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European Burns Association guidelines for the management of burn mass casualty incidents within a European response plan

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ABSTRACT

Background: A European response plan to burn mass casualty incidents has been jointly developed by the European Commission and the European Burn Association. Upon request for assistance by an affected country, the plan outlines a mechanism for coordinated

Abbreviations: ABA, American Burn Association; BAT, Burn Assessment Team; BMCI, Burn Mass Casualty Incident; DG-ECHO, Directorate-General for Civil Protection and Humanitarian Aid Operations of the European Commission; EBA, European Burns Association; ERCC, Emergency Response Coordination Center of the European Commission; ICU, Intensive Care Unit; ISBI, International Society of Burn Injuries; MEDEVAC, Medical Evacuation; TBSA, Total Body Surface Area; UCPM, European Union Civil Protection Mechanism; WHO, World Health Organization

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international assistance, aiming to alleviate the burden of care in the affected country and to offer adequate specialized care to all patients who can benefit from it. To that aim, Burn Assessment Teams are deployed to assess and triage patients. Their transportation priority recommendations are used to distribute outnumbering burn casualties to foreign burn centers. Following an appropriate medical evacuation, these casualties receive specialized care in those facilities.

Methods: The European Burns Association's disaster committee developed medical-organizational guidelines to support this European plan. The experts identified fields of interest, defined questions to be addressed, performed relevant literature searches, and added their expertise in burn disaster preparedness and response. Due to the lack of high-level evidence in the available literature, recommendations and specially designed implementation tools were provided from expert opinion. The European Burns Association officially endorsed the draft recommendations in 2019, and the final full text was approved by the EBA executive committee in 2022.

Recommendations: The resulting 46 recommendations address four fields. Field 1 underlines the need for national preparedness plans and the necessary core items within such plans, including coordination and integration with an international response. Field 2 describes Burn Assessment Teams' roles, composition, training requirements, and reporting goals. Field 3 addresses the goals of specialized in-hospital triage, appropriate severity criteria, and their effects on priorities and triage. Finally, field 4 covers medical evacuations, including their timing and organization, the composition of evacuation teams and their assets, preparation, and the principles of en route care.

1. Introduction

The analysis of recent events that yielded large numbers of burned casualties in and outside Europe has highlighted the need for a coordinated response when national capabilities are overwhelmed. In close collaboration with the Disaster Committee of the European Burns Association (EBA), the Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG-ECHO) of the European Commission has developed a European response plan to Burn Mass Casualty Incidents (BMCIs) within the Union Civil Protection Mechanism (UCPM) framework. This plan and its elaboration process have been described in detail in a previous article [1].

The plan aims to provide the best possible outcome to the highest number of burn casualties and to alleviate the burden of care in a European or even non-European country affected by a BMCI that overwhelms their national burn care capacity. The plan is activated upon request for international assistance to the UCPM from the affected country or relevant international organizations, such as the World Health Organization (WHO). The affected country remains responsible for on-scene disaster response, initial management and national coordination. Their request for assistance is transferred to UCPM member or participating states by the European Emergency Response Coordination Center (ERCC). These states can offer second-line assistance as deployable burn assessment teams, air or ground medical evacuation assets, or hospitalization capacity within their burn centers. In their offer of assistance, countries must indicate whether their burn center has been given an internationally recognized quality label and specify which one (EBA verification for example) [1,2]. Upon acceptance by the requesting country, the ERCC can coordinate the quick deployment of one or more burn assessment teams. These teams assess burn casualties initially admitted to nonspecialized hospitals. Following assessment, triage recommendations are provided by the assessment teams detailing transfer needs, fitness for transportation, the required intensity of care both en route and at destination, and evacuation priority levels. After secure communication of the information thus collected, the affected country decides on the medical evacuations to foreign burn centers. National and international assets perform medical evacuation under coordination facilitated by the ERCC. Evacuated patients are treated in destination burn centers [1,2].

Following a suggestion of DG-ECHO, as an adjunct to this plan and to ensure the medical relevance of its implementation, the EBA disaster committee has developed practical medical and medical-organizational guidelines on four key components of the plan, namely national preparedness requirements, Burn Assessment Teams (BAT), specialized in-hospital triage, and medical evacuation (MEDEVAC) of patients.

This paper provides the full text of these guidelines with their rationale.

2. Methods

The present guidelines were developed by a group of experts appointed by the EBA as members of its disaster committee. The group members represent first hand experiences from four large scale European burn mass casualty incidents. The elaboration process of these guidelines was closely coordinated with the development of the European BMCI response plan. It integrated additional disaster management expertise from members of the Directorate-General of Civil Protection and Humanitarian Aid Operations (DG-ECHO) of the European Commission. The committee conducted three on-site meetings and a series of virtual meetings between November 2016 and August 2019 before the formal submission of the draft guidelines to the general assembly of the EBA in September 2019. The writing process of the detailed final guidelines extended until their submission to the EBA executive committee in November 2022.

Based on their shared experience of burn disaster planning and management and especially the lessons learned from the fire disaster in Bucharest on 30 October 2015, the experts initially defined key medical or medical-organizational issues to be addressed by a European BMCI response plan. These key issues were made into corresponding questions within the four aforementioned fields, to be answered by accompanying practical guidelines. They are summarized in Table 1.

Literature searches in PubMed were performed for all the four identified fields. Considering available literature about burn disaster planning and management, the experts agreed that the lack of high-level evidence precluded purely evidence-based recommendations using the GRADE system [3,4]. The present recommendations are thus based on expert opinion.

The general assembly of the EBA officially endorsed the resulting draft guidelines in Helsinki on 5 September 2019. The present finalized full text includes the detailed rationale of each recommendation and corresponding specifically designed implementation tools. It incorporates suggested adjustments by DG-ECHO in the plan's final version before it was issued by the European Commission as a Commission Staff Working Document on 7 January 2020 [2]. The present recommendations represent a unanimous consensus from the EBA disaster committee. They were approved by the EBA executive committee in November 2022. Members of both committees are listed in Table 2.

Table 1 – Scope of guidelines: key medical or medical-organizational issues to be addressed when implementing the European BMCI response plan.

Field 1 – National preparedness requirements
Q 1.1 – Can a European response plan compensate for the absence of a national preparedness plan?
Q 1.2 – What are the core principles of national Burn Mass Casualty Incidents (BMCI) preparedness?
Q 1.3 – How should burn-specific plans connect with national preparedness plans for other types of disasters?
Q 1.4 – How should national preparedness plans set appropriate response levels and triggers?
Q 1.5 – How should specialized burn care resource availability and utilization be coordinated?
Q 1.6 – How should burn-specific specialized triage be organized and conducted?
Q 1.7 – How should intra-national patient transfers be dealt with?
Q 1.8 – How should national preparedness plans connect with the European response plan for burn mass casualty incidents?
Q 1.9 – How should a national BMCI preparedness plan evolve?
Field 2 – European burn assessment teams (BATs)
Q 2.1 – What are the roles of European Burn Assessment Teams?
Q 2.2 – Which step of burn-specific triage should be devolved to BATs?
Q 2.3 – How should BATs be composed?
Q 2.4 – How should BATs be trained?
Q 2.5 – How should BATs clinically assess burn casualties and report their conclusions?
Field 3 – Specialized in-hospital triage
Q 3.1 – What are the goals of specialized in-hospital triage of burn casualties within the European BMCI response plan?
Q 3.2 – Which main severity criteria should be used for specialized in-hospital triage?
Q 3.3 – Which triage rules should apply?
Field 4 – Medical evacuation
Q 4.1 – Should all patients be evacuated with the same level of en route care?
Q 4.2 – What timeline should be targeted for patient evacuation?
Q 4.3 – How should mode of evacuation be selected?
Q 4.4 – How should evacuation teams be composed?
Q 4.5 – Which minimal assets should evacuation teams have?
Q 4.6 – How should patients be prepared for evacuation and managed en route?

3. Recommendations

3.1. *Field 1 – National preparedness requirements*

Background – In this field, the experts targeted their recommendations on countries with specialized burn centers. They can easily be simplified to adapt to those who have none.

Most items in the present field's recommendations and corresponding rationale equally apply to international BMCI preparedness.

General disaster preparedness plans are beyond the scope of these guidelines. However, they are critical in BMCI preparedness. They address essential items that may be divided between early/on-scene and hospital response. Both need to be duly articulated. Common issues also need to be addressed at both response levels. Table 3 summarizes typical components of general-purpose disaster preparedness plans [5–8]. Table 4 presents common mnemonics that can guide their implementation [7].

Q 1.1 – Can a European response plan compensate for the absence of a national preparedness plan?

R 1.1 – The European response plan for burn mass casualty incidents (BMCIs) is complementary to and coordinated with national preparedness plans, but no substitute to them. Each state participating in the European BMCI response system should have its own national preparedness plan for BMCIs.

Rationale – 1.1 – The European BMCI response system is not meant to be a substitute for a national preparedness plan for disaster-affected countries.

The need for a European BMCI response plan emerged from lessons learned from previous disasters in Europe and

Table 2 – Members of the Executive Committee and of the Disaster Committee of the European Burns Association (EBA).

Executive Committee	Disaster Committee
Jyrki Vuola (president) – Finland	Stian K. Almeland (chair) – Norway
Stian K. Almeland[a] – Norway	Thomas Leclerc – France
Alette de Jong – The Netherlands	Folke Sjöberg – Sweden
Nadia Depetris – Italy	Serge Jennes – Belgium
José R. Martinez-Mendez[a] – Spain	José R. Martinez-Mendez – Spain
Frank Siemers – Germany	Cornelis H. van der Vlies – The Netherlands
Andy Williams – United Kingdom	
Paul van Zuijlen – The Netherlands	
Juan P. Barret – Spain	
Clemens Schiestl – Switzerland	
Jill Meirte – Belgium	

[a] co-authors of the present recommendations did not take part in their approval by the EBA Executive Committee.

Table 3 – Typical components of mass casualty incidents preparedness plans.

Early & on-scene response	Hospital response
– Safety – Alert, initial response, first rescue, triage, on-site management and their coordination and scale-up if necessary. – Roles, responsibilities and coordination of fire departments, civil protection units, emergency medical services (EMS) and ambulance services, police, military forces and / or relevant non governmental organizations. – Dispatching and (ground / air) transfer of patients to treatment facilities. – Management of CBRN risk if appropriate, including detection, protection and decontamination. – Social and psychological support of affected population.	– Alert and adaptation / suspension of daily activity. – Reinforcements by recalled healthcare providers. – In-hospital triage. – Special organization of emergency departments, operating theaters, ICUs, surgical / medical wards, as well as supporting services (transfusion, medical imaging, laboratory).
Components shared by both response levels	
– Command and control. – Communications, coordination with national authorities. – Casualty identification & traceability. – Logistical issues. – Crisis communication & collaboration with media. – Scheduled training exercises and regular updates.	

other parts of the world [1]. Its core goal is to efficiently organize international help when national capabilities are saturated or overwhelmed. As such, it provides but a second line in burn disaster management. Each member or participating state in the Union Civil Protection Mechanism (UCPM) retains its responsibility for first-line response and its sovereign capacity to request this second-line international assistance or not. Any such second-line response system implies additional delay even when optimally set up and quickly activated. BMCI national preparedness plans are thus a prerequisite to the timeliness and usefulness of the European BMCI response system. This recommendation is in line with the general burn disaster guidelines issued by the International Society of Burn Injuries (ISBI) in 2006 [9].

Q 1.2 – *What are the core principles of national BMCI preparedness ?*

R 1.2.1 – National BMCI preparedness plans typically rely on a staged response. They should:

- **define different levels of activation, e.g. local, regional, national and international as appropriate, with their activation procedure and corresponding mobilised resources;**
- **contain practical procedures to request, receive and integrate international assistance.**

R 1.2.2 – National BMCI preparedness plans should provide:

- **directions for primary referral to appropriate treatment facility according to clinical situations;**
- **mechanisms to secondarily triage burn patients non directly admitted to burn centers;**
- **organization and assets for secondary patient transfers.**

Rationale – 1.2.1 – Disaster medicine is primarily about the optimal allocation of limited resources to the largest number of casualties, hence to those who need them most and are most likely to benefit from their use [8]. The most limited

Table 4 – Mnemonics to help manage mass casualty incidents (after [7]).

