeon), and a burn nurse. This team composition is one member short of the burns rapid response teams suggested by the WHO Technical Working Group on Burns [7], purposely reduced to enable Member and Participating States to train and roster such teams effectively. The limited number of specialists available, and the need to offer a complete team when responding to an urgent request, speak to limit the required number of team members in a burn assessment team. Additionally, each team must train several optional team members for each role to ensure 24/7 availability. The presumption of self-sufficiency is an essential difference in the purpose of WHO burns rapid response teams and the EU burn assessment teams. Within Europe, the teams will not need to deal with medical supplies and complex logistics. They would only be working within existing hospital facilities, supported by the local staff and structures. The simplicity of the team composition makes it

possible to scale responses to different settings and demands and might even be crucial to success.

4.2. Prioritization of patients for specialized care and air transfer

Even with optimal planning, there will remain limitations in the available capacity of specialized burn center beds, available assets, and teams for air transportation. Furthermore, some burn victims' conditions may be too critical, and evacuation would be futile. The American Burn Association has made an important secondary triage and priority tool available through several publications and refinements [31–33]. The American priority tool may create a basis for developing a European priority tool to aid authorities and burn assessment teams in decision-making around priorities for transfer.

4.3. Verification of expertise

For international cooperation to happen, there is a basic need for trust in inter-state care levels to ensure no degradation of care. The trust needed may be built through transparent training programs for burn assessment teams, establishing the level of expertise expected from team members. In addition, the care the patients receive in other Member and Participating States should be of high and transparent standards, especially since activation of the European burn response plan will involve not only immediate emergency management but also long-term care in distant burn centers. An affected country's national authorities may need to base their trust on an objective assessment of the quality of care provided in the burn centers in Member and Participating States, both as responsible health authorities and for political justification to their public. Additionally, involved clinicians need to be able to justify referrals to patients and affected families. Although burn centers are often verified nationally by their authorities, there are currently no available common standards for burn center verification within the EU system. The EBA verifications program, following EBA guidelines for burn care [34] is currently the only pan-European system for quality of care recognition and may easily be adopted within national verification programs. However, the UCPM Member and Participating States are currently not obliged to have their burn centers partake in such verification, and the process remains voluntary in nature. Nevertheless, States may indicate the verification status of their burn centers when offers of assistance are submitted. Burn center verification is a quality guarantee. We believe this feature might be the appropriate quality of care system for all internationally dispatched patients and represents an identified challenge for further implementation.

4.4. Remaining issues for future developments

As the burn assessment teams perform their task, their work must be safely and reliably communicated to local authorities, involved UCPM Member and Participating States, and burn centers. Electronic burn mass casualty assessment,

tracing, and tracking systems have been developed in some countries [35,36]. However, an adaptable and secure system, in line with existing EU regulations, is still needed. In fact, there is a clear need to develop standardized operational procedures for all operational levels of the European burn response plan to enable safe and efficient implementation. Additionally, specific regulations for cross-border transfer of patients and care coverage have not yet been developed, nor have liability issues for involved cross-border health personnel in burn assessment teams and medevac teams. Such regulations may be developed as part of the ongoing implementation. Currently, it is advised that the requesting country specify these issues (i.e., cost coverage for definitive care and a temporary waiver of licensing requirements) in the request forms submitted to the Emergency Response Coordination Center for plan activation. Further implementation of the burn response plan into the UCPM will require the continuation of centralized training courses and integration of burn assessment teams in the regular EU Module Exercise program.

5. Conclusion

The European burn mass casualty response plan provides a well-structured basis to ensure good quality care for burn victims in the event of a burn mass casualty incident in Europe. Local and national plans will dictate the initial distribution of patients to primary hospitals, resource distributions within every country, and identify thresholds for national capacities and the need to request cross-border mutual assistance through a UCPM activation. Further development is needed and should focus on:

- Implementation of an acceptable burn center verification scheme
- Electronic burn mass casualty assessment, tracing, and tracking systems
- Regulations for cross-border transfer and patients care coverage
- Regular burn assessment team training courses and large-scale exercises

Significant steps have been taken within the EU in recent years. A solid and cohesive European effort is still needed to integrate the burn mass casualty plan within the structure of the UCPM.

6. Disclosures

None of the authors have any conflict of interest to declare.

Authorship

All authors have approved the final article.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential

competing interests: Stian Kreken Almeland: No conflicts of interests to declare, Evelyn Depoortere: No conflicts of interests to declare, Serge Jennes: No conflicts of interests to declare, Folke Sjöberg: No conflicts of interests to declare, J. Alfonso Lozano Basanta: No conflicts of interests to declare, Sofia Zanatta: No conflicts of interests to declare, Calin Alexandru: No conflicts of interests to declare, José Ramón Martínez-Mendez: No conflicts of interests to declare, Cornelis H van der Vlies: No conflicts of interests to declare, Amy Hughes: No conflicts of interests to declare, Juan Pedro Barret: No conflicts of interests to declare, Naiem Moiemmen: No conflicts of interests to declare, Thomas Leclerc: No conflicts of interests to declare.