Declaration of a major incident		Management process	
METHANE		CSCATTT	
M	Major incident declared / My call sign	***Incident response***	
E	Exact location	**C**	Command and control
T	Type of incident	**S**	Safety of self (rescuers), scene and survivors
H	Hazards	**C**	Communications
A	Access	**A**	Assessment of the situation
N	Number / Nature of casualties (estimated)	***Medical support***	
E	Emergency services (present / needed)	**T**	Triage
		T	Treatment
		T	Transport

resource in BMCIs is specialized hospital burn care capacity. Out of disaster situations, severe burns requiring in-hospital treatment are rare in middle- to high-income countries. The capacity to provide such treatment in European countries is therefore limited, typically a few specialized burn beds per million inhabitants. Accordingly, the number of healthcare professionals with suitable training and expertise in burn treatment is low. As a result, burn care networks have a low density [10–13]. Furthermore, burn care is especially labor- and resource-intensive [14]. In case of a BMCI, the saturation thresholds of adequate local and national treatment capacities are therefore likely to be much lower than for non-burn mass casualty incidents. The mean duration of hospital stay of burn patients is also long, above one day per percent of total body surface area (%TBSA) burned even in efficient healthcare systems with extensive resources [14–17]. The saturation of burn centers following a BMCI is a long-lasting situation. Consequently, early, extensive, and long-lasting burn center saturation, hence also in upstream non-specialized primary receiving hospitals, has long been identified as the critical bottleneck in BMCI response [18].

Sizing the response to the magnitude of the incident as compared to burn care capacity is thus paramount. Although relatively rare and with a decreasing incidence over the 20th century, at least in high-income countries, actual burn disasters yielding tens of burn casualties are still a current threat with higher complexity resulting from terror-related events [18,19]. Such disaster magnitude and especially that of the largest semi-recent burn disasters in Europe – the 2001 café fire in Volendam, Netherlands, the 2004 gas pipeline explosion in Ghislenghien, Belgium, and the 2015 nightclub fire in Bucharest, Romania – would inevitably saturate not only any burn center but also any regional burn care capacity and likely even the total national burn care capacity of most European countries [1,20,21]. This requires a staged local, regional, national, and possibly an international response to BMCIs. National BMCI preparedness plans should coordinate all those steps but the latter and allow their timely and swift activation. Although they cannot coordinate an international response, they should include provisions to address a need for international assistance, its timely request, and its appropriate integration with a national response. Several European states already share common BMCI preparedness plans with their neighbors, providing them with a capacity scale-up as needed [22]. The European BMCI response plan makes an even larger scale-up possible [1]. The affected state should decide which response level needs to be activated based on pre-determined algorithms (see recommendation R 1.4).

1.2.2 – In actual BMCI response, adequate prehospital management and nonspecialized care at primary receiving hospitals are paramount. In a major incident with 499 burn casualties in Taiwan in 2015, they helped achieve mortality as low as 2.4% vs. a statistically predictable 26% [23–25]. Patients should be initially managed according to reliable clinical practice guidelines, either national or international [26–29]. The criteria for burn center referral described in such guidelines usually apply to routine situations rather than mass casualty situations. National BMCI preparedness plans should therefore guide primary referral to trauma centers, burn centers, or local hospitals as appropriate. Few specific guidelines address this topic in disaster situations [30,31]. Total body surface area (TBSA) burned is important in decisions on referral and initial treatment, but its assessment by non-specialized care providers is poorly reliable, especially in prehospital settings [32–36]. This seems especially true in pediatric patients, whose TBSA is often overestimated although with limited resulting harm in terms of referral decisions or fluid resuscitation [37–39]. Using a dedicated smart device-based application such as e-Burn or other similar tools may be advisable to reduce error and TBSA assessment time [40–43].

The need for secondary triage and subsequent patient transfers is put forward by most existing BMCI preparedness plans [21,44–47]. Their implementation is addressed in recommendations R 1.6 and R 1.7.

Q 1.3 – How should burn-specific plans connect with national preparedness plans for other types of disasters?

R 1.3.1 – The likelihood of burn occurrence should not disrupt common disaster management.

R 1.3.2 – It is advisable that a BMCI national preparedness plan builds upon regular disaster national preparedness plans. The BMCI national preparedness plan can either be part of a general national disaster preparedness plan, or be a separate dedicated burns plan.

Rationale – 1.3.1 – For efficacy, existing national BMCI preparedness plans commonly rely on unmodified on-scene disaster management without the initial involvement of burn specialists [21,44,46,48]. ISBI burn disaster guidelines chose a similar approach [9]. Less frequently, preparedness plans may include deploying burn specialists on-scene to assess and triage burned patients on-site [47]. The corresponding disruption of standard on-scene disaster management is supposed to improve the adequacy of primary triage and patient dispatching. The expected gain may be questioned [18]. For the past two decades, large burn disasters worldwide were increasingly related to terrorist attacks, which typically cause a combination of burns and trauma [19]. Such situations resemble war, where dramatically shortening the delay to lifesaving interventions (the “golden hour” strategy) improves combat casualty survival [49]. But as already mentioned, burn care networks have a low density [10–13]. The corresponding paucity of burn specialists makes their on-scene deployment likely to unduly lengthen the on-scene time, worsening trauma and overall casualty outcome. Conversely, even for severe burns in mass casualty situations, provided simple, early interventions including fluid resuscitation, burn outcome is not a matter of minutes but of days or hours at the earliest [50]. The latter statement does not conflict with the worldwide consensus that early burn wound excision is paramount for optimal burn care, even with still open discussions about what “early” actually refers to in the 24–72 h range [51,52]. In summary, on-site disaster management of BMCIs should follow general disaster and trauma management principles without organizational specificity on burns. Command and control, casualty extraction or pick-up, initial management, primary triage and evacuation, and their modification in case of CBRN risk should abide by standard guidelines and corresponding plans.

1.3.2 – BMCIs are only a subgroup of mass casualty incidents. Recent BMCIs have often combined burns and trauma [19]. In a meta-analysis of injury profiles after terrorist bombings, burns accounted for 15% of total injuries [53]. An earlier analysis of 12 consecutive suicide bombing mass casualty incidents only briefly mentioned burns, seemingly without noteworthy medical consequences regarding disaster response [54]. Compared with major incidents that cause few or no burn casualties, such as earthquakes, floodings, mass shooting events, building collapses, or explosions without fire, the relative frequency of BMCIs is challenging to estimate. Still, it likely depends on the magnitude of disasters considered. The response to BMCIs follows the same principles as those listed in Tables 2 and 3. First responders need basic burn assessment and management skills, which should be included in general Emergency Medical Services (EMS) provider training. Besides that, early & on-scene disaster responses have limited burn specificity. In summary, no BMCI national preparedness plan would make sense without a general-purpose national disaster preparedness plan, including hospital response.

Depending on the national situation and organization, as exemplified in existing plans, a BMCI national preparedness plan can be:

- either a separate dedicated plan [21,44–47,55],
- or an addition to or part of general preparedness plans [48,56].

Both solutions can be suitable, provided that specific challenges of managing multiple burned patients and general disaster management issues are taken into account. Most importantly, they need to be adequately articulated.

Q 1.4 – How should national preparedness plans set appropriate response levels and triggers?

R 1.4.1 – The total national burn care capacity should be quantified in terms of *burn beds*, distinguishing:
- **adult and pediatric treatment capability,**
- **intensive care (ICU) / medium care / surgical ward capability,**
- **burn care only or combined burn & trauma treatment capability.**

R 1.4.2 – Saturation thresholds should be defined as activation triggers for the different response levels within the national BMCI preparedness plan, depending on:
- **the type of incident (e.g. structure fire, industrial disaster, terrorist attack),**
- **the number of available burn beds at each response level,**
- **the possibility of a surge capacity, i.e . a temporary increase of treatment capacity, at each response level.**

Rationale – 1.4.1 – Detailed quantification of burn care capacity is essential to optimal resource allocation in a BMCI. To that aim, a *burn bed* describes the ability to provide in-hospital specialized burn care to one patient, including corresponding specialized healthcare professionals and technical assets. Burn beds should be registered according to patient age group and intensity of care, in line with applicable national regulations.

Pediatric burn care presents many similarities with adult burn care, but also specific challenges [57]. Thanks to the progress made over the last decades, severely burned children have reached both a high survival and an improved long term outcome even after massive burns in routine situations, provided that they are managed by burn teams with high pediatric expertize [58–60]. BMCIs with many pediatric casualties would be even more challenging because disaster planning is often mostly adult-focused and pediatric burn care capacities are typically more limited than adult ones, especially for critically injured children [61–63]. As a result, even a few severely burned patients would already be a mass casualty situation in most European countries. Detailed knowledge of pediatric vs. adult burn care capacity is thus essential.

Particular attention should also be paid to combined burn & trauma capability, in line with the epidemiology of recent burn disasters [19].

1.4.2 – At each level of the national burn care network, local burn center, region, and total capacity defines a corresponding saturation threshold. At best, these thresholds should be based on statistical estimates of daily bed availability and possible second wave beds. For example, with a total of 20 burn beds and a mean occupancy rate of 85% (17 patients), among whom 15% (3 patients) could be discharged earlier to obtain second wave beds, the saturation threshold would be six patients. Alternatively, an arbitrary yet reasonable estimate of this threshold could be set around one third of total capacity based on the following underlying assumption. Unless oversized and hence rarely full, no burn unit can manage to free up more than one third of its bed capacity from transferring patients to less or nonspecialized units. Saturation thresholds can also be estimated with more complex models to predict resource utilization and identify management bottlenecks [64,65]. In such a study in New Zealand, the overall saturation threshold of a regional burn center was 12 patients. Still, a cluster of patients with a cumulated 129% TBSA burns would have saturated the operating theater and required reallocating operating theater time [14]. For the reasons mentioned above, pediatric saturation thresholds are also typically lower than adult ones.

Saturation thresholds provide activation triggers for the various levels of staged response [66]. National BMCI preparedness plans should distinguish between the following situations at every response level of the local burn center, region, and nation. Below corresponding saturation thresholds, all burn patients should be admitted to burn centers after their primary triage and initial on-site or near-site local management. Above those thresholds, the higher response level should immediately be activated. Part of burn patients should then be initially admitted to nonspecialized facilities, at least temporarily, until specialized secondary triage.

A surge capacity, meaning a temporary capacity increase of involved hospitals and burn centers, should also be planned for. The American Burn Association (ABA) defines a surge capacity as a capacity to handle 50% more patients than the routine maximum number of burn patients [46,67]. Such a high increase may require to deploy large burn specialty teams from non-affected states to provide additional burn treatment capacity to burn centers in the affected state [46]. This makes sense with the federal structure of a nation with a continental scale and one healthcare organizational model. Conversely, Europe is a union of smaller sovereign states with different healthcare organizations. The EBA disaster committee has thus not recommended a quantified target surge capacity. Conversely, it recommends that each hospital with a burn center plans for a locally manageable, likely lower surge capacity. This way, significant overall burn surge capacity may be achieved collectively if burn patients are distributed to remote burn centers.

Q 1.5 – How should specialized burn care resource availability and utilization be coordinated?

R 1.5.1 – The national preparedness plan should include a national burns coordination cell with two tasks:

- **ensuring real-time information on immediate and *second wave* availability of burn beds,**
- **mobilizing the suitable healthcare professionals to perform specialized in-hospital triage for the dispatching of burn patients.**

R 1.5.2 – As appropriate, the national burns coordination cell may be permanently active, or activated on an ad hoc basis, and may use semi-automated bed availability tracking tools.

Rationale – 1.5.1–1.5.2 – Optimized allocation of limited specialized burn care resources is paramount in BMCI response. This requires timely, reliable, and actionable information about burn bed availability and patient needs, best obtained by a national burn coordination cell. Its actual organization may depend on the national burn care network's size and existing national coordination systems and capacity management tools. The following practical options may be considered.

- It can either be a component of a common Emergency Medical Services or disaster coordination system or the national burn care network. In both cases, its main role is to connect both. The Belgian Association of Burn Injuries (BABI) runs its coordination cell in Brussels military burn center [21]. Conversely, health authorities perform this task in Nordic countries [22].
- It can either be permanent or transient, then activated when needed. Regular checks of its operational capability should be especially stringent in the latter case.

The national burn coordination cell should not rely solely on burn-specialized healthcare professionals, whose expertise would be most needed in case of BMCI, yet ideally, involve one for optimal coordination with burn centers.

Real-time or near real-time assessment of actual burn bed availability should be operating, with the same categorization of burn beds described above. Besides immediately available burn beds, a second wave of supplementary burn beds that can be made available within a short time frame (few hours) should also be identified. Two types of second-wave burn beds should be considered. The first type involves the early discharge of patients. Time is needed to dispatch appropriately and transport casualties in a BMCI. This is compatible with the kinetics of acute burn-related complications. This delay can be used to discharge some burn patients previously hospitalized in burn centers based on limited severity or nearly achieved healing. The second type of second-wave beds results from the activation of the surge capacity (see recommendation R 1.4.2). This stresses the need for a local BMCI preparedness plan in each hospital with a burn center [64,68]. Immediate and second-wave burn bed availability tracking could rely on direct telephone contacts with the coordination cell, as in the Belgian Association for Burn Injuries plan [21]. It could also involve a semi-automated computerized tracking system with at least daily data collection. American burn centers validated such a system to help prepare for military conflicts or disasters [69]. Similar software proved helpful in managing ICU bed availability during the COVID-19 crisis at the regional level in France [70]. Special attention should then be paid to system robustness and resilience.

If the deployment of a burn assessment team is necessary (see recommendation R 1.6) to account for its impact on involved burn centers, it makes sense to have the national burn coordination cell mobilize it.

Q 1.6 – How should burn-specific specialized triage be organized and conducted?

R 1.6 – National BMCIs preparedness plans should include:

- **national specialized burn assessment teams to perform specialized in-hospital triage, advisably with similar composition, qualifications, tasks and tools as the European burn assessment teams (BATs);**
- **a process for optimal patient distribution, including efficient communication and data sharing, and definition of roles and responsibilities regarding dispatch decisions.**

Rationale – 1.6 – Field triage of burn casualties in BMCIs is often poorly reliable [71]. As mentioned in recommendation R 1.3.1, burn-specific specialized triage is impractical on-scene. Many burn casualties are initially admitted to non-specialized hospitals. This can result from quick saturation of burn centers, from an active choice not to primarily saturate burn centers with the wrong patients, excessive distance between the disaster site and burn centers, or a combination of those factors. *Secondary specialized in-hospital triage* is thus required to refer burn patients to the most appropriate treatment facility. It is also often called “secondary triage”, but this appellation is confusing. Specialized in-hospital triage is indeed often at least the third triage step, after field triage and re-triage when casualties reach the first receiving hospital. Conversely, in the ABA disaster plan, primary triage is any triage performed in the first 24 h to admit a patient to a burn center. Secondary triage is a later triage to transfer patients from a burn center to another [46].

Most existing BMCI plans have addressed the need for specialized in-hospital triage, to be performed by teams of 2 or more burn care professionals quickly deployed to first receiving hospitals or sometimes on-scene [21,22,45–47]. Because burn centers are used to provide remote help to nonspecialized healthcare professionals with individual patients in a routine situation, telemedicine as an alternative to specialized in-hospital triage has been questioned. Telemedicine has been advocated as a potentially useful tool in disaster medicine to support medical management decisions and possibly triage [72–75]. Actual simulations have yet so far shown its limits, mostly dependency on one technology platform with a risk of non-interoperability, complex interface, lack of reliability, and lengthened triage time [72,76,77]. In summary, although interesting, telemedicine is currently not sufficiently mature and possibly too complex and fragile to be used in burn disaster triage. No short-term evolution is anticipated thereabout. Specialized in-hospital triage by burn teams, therefore, remains the recommended solution. If no such national organization exists, modeling national burn teams after European Burn Assessment Teams (BATs, see field 2 below) would make sense to avoid duplicating efforts and increase national/international interoperability.

A robust and operational patient distribution system is the necessary continuation of reliable specialized triage. It is usually part of general, non-burn-specific disaster response.

Q 1.7 – How should intra-national patient transfers be dealt with?

R 1.7 – National BMCI preparedness plans should include appropriate provisions for timely intra-national secondary patient transfers, whether by ground or by air. The EBA guidelines for transportation of burn patients also apply to intra-national patient transport.

Rationale – 1.7 – After specialized triage and appropriate patient dispatch, secondary patient transfers are the last step before final specialized treatment in burn centers. Due to disparities in size among European countries, international transfers are not necessarily longer than national transfers. As a consequence, recommendations about medical evacuations in field 3 generally also apply nationally. This also makes sense for national/international interoperability.

Q 1.8 – How should national preparedness plans connect with the European response plan for burn mass casualty incidents?

R 1.8.1 – In order to maximize efficacy of international help, the European BMCI response system needs proper articulation with existing national preparedness plans. To that aim and whenever possible, convergence between them should be sought regarding tools and organization.

R 1.8.2 – In order to link the national BMCI preparedness plan with the European plan, the former should set a direct and permanent link between the national burns coordination cell and the national contact point for the European Emergency Response Coordination Center (ERCC), and maintain a roster of healthcare professionals qualified for European burn assessment teams.

Rationale – 1.8.1 – When a BMCI overwhelms national capacities, the European BMCI response system is an extension of a national response. It provides a second-line response due to the time needed for its activation [1]. National BMCI preparedness plans should thus include provisions to request international assistance and to ensure its articulation with the national response. Convergence of procedures and tools between the 1st national step and the 2nd international step is advisable to ease interoperability and transition between both steps. This principle is already implemented in smaller-scale international plans such as the Nordic burn disaster plan [22].

1.8.2 – The national contact point of the European Emergency Response Coordination Center (ERCC) is typically a national civil protection authority. In the European BMCI response plan, this contact point is the link between national and international responses [1]. Either to request or offer assistance, respectively, in case of a home or remote BMCI, it crucially needs information about the national availability of burn beds and burn assessment team members. The national burn coordination cell, as defined in recommendation R 1.5.1, is the entity with the easiest direct access to this information. The need to link both permanently is thus obvious. However, the national burn coordination cell may not be permanent but only activated ad hoc (see R 1.5.1). In that case, the mentioned permanent link means a permanent possibility for the national UCPM contact point to activate the national burn coordination cell in case of a BMCI abroad to help answer a potential request for assistance from the affected state.

Q 1.9 – How should a national BMCI preparedness plan evolve?

R 1.9 – As for any preparedness plan, along with appropriate training, the national BMCI preparedness plan should be regularly tested and exercised, and adjusted according to lessons learned.

Rationale – 1.9 – National BMCI preparedness plans should include appropriate training of various partakers. Basic initial burn management, including burn severity criteria, is part of general training for first-line EMS providers such as Advanced Trauma Life Support (ATLS). Non-burn-dedicated multi-professional training programs are essential to actual disaster preparedness and response. International examples include MIMMS (Major Incident Medical Management and Support) and the more recent European MRMI (Medical Response to Major Incidents) courses [78,79]. Dedicated training programs for initial burn management skills such as Emergency Management of Severe Burns (EMSB), Advanced Burn Life Support (ABLS), Combat Burn Life Support, or national equivalents should be encouraged for relevant personnel in all hospitals without burn centers [80–82].

Finally, the implementation of the plan should be regularly tested and exercised. Whenever implemented in an actual situation, it should be debriefed and evaluated after action. Feedback from those exercises and actual BMCI situations should prompt plan revision and update.

3.2. *Field 2 – European burn assessment teams*

Background – The European BMCI response plan has two core intricated goals: to provide the largest number of burn casualties with the most appropriate level of care hence with the highest probability of a favorable outcome, and to alleviate the burden of care for the affected country [1]. To this effect, Burn Assessment Teams (BATs) are the first possible step of international assistance. They are teams of specialized burn care experts. Their expertise can be mobilized as early as possible after a BMCI to help local authorities and healthcare providers achieve the highest standards of medical management. Their deployment, activity, and reporting are conducted according to the European BMCI response plan [1,2].

Q 2.1 – *What are the roles of European Burn Assessment Teams ?*

R 2.1.1 – The primary role of European Burn Assessment Teams (BATs) is to clinically assess burn casualties regarding burn and general severity, fitness for transportation and treatment requirements. This assessment should result in triage recommendations for international referral and transportation of burn casualties.

R 2.1.2 – European BATs should not engage in actual burn casualty treatment except for specialized technical advice given while performing their assessment and triage tasks.

Rationale – 2.1.1 – The main bottleneck in BMCI management is the lack or saturation of specialized burn care capacity [18]. Two main strategies have been proposed to handle this issue, possibly in combination. They translate into different types of burn specialist teams. The first strategy focuses on reinforcements sent to local treatment facilities. Large multi-professional teams with appropriate assets are deployed to stay for weeks and actually treat patients with relative autonomy, as for Burn Specialty Teams in the American Burn Association disaster plan or Burn Specialist Teams in World Health Organization (WHO) recommendations [31,46]. They can fill a gap when national possibilities of treatment and evacuation are so limited that bringing a new capacity from abroad seems the only solution [31]. Conversely, they can help avoid unnecessary transfers within a single coherent healthcare system in high-resource environments [46]. The second strategy focuses on patient distribution. It aims to quickly bring the burden of care back to baseline and treat patients in the most appropriate facilities, even remotely if necessary. Small teams of burn specialists or single burn physicians help triage and dispatch patients from first receiving hospitals [21,31,47]. When they are also involved in treatment, such as Burn Rapid Response Teams, as defined in WHO recommendations, they do it only in support of local providers and for a short time [31].

In 2015 in Taiwan, a large-scale BMCI caused 499 severely burnt casualties. Remarkably, only 2.4% of them died versus a statistically predictable 26% [25]. This showed that a well-organized, staffed, and equipped healthcare system could achieve optimal outcomes even in an overwhelming situation. Countries participating in the European BMCI response plan are high- or medium-income countries with resilient and efficient healthcare systems. They are sovereign independent states with different organizations, languages, and healthcare systems. With typically a few burn beds per million inhabitants, most European countries could not handle such a large-scale burn disaster alone. But taken together, the total European burn center capacity could do it. For those reasons, the first strategy of reinforcing treatment teams deployed to the BMCI-affected country has been deemed unsound and ill-adapted to the European background. Conversely, the European BMCI response plan implements the second strategy of early burn casualty distribution among European burn centers [1].

The main role of BATs is thus to clinically assess burn casualties regarding burn and general severity, fitness for transportation, and treatment requirements. Based on their assessment, BATs should provide dependable triage recommendations on whether to transfer patients abroad, appropriate treatment facilities, evacuation priority, and adequate level of en route care. Countries participating in the European BMCI response plan retain their authority to make decisions regarding casualties under their responsibility [2]. Therefore, BAT conclusions are actionable medical recommendations, not actual decisions.

2.1.2 – It is estimated that a BAT can assess roughly 20–30 burn patients in 24 h. The medical evacuation of burn patients is best performed within 96 h after the incident (see recommendation R 4.1) [83]. BATs should thus finalize their assessment and triage within 72 h after the incident. This precludes their actual involvement in casualty treatment to avoid undue and potentially harmful delays. BATs are also composed of highly experienced professionals with optimal treatment skills and efficiency within their burn center (see recommendation R 2.3). Bringing BATs back home as early as possible thus helps optimize the capacity of remote burn centers to treat casualties evacuated from the affected country. This is also why BATs should not stay there longer to treat patients.