Acknowledgments

This work was supported by funding from the European Commission, Directorate-General for European Civil Protection and Humanitarian Aid Operations (ECHO), Directorate B - Disaster Preparedness and Prevention, Unit B1 - Civil Protection Horizontal Issues by tender contract ECHO-B1-NP-2019-05 regarding a European response to mass burn casualty disasters.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.burns.2022.07.008](https://doi.org/10.1016/j.burns.2022.07.008).

REFERENCES

- [1] Palmieri TL, Taylor S, Lawless M, Curri T, Sen S, Greenhalgh DG. Burn center volume makes a difference for burned children. *Pediatr Crit Care Med J Soc Crit Care Med World Fed Pediatr Intensive Crit Care Soc* 2015;16:319–24. <https://doi.org/10.1097/PCC.0000000000000366>
- [2] Al-Shamsi M, Jennes S. Implication of burn disaster planning and management: coverage and accessibility of burn centers in Belgium. *Disaster Med Public Health Prep* 2020;14:694–704. <https://doi.org/10.1017/dmp.2019.89>
- [3] Kearns RD, Marcozzi DE, Barry N, Rubinson L, Hultman CS, Rich PB. Disaster preparedness and response for the burn mass casualty incident in the twenty-first century. *Clin Plast Surg* 2017;44:441–9. <https://doi.org/10.1016/j.cps.2017.02.004>
- [4] Dai A, Carrougher GJ, Mandell SP, Fudem G, Gibran NS, Pham TN. Review of recent large-scale burn disasters worldwide in comparison to preparedness guidelines. *J Burn Care Res* 2017;38:36–44. <https://doi.org/10.1097/bcr.0000000000000441>
- [5] Disaster management and the ABA Plan. *J Burn Care Rehabil* 2005;26:102–106. <https://doi.org/10.1097/01.bcr.0000158926.52783.66>
- [6] Hick JL, Barbera JA, Kelen GD. Refining surge capacity: conventional, contingency, and crisis capacity. *Disaster Med Public Health Prep* 2009;3:S59–67. <https://doi.org/10.1097/DMP.0b013e31819f1ae2>
- [7] Hughes A, Almeland SK, Leclerc T, Ogura T, Hayashi M, Mills J-A, et al. Recommendations for burns care in mass casualty incidents: WHO Emergency Medical Teams Technical Working Group on Burns (WHO TWGB) 2017–2020. *Burns J Int Soc Burn Inj* 2020. <https://doi.org/10.1016/j.burns.2020.07.001>
- [8] Haller H.L., Peterlik C., Gabriel C. Chapter 5 - Burn management in disasters and humanitarian crises A2 -