Conversely, considering their potentially high added value and provided the assessment process is not delayed, BATs should share specialized technical advice with local non-specialized healthcare providers whenever possible.

A slightly longer stay could be considered for one of several deployed BATs at the end of their mission, or for the coordinator when only one BAT is deployed, in order to fulfill mission conclusion tasks and handover when necessary.

Q 2.2 – Which step of burn-specific triage should be devolved to BATs?

R 2.2 – BATs should perform specialized in-hospital assessment and triage of burn casualties who have already been admitted to a first-receiving hospital.

Rationale – 2.2 – International BATs would need more time to deploy than national teams, even with an optimized triggering process. The rationale of recommendation R 1.6 about burn-specific triage in national BMCI preparedness plans fully applies to them. In a BMCI, field triage and re-triage on arrival at the primary receiving hospital would inevitably occur before European BATs are deployed to the affected state. Their expertise should thus be used to perform specialized in-hospital triage, sometimes referred to as specialized secondary triage, of burn casualties who have already been admitted to a first-receiving hospital. This would usually occur in nonspecialized hospitals without burn centers. Unless overwhelmed, local specialized burn teams would indeed perform specialized in-hospital triage at their own burn centers.

Q 2.3 – How should BATs be composed?

R 2.3 – BATs should be composed of four members: one coordinator, two experienced burn physicians (one surgeon and one anesthesiologist/intensivist) and one experienced burn nurse (Table 5).

Rationale – 2.3 – According to missions and national variations, burn teams do not have a uniform composition in existing BMCI response plans. In Switzerland, one single expert performs on-scene burn triage [47]. One surgeon and one nurse perform specialized burn triage in the United Kingdom, and a similar team with an added anesthesiologist intensivist in Belgium [21,45]. In the USA, 15 burn professionals provide an extended burn treatment capacity [46]. The latter is beyond the scope of European BAT missions (see recommendation R 2.1.2).

European BATs should include all necessary competences to fulfill their assessment and triage mission, with the smallest possible logistical footprint hence as few members as possible. Their standard composition is detailed in the European BMCI response plan and summarized in Table 5 [2]. An incident response coordination officer, trained under the UCPM and experienced in international responses, should be the team coordinator. He or she can best liaise with national and European authorities and organizations, coordinate team activity and reporting, and handle potential administrative issues, logistics and safety if necessary. These tasks should best not be managed by healthcare professionals so as to avoid interfering with their clinical tasks. A burn surgeon can best assess overall burn severity and estimate the need for specialized surgical management. A burn intensivist or anesthesiologist can best assess the general severity status of burn casualties, including organ failures, their potential for decompensation, and replacement therapy requirements. In combination, this should enable teams to determine fitness for transportation and intensity of care needed, both at destination and during evacuation [84–86]. Both specialties are therefore needed. Seniority in burn care rather than specialty should dictate senior and second position among both physicians. Finally, a burn nurse can best handle dressings with local care providers to allow burn wound examination, especially when differences in the process of care or language barriers make the interaction of BAT physicians with local teams more difficult.

High clinical experience in burn care is crucial to the relevance of BAT work. To that effect, the experts agreed on a minimum requirement of 5 full years working in a burn center for the three burn care professionals (Table 5). Considering the rarity of burn physicians also trained in disaster medicine, they also conceded the possibility to integrate highly experienced burn physicians who stopped their clinical burn care activity less than three years before.

For the reliability of BAT conclusions, these burn care professionals should comply with shared standards of care.

Table 5 – Composition of a European Burn Assessment Team.

Function	Profile	Requirements
1 coordinator	Emergency response coordination expert	Certified incident response coordination officer
1 senior burn physician	Burn surgeon or burn intensivist/anesthesiologist	At least 5 years of experience in an EBA verified burn center[a] during last 8 years, experience of trauma care desirable – Both specialties needed
1 burn physician	Burn intensivist/anesthesiologist or burn surgeon	
1 nurse	Burn nurse	Current work in burn center, for at least 5 years

[a] Provisional transition criteria may apply while the EBA is in the process of verifying interested centers. Such criteria may include (a) compliance with national burn care regulations; (b) a written statement of compliance with EBA recommendations, including a detailed description of areas that need more work; (c) a written commitment to engaging in the EBA verification process until the transition period ends.

This can be approached by a quality certification of their burn centers. To that aim, the verification of burn centers is a valuable tool, best documented with the ABA verification program in North America [87,88]. The only equivalent international program in Europe is the burn center verification program of the EBA. In the future, healthcare professionals in BATs should preferably come from EBA-verified or similarly certified burn centers, but the verification process is still in progress in Europe. Transitional provisions have thus been set in the plan to bridge this gap [2].

Specific BAT training requirements are addressed in recommendation R 2.4. Organizational and administrative requirements are also mentioned in the plan, mainly fluency in English, compliance with mandatory vaccinations, registration on a roster, and specific coordinator training [2]. Nontechnical skills also deserve close attention when selecting team members, especially teamwork ability, organizational skills, openness, adaptability, and capacity to assume leadership.

According to the plan, if several BATs are deployed, they are cross-coordinated and supported by a supplementary liaison officer deployed from the ERCC [2].

Q 2.4 – How should BATs be trained?

R 2.4.1 – Burn Assessment Teams should be trained together and certified for 5 years in a standardized BAT course.

R 2.4.2 – Standardized BAT courses should include prior personal learning, active skill acquisition through teamwork, and realistic exercises involving BAT deployment, actual assessment and triage of simulated patients and accompanying tasks.

Rationale – 2.4.1–2.4.2 – Emergency Management of Severe Burns (EMSB), Advanced Burn Life Support (ABLS) / Combat Burn Life Support, or similar national courses are advisable as background training for healthcare professionals in BATs [80–82].

BAT members should have an in-depth understanding of the European Union Civil Protection Mechanism (UCPM) as the general framework of their missions [89,90]. They should also know how the European BMCI response plan works and be fully familiarized with its procedures and tools as described in the present recommendations [1,2]. This involves personal learning.

Members of a BAT do not necessarily work together on a daily basis. Even in that case, their daily work differs greatly from BAT tasks. To fulfill their mission effectively and reliably, all members of a team should be trained together. The three goals of such team training are to:

- build coherent operational teams, and allow them to mobilize their prior knowledge
- let them acquire practical experience of the deployment process and their specific tasks in as realistic conditions as possible, hence the need for simulation
- achieve interchangeability of BATs.

They should directly translate into course construction.

The goal of interchangeability is fundamental. In countries that request and offer assistance, authorities and healthcare providers need confidence in BAT conclusions whereby they can make informed decisions on transfers, adequately organize and perform evacuations, or prepare to receive and treat patients. This should prevent time loss and disorganization related to duplicate assessments, as observed in previous disasters [1]. This warrants course standardization, its relevance and performance evaluation, and periodic revalidation of trained BATs. The suggested revalidation time is five years. This delay should be reassessed based on BAT feedback.

Q 2.5 – How should BATs clinically assess burn casualties and report their conclusions?

R 2.5.1 – BATs should best assess patients with open dressings for reliable assessment of burn wounds.

R 2.5.2 – A dedicated standardized assessment template should be used to collect relevant information and conclude on severity-based triage, fitness for transportation, evacuation priority level, and required intensity of care both en route and at destination (Fig. 1).

Rationale – 2.5.1 – For reliable clinical assessment of burn wound depth and extent and potential complications, BATs should actively be involved in dressing changes under adequate sedation or analgesia. Local medical teams should be requested to ensure compatible conditions. They should also allow BAT physicians to access patient records as needed.

2.5.2 – The template assessment form should be completed for each patient to gather a suitable and easily usable set of relevant clinical data (Fig. 1). Patient identification, including gender and age, is vital for appropriate dispatching. It should be paid the most attention. The form is divided into three frames. The surgeon completes the first one about burn wounds, potential associated injuries, and surgical management. The intensivist anesthesiologist completes the second one about general status, organized by vital functions and corresponding therapy. Both jointly complete the third one with their conclusions and triage recommendations. The completed assessment form is also a synthetic patient record to share crucial information with the transport team and the burn center at destination.

At the end of the process, completed assessment forms should be communicated to local health authorities and remote referral burn centers selectively and securely. The European Early Warning and Response System (EWRS) enables such communication, as recently exemplified when organizing the transfer of Ukrainian war casualties to several European countries. The BAT should also provide a summary of completed assessments, specifying the number of patients needing international medical evacuation and their levels of priority for evacuation. Completed assessment forms should also be communicated to evacuation teams if applicable.

3.3. *Field 3 – Specialized in-hospital triage*

Background – Triage has come from the military to disaster medicine. When medical resources are limited, triage is the

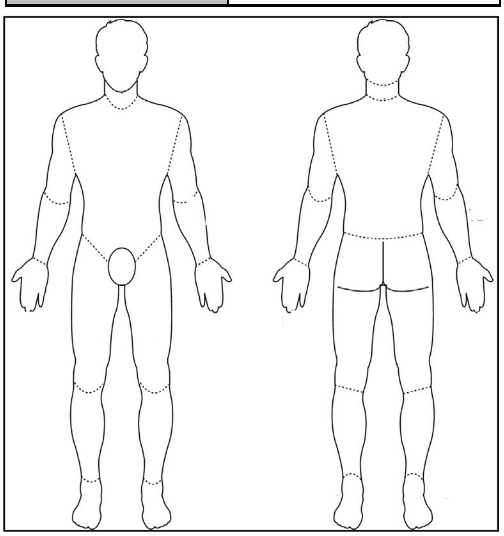
EBA

BURN TRIAGE

DATE OF ASSESSMENT:
DATE OF INJURY:

ASSESSED

WOUND MANAGEMENT	
AGE	
WEIGHT ADMISSION CURRENT	
TBSA	
TBSA w/DEEP BURNS	
ASSOCIATED TRAUMA	CHEST ABDOMINAL HEAD LIMBS OTHER: NONE
ESCHAROTOMY NEEDED	YES NO
SURGERY NEEDED EXCISION AND GRAFTING OTHER COMMENT:	 YES NO YES NO
TYPE OF DRESSING	
BAUXr SCORE	
ABSI SCORE	



Sketch burns, surgery , trauma, drains and tubes

PEDIATRIC	ADULT
PATIENT ID NAME LAST NAME BIRTH DATE SEX	

ASSESSED

GENERAL STATUS	
SUSPECTED INHALATION INJURY	YES NO
RESPIRATORY VENTILATED TRACHEAL TUBE FiO2/PEEP V_t / RR PIP / PFR SpO_2	 YES NO ETT TRACHEOST NONE
CIRCULATION PULSE BLOOD PRESSURE VASOPRESSORS AGENT/DOSE	 YES NO
INFECTION ANTIBIOTIC TREATMENT	NONE SKIN LUNG BLOOD OTHER: YES NO TYPE:
KIDNEY URINARY OUTPUT Creatinine clearance Creatinine/urea RRT	 Hemofiltration Hemodialysis NO
NEUROLOGICAL INITIAL CURRENT SEDATED RASS	 A V P U A V P U YES NO +4 +3 +2 +1 0 -1 -2 -3 -4 -5
COMORBIDITIES ALLERGY MEDICINES PAST MEDICAL HISTORY EVENTS	YES NO

TRANSFER RECOMMENDATION	NEEDED		NOT NEEDED	FUTILE
FIT FOR TRANSPORTATION	YES		NO	REEVALUATE
RECOMMENDED EN ROUTE CARE LEVEL	CRITICAL		STANDARD	
RECOMMENDED BURN CENTER CARE LEVEL	ICU	MEDIUM CARE	SURGICAL WARD	
PRIORITY LEVEL	1	2	3	4
SIGN				

Fig. 1 – Burn casualty assessment template form. The back page reproduces Abbreviated Burn Severity Index (ABSI) table and revised Baux score (rBaux) nomogram as reminders [106,167].

process of rationally and fairly allocating them to patients or casualties [91]. It is a medical decision that targets the greatest benefit for the largest number of patients. Patients are sorted by priority level to access specific management steps such as field casualty care, resuscitation, evacuation, or surgery. When resource scarcity prevents treating all patients, or at least all at once, some may have to receive comfort care only. Triage is the only ethical care strategy under resource scarcity if triage criteria are fair, non-discriminatory and medically sound. They should ideally be based on good medical knowledge, robust epidemiological data, and a clear understanding of logistical issues. The COVID-19 pandemic has shown the need for triage in other types of crises and shed light on the ethics of triage, which relies on distributive justice [92,93].

The medical management of mass casualty incidents involves several successive triage steps, which may receive different appellations (see the rationale of recommendation R 1.6). In this text, *primary triage* refers to early nonspecialized triage performed before evacuation and admission to a first receiving hospital, which may either be a burn center or, more often, a nonspecialized structure. Many simple primary triage strategies have been proposed for burn casualties. They usually account for burn severity based on gross categories [48,94–96]. In civilian settings, they rarely address combined burns and trauma [94]. Due to the frequency of associated injuries at war, military triage systems have included both [91]. Logistics and persistent threats admittedly induce differences between military and disaster medicine. However, the transposition of military triage systems to civilian settings may be relevant considering the increasing frequency of terror-related burn disasters [19]. No primary triage strategy for burn casualties has a proven superiority over others to our knowledge. One study claimed otherwise, but it inappropriately compared a non-burn-specific triage tool with burn severity scores targeting only mortality prediction [97].

Primary triage strategies are not further discussed in the present guidelines. In the European BMCI response plan, due to its unavoidable activation delay, primary triage occurs before international assistance begins. It is the responsibility of the affected state (see recommendation R 1.6) [1]. This field of recommendations instead addresses delayed specialized in-hospital triage of burn casualties as planned in the European BMCI response.

Q 3.1 – *What are the goals of specialized in-hospital triage of burn casualties within the European BMCI response plan?*

R 3.1.1 – Specialized in-hospital triage of burn casualties should allow to select patients to be transferred to remote burn centers, and to prioritize their transfer.

R 3.1.2 – Patient selection and prioritization for transfer should aim at providing all casualties with the same probability of recovery as in a non-mass casualty situation.

Rationale – Following a BMCI, the European response plan expands the initial national response when the burn casualties outnumber national capacity. BATs are deployed to nonspecialized primary receiving hospitals to perform a specialized assessment of those hospitalized burn casualties and to provide triage recommendations (see recommendation R 2.1).

3.1.1 – The first goal of this triage should be to select burned patients whose transfer to foreign burn centers makes sense. Only patients likely to benefit from specialized in-hospital burn care should be transferred. Patients with burns of sufficiently low severity to be treated as outpatients or in facilities other than burn centers should thus not be evacuated. Neither should patients with such severe burns that their likelihood to survive is minimal, even under maximal specialized treatment. The death of non-survivable patients early after routine transfer is a system failure. A palliative, patient- and family-centered approach should be preferred [98]. This would be even more applicable when considering a border crossing in a context of disaster.

Among patients selected to be transferred, the second goal of this triage is to set evacuation priority levels. Not all transfers can occur at the same time. Patients who should be transferred first are those with a condition severe enough that delaying their admission to a burn center could impair their outcome. For instance, patients with the most extensive deep burns need early burn wound excision and should be transported early [51,52]. Conversely, the set priority level should also account for patient fitness for transportation. For instance, patients with non-stabilized organ failures may have such a high risk of en route complications and death that their early transportation could be riskier than a delay until relative stabilization [83,99].

3.1.2 – The overall aim should be to provide all burn casualties with the same probability of recovery as in non-disaster conditions. The 2015 Formosa water park disaster in Taiwan has shown that such a goal is at hand in a well-prepared, high-level healthcare system faced with hundreds of severe burn casualties, many of them with inhalation injuries [25,100]. In this disaster, the remarkably high observed survival was precisely achieved with a similar strategy of initial admission of many patients in nearby nonspecialized hospitals and subsequent in-hospital re-triage by visiting burn care specialists [23]. Whether such an outcome could be achieved in combined burn and trauma disasters is uncertain. However, except for severe hemorrhagic trauma casualties who bleed to death too early to be evacuated, US military data suggest it is indeed possible. Compared with matching civilian burn patients, survival was similarly high in the US burn casualties evacuated from Iraq and Afghanistan to San Antonio military burn center, often with associated injury [101,102].

Q 3.2 – *Which main severity criteria should be used for specialized in-hospital triage?*

R 3.2.1 – Specialized in-hospital triage of burn casualties should be based on burned surface area and patient age, but not on inhalation injury.

R 3.2.2 – Organ failure criteria should be considered as potential triage modifiers.

R 3.2.3 – When burns are not the most threatening condition, trauma triage criteria should prevail.

Rationale – In order to achieve a fair and rational allocation of specialized burn care resources for the highest benefit of the greatest number of patients, triage criteria should help estimate the balance between resource utilization and its probability of success.

3.2.1 – Total Body Surface Area (TBSA) burned is a key predictor of burn-specific resource utilization. A retrospective study on 1043 patients strongly correlated TBSA with the number of operating theater visits, including surgical operations and dressing changes, cumulated operative time, and hospital length of stay. Respectively, a mean of 0.3 visits, 23 minutes operating time, and 1.1 days per %TBSA burned were reported [14]. In a prospective multicenter study on 573 patients, TBSA was associated with the incidence of sepsis, burn wound infection, pneumonia, and multiple organ failures, all of which suggest increased ICU resource utilization [103]. Its main limitations are that it does neither account for the differences between superficial and deep burns nor for surgically demanding specific burn localizations such as face or hands. In contrast, both significantly impact treatment strategies and resource utilization. Besides TBSA burned, age and inhalation injury were the other two significant predictors of resource utilization, measured as hospital length of stay, in a large retrospective study on 95,579 burn patients in North America [104].

Survival is the most robust outcome measure in severe burns as in other severe conditions. In severe burns, its universal predictors are TBSA and age [58,105]. Depending on epidemiological studies, both criteria may be completed by additional variables, mostly inhalation injury (binary item) and sometimes third-degree burns (binary item or TBSA burned at third degree) or gender [106–112]. Other outcomes, such as functional recovery or quality of life, have high patient value. Their prediction is difficult and poorly documented in the early phase after injury. Still, age is associated with poor recovery and poor quality of life after burns [113].

Overall, TBSA, age and inhalation injury are the three main predictors of both resource utilization and outcome in severe burns and could be considered as triage criteria. The experts suggest keeping only the first two without including inhalation injury for the following reasons. TBSA assessment by nonspecialized healthcare professionals is admittedly poorly reliable, especially in pre-hospital settings [32–36]. In this setting, TBSA is especially often overestimated in pediatric patients [37–39]. Its expected reliability should be conversely high when assessed by expert BATs in hospital settings. Except for cases when patient identity is unknown, which would likely occur for part of disaster casualties, age is also an easily accessible and reliable parameter. However, inhalation injury is a difficult diagnosis that mainly relies on fiberoptic bronchoscopy [114–116]. In a BMCI, many patients initially admitted to a nonspecialized primary receiving hospital would likely not undergo fiberoptic bronchoscopy before their assessment by BATs. Consequently, BATs should not base their recommendations on this diagnosis under such circumstances.

3.2.2 – Organ failures are associated with increased ICU resource utilization and risk of poorer outcomes in critical conditions. In the assessment of burn casualties by BATs, they are recorded to assess fitness for transportation and required intensity of care (see recommendation R 2.5.2 and "GENERAL STATUS" frame of Fig. 1). They should also be considered as potential triage modifiers to account for severe conditions not related by TBSA burned and age. For instance, severe acute respiratory distress syndrome could justify retriage in an immediately higher category of burn severity (or poorer outcome-to-resource ratio). It would be a more straightforward diagnosis than inhalation injury in the setting of BAT assessment.

3.2.3 – All triage systems have limitations. As previously mentioned, most of them do not consider associated traumatic injuries. Classical civilian or military triage criteria for mass trauma casualties can initially be better suited if most patients associate trauma and burns [91,94]. They should prevail in any case where burns are not the most threatening condition.

Q 3.3 – Which triage rules should apply?

R 3.3.1 – Specialized in-hospital triage of burn casualties should proceed in following 3 steps.

- **Step 1: assess outcome to resource utilization ratio adjusted from probability of survival (Table 6)**
- **Step 2: assign triage priority level for evacuation (Table 7)**
- **Step 3: reassess at least when triage is completed or when logistical situation evolves**

R 3.3.2 – For patients selected to be transferred, priority level should be rated between 1 (high priority) and 3 (low priority), with higher priority nominally given to greater severity.

R 3.3.3 – A triage priority level 4 (lowest priority) should be added only in degraded situations where even international assistance capacity cannot meet the needs.

Rationale – The recommended triage approach combines the aforementioned principles and triage criteria in the following three steps.

In step 1, patients should be sorted into one of six severity groups which summarize their outcome to resource utilization ratio (Table 6). This is based on the American Burn Association (ABA) triage table for burn disasters as updated in 2014 [46,117,118]. It is the only current burn triage tool derived from robust large-scale epidemiological data, actually 112.912 patient records from the American National Burn Repository in the 2014 update [118]. Based on age group and TBSA decile, patients are sorted by probability of survival, then by mean length of burn center stay for those with a high likelihood of survival. This yields a qualitatively expressed outcome to resource utilization ratio [117,118]. It is likely more relevant than the raw probability of survival to triage patients with less severe burns. For them, indeed, the probability of survival with current standards of burn care has reached such high levels that it is poorly informative on resource utilization [112,119,120]. Conversely, survival probability alone could be informative enough regarding severity and resource utilization for more severe burns.

In the 2014 version of the ABA triage table, additional separate triage tables are provided for patients with and without inhalation injury. This modification has deliberately

Table 6 – Outcome to resource utilization ratio, adjusted from probability of survival, in burn patients according to age and body surface area burned. Adapted from [118]. The ratio of expected outcome to specialized burn care resource utilization under maximal treatment is summarized as follows. *Outpatient* (blue): survival ≥ 95%, outpatient treatment possible. *Very high* (green): survival ≥ 90%, short stay < 3 weeks, ≤ 2 operations. *High* (yellow): survival ≥ 90%, long stay ≥ 3 weeks, multiple operations. *Medium* (orange): survival 50–90%. *Low* (red): survival 10–50%. *Expectant* (grey): survival < 10%.

Age (years)	Body surface area burned (%TBSA)									
	0-9,9	10-19,9	20-29,9	30-39,9	40-49,9	50-59,9	60-69,9	70-79.9	80-89,9	90-100
0-1,99	Very high	Very high	High	High	High	Medium	Medium	Medium	Low	Low
2-4,99	Outpatient	Very high	High	High	High	Medium	Medium	Medium	Low	Low
5-19,9	Outpatient	Very high	High	High	High	High	Medium	Medium	Low	Low
20-29,9	Outpatient	Very high	High	High	High	Medium	Medium	Medium	Low	Low
30-39.9	Outpatient	Very high	High	High	Medium	Medium	Medium	Low	Low	Expectant
40-49,9	Outpatient	Very high	High	Medium	Medium	Medium	Medium	Low	Low	Expectant
50-59,9	Outpatient	Very high	High	Medium	Medium	Low	Low	Expectant	Expectant	Expectant
60-69,9	Outpatient	High	Medium	Medium	Low	Low	Low	Expectant	Expectant	Expectant
≥ 70	Very high	Medium	Low	Low	Low	Expectant	Expectant	Expectant	Expectant	Expectant

not been integrated into the present guidelines despite the consistent epidemiological association of inhalation injury with worse outcomes [106–110,112]. The practical difficulty of diagnosing inhalation injury in such triage settings likely counterbalances its theoretical predictive ability (see recommendation R 3.2.1). Of note, the ABA has recommended that its triage tables be used for pre-hospital triage, mainly by non-burn specialized healthcare professionals. It is questionable whether this would be practical and effective, considering their complexity and the lack of TBSA reliability in that setting [32–36]. Expert BATs performing specialized in-hospital triage should be better positioned to use this tool.