- Herndon, David N. Total Burn Care Fourth Ed., London: W.B. Saunders; 2012, p. 57–79.e3. <https://doi.org/10.1016/B978-1-4377-2786-9.00005-9>.
- [9] Van Hoving DJ, Wallis LA, Docrat F, De Vries S. Haiti disaster tourism—a medical shame. *Prehosp Disaster Med* 2010;25:201–2. <https://doi.org/10.1017/s1049023x00008001>
- [10] Amat Camacho N, Hughes A, Burkle FM, Ingrassia PL, Ragazzoni L, Redmond A, et al. Education and training of emergency medical teams: recommendations for a global operational learning framework. *PLoS Curr* 2016;8. <https://doi.org/10.1371/currents.dis.292033689209611ad5e4a7a3e61520d0>
- [11] Norton I, von Schreeb J, Aitken P, Herard P, Lajolo C. Classification and minimum standards for foreign medical teams in sudden onset disasters 2013.
- [12] SEVERE BURN INJURY ANNEX to AUSTRALMAPLAN 2011:12.
- [13] Welling L., Harten S.M. van, Patka P., Bierens J.J.L.M., Boers M., Luitse J.S.K., et al. The café fire on New Year's Eve in Volendam, the Netherlands: description of events. *Burns* 8;31:548–554. <https://doi.org/10.1016/j.burns.2005.01.009>.
- [14] Al-Shamsi M, Moitinho de Almeida M, Nyanhoka L, Guha-Sapir D, Jennes S. Assessment of the capacity and capability of burn centers to respond to burn disasters in Belgium: a mixed-method study. *J Burn Care Res* 2019;40:869–77. <https://doi.org/10.1093/jbcr/irz105>
- [15] Potin M, Senechaud C, Carsin H, Fauville JP, Fortin JL, Kuenzi W, et al. Mass casualty incidents with multiple burn victims: rationale for a Swiss burn plan. *Burns* 2010;36:741–50. <https://doi.org/10.1016/j.burns.2009.12.003>
- [16] Yang C-C, Shih C-L. A coordinated emergency response: a color dust explosion at a 2015 concert in Taiwan. *Am J Public Health* 2016;106:1582–5. <https://doi.org/10.2105/AJPH.2016.303261>
- [17] Welling L, Boers M, Mackie DP, Patka P, Bierens J.J.L.M., Luitse JSK, et al. A consensus process on management of major burns accidents: lessons learned from the café fire in Volendam, The Netherlands. *J Health Organ Manag* 2006;20:243–52. <https://doi.org/10.1108/14777260610662762>
- [18] European Parliament. DECISION No 1313/2013/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 December 2013 on a Union Civil Protection Mechanism (Text with EEA relevance). 2013.
- [19] European Commission. EU Civil Protection Mechanism. *Eur Civ Prot Humanit Aid Oper - Eur Comm* 2018. https://ec.europa.eu/echo/what/civil-protection/mechanism_en (accessed November 28, 2021).
- [20] European Commission. Commission Staff Working Document Preparing for mass burn casualty incidents 2020. https://ec.europa.eu/echo/sites/default/files/swd_preparing_for_mass_burn_casualty_incidents.pdf (accessed May 26, 2021).
- [21] Crețan R, O'Brien T. Corruption and conflagration: (in)justice and protest in Bucharest after the Colectiv fire. *Urban Geogr* 2020;41:368–88. <https://doi.org/10.1080/02723638.2019.1664252>
- [22] European Commission, European Civil Protection and Humanitarian Aid Operations. Emergency Response Coordination Centre (ERCC). *Eur Civ Prot Humanit Aid Oper - Eur Comm* 2018. https://ec.europa.eu/echo/what/civil-protection/emergency-response-coordination-centre-ercc_en (accessed November 28, 2021).
- [23] European Commission, European Civil Protection and Humanitarian Aid Operations. *European Medical Corps* 2021. https://ec.europa.eu/echo/printpdf/what-we-do/civil-protection/european-medical-corps_en (accessed June 4, 2021).
- [24] Judkins KC. *Aeromedical transfer of burned patients: a review with special reference to European civilian practice. Burns Incl Therm Inj* 1988;14:171–9.
- [25] Kearns RD, Conlon KM, Matherly AF, Chung KK, Bebartha VS, Hansen JJ, et al. Guidelines for burn care under austere conditions: introduction to burn disaster, airway and ventilator management, and fluid resuscitation. *J Burn Care Res* 2016;37:e427–39. <https://doi.org/10.1097/BCR.0000000000000304>
- [26] Cancio LC, Horvath EE, Barillo DJ, Kopchinski BJ, Charter KR, Montalvo AE, et al. Burn support for Operation Iraqi Freedom and related operations, 2003 to 2004. *J Burn Care Rehabil* 2005;26:151–61.
- [27] Renz EM, Cancio LC, Barillo DJ, White CE, Albrecht MC, Thompson CK, et al. Long range transport of war-related burn casualties. *J Trauma* 2008;64:S136–44. discussion S144–5. <https://doi.org/10.1097/TA.0b013e31816086c9>.
- [28] European Commission, European Civil Protection and Humanitarian Aid Operations. *rescEU* 2022. https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/resceu_en (accessed July 2, 2022).
- [29] Mackie DP, Koning HM. Fate of mass burn casualties: implications for disaster planning. *Burns* 1990;16:203–6. [https://doi.org/10.1016/0305-4179\(90\)90040-4](https://doi.org/10.1016/0305-4179(90)90040-4)
- [30] Mackie D. Mass burn casualties: a rational approach to planning. *Burns J Int Soc Burn Inj* 2002;28:403–4. [https://doi.org/10.1016/s0305-4179\(02\)00081-5](https://doi.org/10.1016/s0305-4179(02)00081-5)
- [31] Saffle JR, Gibran N, Jordan M. Defining the ratio of outcomes to resources for triage of burn patients in mass casualties. *J Burn Care Rehabil* 2005;26:478–82. <https://doi.org/10.1097/01.bcr.0000185452.92833.c0>
- [32] Taylor S, Jeng J, Saffle JR, Sen S, Greenhalgh DG, Palmieri TL. Redefining the outcomes to resources ratio for burn patient triage in a mass casualty. *J Burn Care Res* 2014;35:41–5. <https://doi.org/10.1097/BCR.0000000000000034>
- [33] Kearns RD, Bettencourt AP, Hickerson WL, Palmieri TL, Biddinger PD, Ryan CM, et al. Actionable, Revised (v.3), and amplified American burn association triage tables for mass casualties: a civilian defense guideline. *J Burn Care Res Publ Am Burn Assoc* 2020;41:770–9. <https://doi.org/10.1093/jbcr/iraa050>
- [34] European Burns Association. *European Practice Guidelines for Burn Care: Minimum level of Burn Care Provision in Europe* 2017.
- [35] Bouman JH, Schouwerwou RJ, Van der Eijk KJ, van Leusden AJ, Savelkoul TJ. Computerization of patient tracking and tracing during mass casualty incidents. *Eur J Emerg Med* 2000;7:211–6. <https://doi.org/10.1097/00063110-200009000-00009>
- [36] Marres GMH, Taal L, Bemelman M, Bouman J, Leenen LPH. Online Victim Tracking and Tracing System (ViTTS) for major incident casualties. *Prehosp Disaster Med* 2013;28:445–53. <https://doi.org/10.1017/S1049023X13003567>