In step 2, patients should receive an evacuation priority level rated between 1 (high priority) and 3 (low priority), and optionally 4 (lowest priority), based on two decision criteria (Table 7). The first one is the previously assigned outcome to resource utilization ratio. The second one is the overall adequacy of internationally available burn beds to the actual needs (Table 7).

Because of negligible benefit, neither patients without significant treatment difficulty (*outpatient*) nor patients almost bound to die of their injuries irrespective of treatment (*expectant*) should be transported (see recommendation R 3.1.1). For all others, two situations should be distinguished. In the nominal situation where internationally available burn beds match the needs, as targeted in the plan, all patients with a *very high* to *low* outcome-to-resource ratio would finally receive specialized care in burn centers. The evacuation priority level would then only describe time priority. Higher priority should be given to patients at higher risk of poorer outcomes if transferred later (Table 7, left column). Conversely, in a degraded situation where available burn beds do not match the needs, some patients would not be able to access specialized care in burn centers. The evacuation priority level would then combine time priority and probability of actual access to burn centers. Proper allocation of available resources would then demand more stringent patient selection, hence the proposed addition of a level 4 – lowest priority. Changes in resource availability should minimally disrupt initial triage. To that aim, the experts suggest always assigning the same priority level to the *very high*, *high*, and *medium* categories of outcome-to-resource

Table 7 – Priority level for evacuation according to individual category of outcome to resource ratio and to overall adequacy of available international assistance versus actual needs.

	Adequacy of available international assistance	
	No international saturation (target situation)	International saturation (degraded mode)
Patient category of outcome to resource utilization ratio	**PRIORITY LEVEL FOR EVACUATION**	
Outpatient	No evacuation (not needed)	No evacuation (not needed)
Very high	3	3
High	2	2
Medium	1	1
Low	**1**	**4**
Expectant	No evacuation (futile)	No evacuation (futile)

ratio, respectively 3, 2, and 1. Only patients with a *low* outcome-to-resource ratio should receive a different evacuation priority depending on the adequacy of available capacity: 1 in the nominal situation versus 4 in the degraded situation (Table 7).

This second step significantly differs from the ABA triage policy [46]. Up to 2014, the ABA recommended directly using its outcome-to-resource ratio tables as triage tables. The implicit instruction was to assign priority levels in the same order as the outcome-to-resource ratio: higher or lower priority to respectively higher or lower outcome-to-resource ratio [46,117,118]. This would set an upper limit to patients who could be treated in a burn center, depending on the magnitude of the burn disaster [46,117,118]. But among patients directed to a burn center with this approach, the most severe ones would reach it latest, hence a risk of poorer outcomes because of resulting delays. The target of the European BMCI response plan is to offer enough internationally available burn beds to match the needs of the affected country [1,2]. Therefore, in this nominal situation, the present guidelines recommend a reverse priority order compared to the implicit priorities in the ABA triage tables (Table 7, left column). A mixed approach should be used in a degraded situation where internationally available burn care beds would not meet actual needs despite plan activation. The added priority level 4 would sort patients theoretically survivable but with too low an outcome-to-resource ratio to sensibly receive the highest priority, as in the ABA policy. They would at least receive supportive care and possibly specialized burn care if burn beds could be made available after the higher-priority patients have been admitted. But the priority order of levels 1–3 would still be reverse compared to the ABA triage priorities. In the present recommendations, the patients who are assigned priority levels 1–3 are those most likely to access a burn center under resource constraints. For them, the priority order is meant to avoid delay-related complications (Table 7, right column). This triage policy has similarities with an updated ABA triage policy of 2020, which proposed explicit limits to burn center admission based on outcome-to-resource ratio severity groups. It did so for each of four saturation levels: conventional, contingency, crisis, and catastrophic situations, respectively less than 50–200 burn victims, 100–500 burn victims, 500–2000 burn victims, or more than 2000 burn victims [121]. This update was published after the draft of the present guidelines was endorsed by the EBA general assembly and has not prompted their revision for two reasons. First, it lacks prioritization among patients to be transferred to burn centers, a key objective of the European plan and a sound necessity due to the limited availability of evacuation assets (see recommendation field 4). Second, the burn care network is currently not highly structured in Europe. Therefore, it seemed more appropriate to distinguish only two saturation levels, with a moving threshold based on actual capacity adequacy rather than a predefined fixed threshold. This choice could be reassessed in potential later revisions of the present recommendations based on feedback from exercises or real disasters. Of note, the European approach resembles US regional adaptations of the ABA plan [122–124]. In these regional plans, a tiered hospital organization also led to transform the ABA triage table into a new priority matrix with a bi-directional priority allocation, quite similar to our priority allocation table (Table 7) in its essence.

Step 3 is that of reassessment. It is warranted if the situation evolves, especially regarding internationally available burn beds or evacuation capability.

In any case, these triage rules should be mitigated with clinical judgment, especially regarding the compatibility of actual patient conditions with transportation.

3.4. *Field 4 – Medical evacuation*

Background – Medical evacuation (MEDEVAC) of selected patients following the recommendations of BATs is a crucial part of the European BMCI response plan. They aim to efficiently dispatch them to selected destinations in the safest way possible. Compliance with high and reproducible standards of care is warranted.

This field of recommendations was initially meant to address mainly burn-specific items of MEDEVACs on a European scale in a mass casualty situation. Due to the current lack of shared international standards for MEDEVAC in general, that was not sufficient to achieve the said goals. For that reason, it also addresses non strictly burn specific items. The main focus is on aeromedical evacuations of critically ill burn patients, as they are the most challenging, but ground transportation and less severe patients are also addressed.

An issue of paramount importance for pediatric burn casualties is not directly addressed in the present guidelines: that of family reunification [125]. As in any disaster involving children, it deserves close attention. Children should be transported with at least one parent or relative whenever possible. When they cannot, appropriate provisions should be made to allow for family reunification as soon as possible.

Since the draft of the present guidelines was endorsed by the general assembly of the EBA in 2019, the COVID-19 pandemic has focused a large part of medical attention. All over the world, many inter-facility transfers of critically ill patients were necessary, part of them medium- to long-range. This led to a renewed interest in critically ill patient transportation in the recent literature [126,127]. Part of this literature may apply to the transportation of critically ill burn patients. The rationale for following recommendations has been accordingly updated when appropriate, but no need to modify them was identified.

Q 4.1 – *Should all patients be evacuated with the same level of en route care?*

R 4.1 – Two different levels of en route care should be distinguished:

- **CRITICAL for critically ill patients already undergoing intensive supportive treatment or for less severe patients yet with a significant risk of severe en route decompensation;**
- **STANDARD for patients with a low probability of severe en route complications.**

Rationale – In a BMCI, patient transfers would be decided based on their need for specialized burn care and local saturation (see recommendation field 3). Not all of them would be in critical condition or at risk of developing critical illness during transfer. For instance, most burned patients with 10–20%TBSA burned and no associated trauma or inhalation injury are expected to be stable during transfer, with a low risk of en route decompensation.

The proportion of critically ill patients is rarely explicitly mentioned in published reports of specific disasters where long-range transportation of patients was necessary. After a civilian airplane crash in 1997, among 16 burned survivors, four were critically ill and 12 were not [128]. Owing to the growing frequency of terror-related burn disasters, a parallel could be drawn with military settings [19]. In an extensive series of US military burn casualties evacuated from Iraq or Afghanistan, 70% required en route critical care and 30% were routine evacuees [85].

Transport of critically injured or critically ill patients is resource-intensive, both regarding assets and personnel (see recommendations R 4.4 and R 4.5) [86,126]. Resource limitation is a landmark of disasters or mass casualty incidents. In such situations, rational and efficient resource utilization warrants a distinction between the two recommended levels of en route care, *CRITICAL* and *STANDARD*. The recommended level of en route care is one of the key conclusions of BAT assessment and triage (see recommendation fields 2 and 3).

Q 4.2 – What timeline should be targeted for patient evacuation?

R 4.2.1 – Provided adequate initial care, burn patients should best be transported after resuscitation of initial burn shock, if any, and before occurrence of severe secondary complications.

R 4.2.2 – Medical evacuation (MEDEVAC) to foreign burn centers should best occur before H96 after event.

Rationale – 4.2.1 – The natural history of severe burns begins with an initial phase of plasmorrhagic shock [129,130]. Provided appropriate resuscitation, and unless concurrent conditions such as associated trauma or severe inhalation injury hasten the course of the disease, a short phase of relative stability is often observed around day three post-burn, with variations depending on actual burn severity and initial management. Further complications, such as sepsis, acute respiratory distress syndrome, or other organ failures, typically develop afterward. This has long been described as a window of opportunity for safe patient transportation, which should best be achieved by day four post-burn [83]. This window is a theoretical advantage for BMCI response as it would leave appropriate time to organize patient evacuations. Since shock resolution depends on resuscitation, the practicality of this advantage depends on the quality of early management. This stresses the importance of initial national response (see recommendation field 1). US data regarding long-range evacuation of military burn casualties from operations in Iraq and Afghanistan further support the safety of long-range transportation of burn patients on days 3–4 [85]. Due to the long distance between both countries and US mainland territory, US military casualties in these war operations were initially treated in forward surgical facilities and then evacuated to a US military hospital in Landstuhl (Germany). They finally underwent long-range transport to San Antonio military burn center, typically in that range, with a similar outcome as comparable civilian burn patients admitted more directly [85,101,131]. Provided adequate en route critical care, transport under shock is also safe when feasible [132].

4.2.2 – In summary, in a BMCI, MEDEVAC of burn casualties to foreign burn centers should best occur before H96 after injury. In most BMCI situations, such as explosions or violent building fires, the causal event is very limited in time. Injury time should then be estimated by disaster onset time for all casualties. In the European BMCI response plan setting, considering the time needed for plan activation, BAT deployment and task completion, and MEDEVAC organization, MEDEVACs should be performed between H48 and H96 after event.

Q 4.3 – How should mode of evacuation be selected?

R 4.3.1 – The following transport modes, or *vectors*, should be considered: ground transportation, helicopter, or fixed wing aircraft for individual or collective patient evacuation.

R 4.3.2 – Whenever applicable, equal attention should be paid to the three phases of patient transportation: upstream small loop, main loop, and downstream small loop (Fig. 2).

R 4.3.3 – The MEDEVAC vector should be selected based on distance / travel time, number and severity of patients, and complexity of the MEDEVAC implementation. An algorithm is suggested as a tool to guide the decision (Fig. 3).

R 4.3.4 – Roles and responsibilities should be clearly defined for the country affected by the burn mass casualty incident and for countries that contribute MEDEVAC assets (Table 8).

Rationale – 4.3.1 – Transferring patients involves caregivers with appropriate medical assets and an evacuation vector. The latter describes both means of transport and the corresponding professionals to operate them. Proper coordination of MEDEVACs first requires an in-depth knowledge of available assets [133]. MEDEVACs are primarily performed either by air or ground. Due to their low speed, logistical complexity, and low applicability, except for disasters occurring near a seashore, seaborne MEDEVACs have not been considered. Aeromedical evacuation vectors are either fixed-wing (airplane) or rotary-wing (helicopter) aircraft and may transport either single or multiple patients [86,99,126,134]. Ground MEDEVAC vectors are mainly single-patient ambulances. Some states also have ambulance buses for collective transportation of small numbers of patients [133]. In Europe, ground evacuations of multiple casualties by train were standard practice during World War I and almost disappeared after World War II. It found new applications during the COVID-19 crisis, and more recently during the Russian war on Ukraine [135]. All these MEDEVAC vectors should be considered to transport burn casualties from non-specialized primary receiving hospitals to remote burn

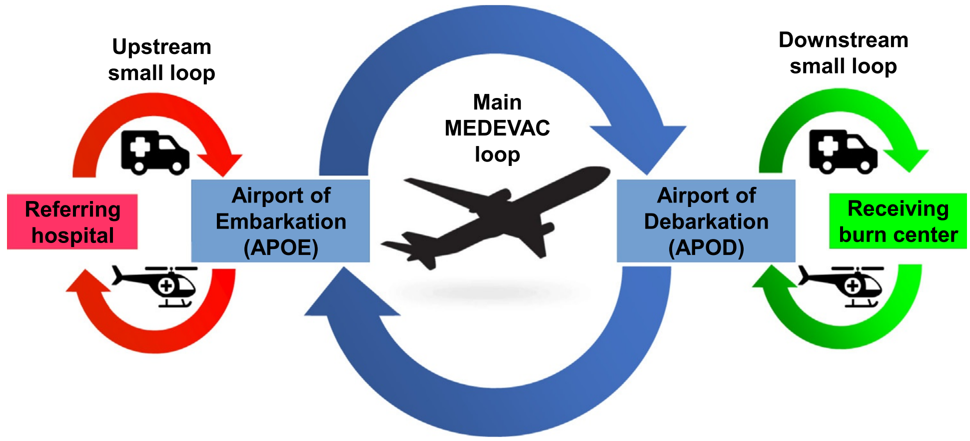


Fig. 2 – General organization of aeromedical evacuations with fixed wing aircraft.

centers, targeting maximum versatility. Burn centers build low-density networks, with rarely more than one in a large city [10–13]. Even with a surge capacity, few of them can receive a large number of casualties at a time. In a BMCI, a large spread of small groups of patients to many different burn centers should thus be anticipated. As a consequence, a combination of multiple MEDEVAC vectors should be preferred. Conversely, unless one single train leaving the affected country can successively stop at several cities with burn centers to disembark patients, and due to its burdensome logistics, the railway likely lacks the required versatility for such patient distribution [135]. Still, it might be a relevant option for the medium range transfer of casualties to countries immediately neighboring the BMCI affected one.

4.3.2 – Whenever transportation requires specific infrastructures for embarkation and disembarkation, end-to-end patient evacuation requires three transport legs, referred to as the main loop and the upstream and downstream small loops, which are typically operated by ground ambulances and less frequently by helicopter (Fig. 2). This organization mainly applies to fixed-wing aeromedical evacuation, which needs airports. It would also apply to railway stations for trains or to ports for boats, should such vectors be considered. In any case, all three phases need equally careful planning and execution.

4.3.3 – The selection of a MEDEVAC vector for a specific patient or group of patients always needs to account for the following parameters: destination hence travel time, number of patients, severity expressed as the level of en route care, and complexity of the considered evacuation mode. Transporting critically ill patients inherently exposes them to risks that need to be minimized [127,136]. Keeping transport time short is one such safety concern. Fixed-wing aircraft are faster than helicopters, which are faster than ground ambulances. But the latter two usually do not require upstream and downstream loops, and ground ambulances are logistically simplest. This simplicity may compensate for the apparent lack of speed. Out of disaster situations, along with technical proficiency, this may contribute to observations of similar outcomes between burn patients transported by ground and those transported by helicopter or between those directly admitted to burn centers and those secondarily transferred [137–139]. Routine overuse of air ambulances to transport patients with low-severity burns is already a waste of resources. It might hide actual outcome differences [140–143]. In a BMCI, misused resources could prevent more severe patients from being timely and quickly evacuated to burn centers, putting them at risk of poorer outcomes.

Vectors and teams could either be public or private assets, provided that they fulfill the requirements of the present guidelines and that their activation can be achieved within the timeframe of recommendation 4.2.2.

Fig. 3 proposes an indicative tool to support the actual selection of evacuation mode to be adjusted to local situations. Critical decision criteria are used as follows. In a BMCI, the duration of transport impacts the transfer conditions of individual patients and joint coordination of MEDEVACs because the time spent on one patient transport may prevent successive rotations. Transport teams and vectors are unavailable for twice to three times the duration of transportation due to the return trip and the potential need for refueling, cleaning, medical resupply and possibly crew replacement or safety break. Therefore, the indicative time threshold proposed for fixed-wing MEDEVAC is three hours. This threshold is likely too low if the embarkation airport is

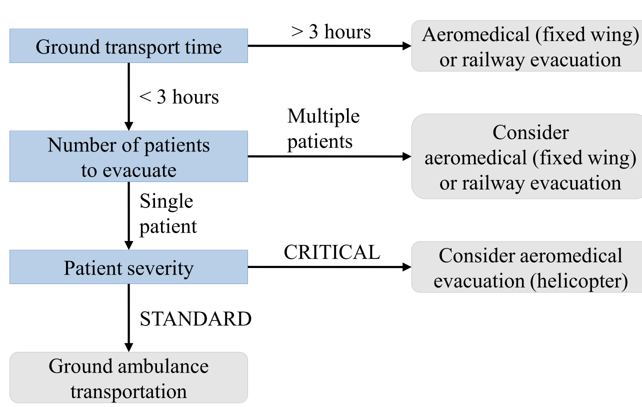


Fig. 3 – Indicative algorithm to help select the mode of evacuation, to be adapted to actually available MEDEVAC teams and vectors and to local logistical constraints.

Table 8 – Roles and responsibilities of the country affected by the burn mass casualty incident and of countries that contribute MEDEVAC assets. *APOE*: airport of embarkation – *APOD*: airport of debarkation – *HLZ* = helicopter landing zone. Ground transportation by train should be organized as transportation by fixed wing aircraft.

Country contribution	Transports performed
BMCI affected country	Upstream small loop (referring hospital→ APOE or initial HLZ)
MEDEVAC / ground transportation (ambulance)	Full range transportation (referring hospital → receiving burn center)
MEDEVAC / helicopter	Full range transportation (HLZ of referring hospital → HLZ of receiving burn center)
MEDEVAC / fixed wing	Main loop (APOE → APOD)
Burn beds	Downstream small loop (APOD or final HLZ → receiving burn center)

far from the hospital, hence the anticipated time loss in the small upstream loop. A large number of patients to evacuate to the same destination should prompt considering one collective evacuation vector rather than a series of ground ambulances if the ground transport time is below yet near this threshold. A critical status should finally lead to selecting the quickest MEDEVAC vector, the small loop included if applicable. In any case, evacuation mode selection would depend on available MEDEVAC teams and vectors and local logistical constraints.

4.3.4 – To ensure the swiftest MEDEVAC process in the international setting of the European BMCI response plan, each MEDEVAC phase should be managed most simply and directly. To that aim, Table 8 summarizes the recommended roles and responsibilities of the countries requesting and offering assistance within the plan. Small loops should be planned for if the referring or receiving hospital only has access to a distant helicopter landing zone. Potential MEDEVACs by rail should be managed similarly to fixed-wing MEDEVACs.

Q 4.4 – *How should evacuation teams be composed?*

R 4.4.1 – For *STANDARD* patients, the transporting team should ensure the level of care of a medical / surgical hospital ward. Its healthcare professionals should also have adequate training and experience in air transportation of patients and acute management of medical emergencies.

R 4.4.2 – The transporting team for *CRITICAL* patients should be composed as described inTable 9, depending on the number of transported patients.

R 4.4.3 – Evacuation teams should not necessarily include burn specialized healthcare professionals.

R 4.4.4 – Evacuation teams who transport children should be trained and experienced in the corresponding level of en route care level for pediatric patients.

Rationale – The present recommendations are given for aeromedical evacuation. They also apply to ground transportation, except that no air transportation training is required.

4.4.1 – 4.4.2 – Besides variable national regulations, published guidelines on inter-hospital transportation of patients are, at best, scarce. They mainly focus on critically ill patients [136]. Underlying evidence is limited, especially regarding long-range aeromedical evacuation of critically ill patients, not to mention burn mass casualties [83,99,127]. Team composition is variable and depends on local regulations. Examples in Northern America may not apply to European countries, where no profession matches respiratory therapists [127]. The team compositions recommended here thus rely on those general guidelines, on shared experience within the EBA disaster committee, and general and burn-specific military practice and published experience [85,86,127,144–146]. For STANDARD and CRITICAL patients, emphasis is placed on MEDEVAC experience and capacity to manage emergencies. For CRITICAL patients, further requirements include critical care experience and team sizing (Table 9).

4.4.3 – In evacuation teams, training and experience in burn care would be optimal if available but they are not strictly required. Based on military expertise, critically ill burned patients can be suitably transported on long distances by non-burn specialized critical care air transport teams [85,145,147]. A recent retrospective study compared US military burn casualties who underwent long-range evacuation either by specialized burn flight teams or by non burn specialized critical care air transport teams. In multivariate analysis, a higher burn severity assessed by higher %TBSA burned was the only factor associated with poorer outcomes, while evacuation team was not [147]. An admittedly important limit of this study was that the casualties with the most severe burns were actually evacuated by burn flight teams. Still, it suggests that proficient critical care transport teams can usually provide appropriate en route care to severe burn patients, even though they are not burn specialized, when they follow appropriate guidelines [148,149].

In a BMCI, burn centers should seek nominal or enhanced staffing to prepare and conduct admission of evacuated casualties, possibly activating a surge capacity. Contrary to burn assessment and triage, where high experience in burn care is vital (see recommendation field 2), experience in critical care transportation should thus prevail over burn care experience in MEDEVAC teams when they cannot have both.

4.4.4 – Pediatric patients deserve specific attention. Pediatric transport teams should be preferred whenever possible, to provide similar care during transportation as in the hospital. If they are too few to handle all pediatric transfers, having them managed by adult teams makes sense. In a regional retrospective study, 333 cases of aeromedical pediatric burn transportation were analyzed, 55% managed by a pediatric care burn flight team and the remaining 45% by alternative flight teams not necessarily specialized in pediatrics. In this series, the overall outcome was similar between both groups, except for a higher incidence of

Table 9 – Minimal composition of a medical evacuation team for *CRITICAL* patients. *ICM*: intensive care medicine – *A*: anesthesiology – *EM*: emergency medicine.

Single patient transportation	Multiple patient transportation
– 1 physician – ICM, A or EM specialist – 1 nurse – trained in ICM, A or EM	– 1 physician – ICM or A specialist (at best with burn training and experience) → *medical mission director* – 1 nurse – trained in ICM or A → *coordinating nurse* – 1 physician – trained in EM, ICM or A / every 4 patients – 1 nurse – trained in EM, ICM or A / every 2 patients
– Personnel trained and experienced in air transportation of critically ill patients – For children, personnel trained and experienced in the care of critically ill pediatric patients	

hypothermia and arterial hypotension on arrival at the burn center [146]. A pediatric team should preferably transport the youngest one between two patients of equally critical severity. Non-pediatric teams could usually manage children older than ten years or above 30 kg without significant difficulty, provided they have suitable equipment.

Q 4.5 – *Which minimal assets should evacuation teams have?*

R 4.5.1 – For each *STANDARD* patient, the minimal transport kit should include assets listed in Table 10.

R 4.5.2 – For each *CRITICAL* patient, the minimal transport kit should include assets listed in Table 11.

R 4.5.3 – A complete emergency kit, with similar composition as for a *CRITICAL* patient, should be available for aeromedical evacuation of *STANDARD* patients. In case of a collective evacuation, at least one emergency kit should be available for a maximum of 10 *STANDARD* patients.

Rationale – The present recommendations are given for aeromedical evacuation. They also apply to ground transportation, except compliance with aviation safety regulations is not needed there.

4.5.1 – 4.5.2 – The lack of supporting data and scarcity of relevant team composition guidelines also applies to equipment and supplies. The minimal transport kits for *STANDARD* and *CRITICAL* patients, respectively given in Tables 10 and 11, are based on the only identified American guidelines, on published equipment lists, and on shared experience within the EBA disaster committee [86,99,126,127,136,150]. These references propose lists of non-burn-specific drugs. They could usefully supplement Tables 10 and 11.

High fluid requirements are a specific issue in the MEDEVAC of severely burned patients [151]. Intravenous fluids should thus be carried according to maximal estimated fluid requirements. A 50% safety margin should be added to the planned transport time to tackle unanticipated delays. When a patient-tailored estimation is impossible, a practical estimation tool is given in Table 12 [145]. It provides a strictly logistical estimate above actual infusion rates. In children, the estimation should also account for dextrose

Table 10 – Minimal transport kit for each *STANDARD* patient.

Equipment & supplies
– Oxygen and aerosol delivery – IV access & fluids (supplemental hydration) – External warming device – Analgesia, thromboembolism prophylaxis and other medications as appropriate

requirements to prevent hypoglycemia, either as a separate infusion or as a supplement in lactated Ringer's (targeting 1% w/v).

Some transport teams have reported using more advanced critical care techniques during patient transportation out of disaster situations. American military burn flight teams have demonstrated the feasibility of in-flight high frequency percussive ventilation for smoke inhalation injury with highly experienced personnel [152]. The same authors reported the first case of in-flight renal replacement therapy with continuous veno-venous hemofiltration during long-distance MEDEVAC of a severely burned patient [153]. But of note, transport time within Europe should be short enough to allow for an acceptably safe transient interruption of renal replacement therapy during MEDEVAC within the European BMCI response plan. In routine civilian settings, extra-corporeal membrane oxygenation (ECMO) during the transport of non-burned critically ill patients has been developing in recent years. Still, its logistical footprint is hefty [154,155]. Evidence of in-hospital ECMO benefits in burn patients is also inconclusive so far. A recent meta-analysis has even suggested a higher risk of death with ECMO [156]. On the whole, in a BMCI situation, due to the complexity of those techniques, the rarity of transport teams able to implement them, and their uncertain benefit so far, they currently cannot be part of recommended technical capabilities for burn MEDEVAC.

4.5.3 – Reported en route complications during long-distance transportation of burn patients are primarily respiratory or hemodynamic events, such as loss of airway, loss of vascular access, dysrhythmia, or pneumothorax [151]. Out

Table 11 – Minimal transport kit for each *CRITICAL* patient.

Equipment	Supplies
– Power supply (batteries / mains power) – Suction, complete with cannulae – Oxygen and aerosol delivery devices – Manual ventilation (bag / valve / mask) – Tracheal intubation kit, – complete with rescue devices – Mechanical ventilator, – complete with tubing and accessories – Infusion pumps – External warming device – Stretcher + bedsore preventing mattress – Monitor (cuff & invasive arterial pressure, ECG, SpO2, EtCO2, neuromuscular blockade) – Portable laboratory exams: blood gases, lactate, hemoglobin, ionogram – Chest tube insertion kit, complete with Heimlich valve – Defibrillator, complete with pads – Portable ultrasound	– Oxygen – Vascular access devices & lines – IV fluids – lactated Ringer's, Albumin – Hypnotics, opioids and neuromuscular blocking agents; non opioid analgesics – Vasopressors & inotropes – Inhaled bronchodilators, mucolytics – Heparin, insulin, antibiotics and other medications as appropriate – Blood products (if associated trauma)

– Pediatric equipment and supplies are required for the transportation of children.
– Preassembled kits with supplies for at least 8 h are advisable.
– Proper integration with the evacuation vector should be sought.
– Compliance with international air transport safety regulations should be ensured.

of disaster situations, autonomy to manage such emergencies is necessary in the air. On the ground, it may be partially mitigated by the possibility of stopping at an intermediate facility or getting reinforcement. A mass casualty situation may impair that possibility. Autonomic capability should thus be sought irrespective of the MEDEVAC vector.

Q 4.6 – *How should patients be prepared for evacuation and managed* en route?

R 4.6.1 – Mission, equipment, supplies and patient preparation should be checked before boarding, advisably using the 3-step checklist provided below (Fig. 4).

R 4.6.2 – Continuity of care should be ensured during the whole transportation process, including upstream and downstream small loops if any, following EBA clinical practice guidelines for the management of burned patients.

R 4.6.3 – Patient monitoring and treatment should be precisely documented through a detailed burn resuscitation flow-sheet, advisably using the one proposed below (Fig. 5).

Table 12 – Estimated maximal amount of intravenous fluids to carry for each *CRITICAL* patient depending on transport duration (adapted from [145]).

	Timing of transport (reference: time of injury)	
	Shock phase (< H48)	Maintenance phase (> H48)
Lactated Ringer's	2 L / h	0.5 L / h
Albumin	40–50 g / h (2 fl. / h)	10–12.5 g / h (½ fl. / h)
	(plus additional 50% safety margin)	

SAFETY WARNING: This is a logistical estimation only, above actual infusion rates.

Rationale – 4.6.1 – Checklists have come to medicine from the aeronautical world, where they have long been a core safety tool. Their usefulness in increasing the safety of patient transportation has already been underlined for in-hospital transfers [157]. It should be even more so for inter-facility transfers. The anticipated gain should be maximum for aeromedical evacuations due to the need for autonomic capability in this setting. A pre-boarding preparation checklist is therefore recommended. The template proposed in Fig. 4 has been adapted from a 3-step checklist designed explicitly for the aeromedical evacuation of burn patients [145].

4.6.2 – The essence of MEDEVAC is to ensure continuity of care during patient transport. Compliance with existing international recommendations ensures minimal reproducible standards of care. In Europe for burn patients, EBA clinical practice guidelines are the shared reference to that aim [28]. Despite existing differences, their overall coherence with the ISBI clinical practice guidelines strengthens their value [26,27].

Particular attention should be paid to the following supplementary points, which are specific of burn MEDEVAC. Loss of airway or vascular access is the most frequently reported adverse event during MEDEVAC [151]. All tubes or cannulae should thus be securely fastened or sutured to the patient and closely monitored during evacuation. Mechanical

AEROMEDICAL EVACUATION OF BURN PATIENTS

Pre-boarding preparation checklist

Date / time :
Patient ID :
MEDEVAC physician :

Check relevant items in frames 1 and 3. Check availability of data in frame 2 and confirm compatibility with transportation
In italics : essential items for burn patients

1 – Equipment and supplies – mostly checked before inbound flight	
☐	Full equipment for aeromedical evacuation, complete, verified and functional
☐	*Infusion pumps (at least 2), electrical syringe pumps (at least 4)*
☐	*Conventional ventilator sufficient ; if not, trained personnel and complete functional equipment*
☐	*Lactated Ringer (+ dextrose for children) : maximum foreseeable volume*
☐	*Albumin : maximum foreseeable volume*
☐	Other fluids
☐	Oxygen : maximum foreseeable consumption
☐	Vasopressors / inotropes (at least norepinephrine & epinephrine)
☐	Current anti-microbial treatments
2 – Patient medical data – ***updated burn assessment sheet (R 2.5.2) = minimal required data set***	
☐	Identity, contact (family, next of kin)
☐	Location and time of arrival confirmed by receiving team or DG-ECHO / ERCC
☐	Medical and surgical history
☐	*Date and time of burns, TBSA, location of burns (Lund & Browder chart), photographs,* *circumferential 3rd degree & location, escharotomies already performed*
☐	*Inhalation injury*
☐	Associated injuries, urgent surgical procedures already performed
☐	Infection or colonisation Microbiological results, local/general anti-microbial treatment Isolation if multi-drug resistant bacteria
☐	Recent evolution
☐	Current organ failures (N / S = stabilized / E = evolving but transportation OK / Y = not transportable) Respiratory – Haemodynamic – Neurological – Renal – Hepatic – Haematologic
☐	**CONCLUSION : Patient transportable Y / N**
3 – Patient preparation	
☐	If spontaneous breathing, confirm absence of indication to intubate
☐	Endotracheal tube: correctly placed, unobstructed, *securely fastened*; balloon inflated with water
☐	Pneumothorax: efficient unobstructed drainage, *securely fastened*, Heimlich valve & collector OK
☐	Mechanical ventilation: adequately set, patient adapted, humidification OK
☐	*Venous access: reliable, securely fastened*, unobstructed; accessible injection sites Infusion fluids in plastic bag or with altitude air entry; flow checked
☐	*Arterial access: reliable, securely fastened*, unobstructed; accessible sampling site Arterial pressure tubing compatible with monitor, pressurized without bubble
☐	*Urinary catheter: correctly placed, unobstructed, with collector graduated for small volumes*
☐	Gastric tube correctly placed, unobstructed; gravity drainage or mild suction; empty stomach
☐	Sedation ongoing & adequate
☐	*Dressing: clean, properly closed, changed less than 24h ago*
☐	Associated injuries External fixators: visible; protection on pins / wires Surgical incisions & drains: identified, accessible, without active bleeding
☐	Monitoring: correctly placed & functional
☐	Thermal protection

Fig. 4 – Pre-boarding preparation check-list (modified from [145]). All relevant items in steps 1 and 3 should be checked. Data items in step 2 should be available, either in full or at least through an updated burn assessment form (R 2.5.2), and suitability for transportation should be confirmed. ***In italics: essential items for burned patients.***

ventilation, if any, should be optimized with proper corrections for altitude, low pressure, and related hypoxia [158–160]. If applicable, appropriate adjunctive therapies for smoke inhalation injury should not be interrupted. Transport teams should be aware of the typically hypermetabolic state of severe burn patients after the initial shock phase, who usually require high minute ventilation and present with hyperthermia even without infection. Due to a high risk of

BURN RESUSCITATION FLOWSHEET

Date		**Initial treatment facility**					
Name		**Date & time of injury**		**Pre-burn weight (kg)**		**%TBSA burned (without 1st deg.)**	
MEDEVAC		**Target treatment facility**					

H from burn	**Local time**	**Fluid infusion (mL/h)**			**Total fluids (mL)**	**Urine output (mL)**	**BD * / LAC (mmol/L)**	**Heart rate (bpm)**	**Art. P S / D (m) (mmHg)**	**EPI*/NOR (µg/kg /min)**
		LR **	**Albumin**							

Additional information (trace all actions & treatments with timing) :

* : select appropriate
** : LR supplemented with dextrose (target 1 % w/v) if patient is a child

Fig. 5 – Burn resuscitation flow sheet (modified from [149,165,166]).

resistant strain dissemination in a BMCI, hygiene precautions should be ensured at all times during MEDEVAC [161]. Finally, even in STANDARD patients, it is advisable to follow pre-operative fasting recommendations in order to ease dressing changes under general anesthesia directly upon arrival at destination burn center [162–164].

4.6.3 – Finally, documenting en route observations and interventions is critical for the accurate information of the receiving burn center. To that aim, the usual medical transport record, if any, may be the most appropriate support as it complies with the routine workflow of the transport team. If no such document is available or if it is ill-adapted to burn casualties, a template burn resuscitation flow sheet is proposed in Fig. 5. It has been modified from an American document developed by the American military for their burn casualties [149,165,166].

Author contributions

NM (past EBA president) tasked the EBA disaster committee with this work. Literature searches: TL, SKA. Supplementary literature: FS, SJ and NM. Disaster response and European Union specific content: JALB, AB. Elaboration of recommendations: SKA, TL, FS, SJ, JRMM, CHvdV. Manuscript draft: TL. Revising and finalizing manuscript: TL, FS, SJ, JRMM, ChvdV, AB, JALB, NM, SKA.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests. Thomas Leclerc: no conflict of interest to declare. Folke Sjöberg: no conflict of interest to declare. Serge Jennes: no conflict of interest to declare. José Ramón Martinez-Mendez: no conflict of interest to declare. Cornelis H. van der Vlies: no conflict of interest to declare. Anna Battustitta: no conflict of interest to declare. J. Alfonso Lozano-Basanta: no conflict of interest to declare. Naiem Moiememen: no conflict of interest to declare. Stian K. Almeland: no conflict of interest to declare.

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