PERSPECTIVE

Application of the Haddon Matrix to Civil-Military Interaction in Disaster Relief Operations

Applicazione della Matrice di Haddon ad Operazioni di disaster relief con interazione civile-militare

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Abstract - Civil-Military Interaction can give a relevant contribution to humanitarian-led Disaster Relief. These operations can be analyzed by means of Military After Action Reports allowing for a continuous improvement process in terms of planning toward a more comprehensive preparedness posture in disaster response. The COVID pandemic highlighted the relevance of the topic within the field of Public Health. Globally, Armed Forces readily supported their civilian counterparts, both in national and international contexts. Collection of reliable data has always been a challenge in disaster contexts. In addition, Military data is often aggregated and subject to secrecy. By means of its "dissect and conquer" approach towards complex, unconventional problems, the Haddon Matrix is a useful analysis tool in evaluating the synergic effect of Civil-Military Interaction within the Disaster Cycle. An evaluation of efficacy can be added in the third dimension of the Matrix introducing indicators derived from Health Economics. Relevant differences can be found analyzing Civil-Military Interaction support in the context of Disaster Relief operations following a natural catastrophe or within a primary Public Health emergency. The Haddon Matrix can dissect, analyze and subsequently improve the support given by the Military in case of lack, insufficiency or destruction of health services following a disaster. Such analysis guides focused preparation efforts towards cost effective choices in terms of both appropriately trained personnel and required equipment.

Riassunto - L'interazione Civile-Militare può dare un contributo rilevante alle operazioni di Disaster Relief umanitarie. Queste Operazioni possono essere analizzate con Rapporti strutturati post-evento che consentano un continuo processo di miglioramento in termini di pianificazione verso uno stato di preparazione più ampio in ambito di risposta ai disastri. La pandemia da COVID-19 ha sottolineato la rilevanza dell'argomento in ambito di Salute Pubblica. In tutto il mondo le Forze Armate hanno supportato la controparte civile, in contesto nazionale ma anche internazionale. La raccolta di dati affidabili è sempre stata una sfida in contesto di disastro. Inoltre, i dati militari sono spesso aggregati e soggetti a segretezza. Grazie al suo approccio "dissect and conquer" verso problemi complessi e non convenzionali, la Matrice di Haddon appare come uno strumento di analisi utile nella valutazione dell'effetto sinergico derivato dall'Interazione Civile-Militare nell'ambito del Ciclo dei Disastri. Una valutazione di efficacia può essere aggiunta alla terza dimensione della Matrice mediante applicazione di indicatori mutuati dall'Economia Sanitaria. Differenze rilevanti possono essere evidenziate analizzando la risposta di Disaster Relief con Interazione Civile-Militare a disastri naturali e ad emergenze primariamente di Sanità Pubblica. La Matrice di Haddon può dissezionare, analizzare e quindi migliorare il supporto che i Militari riescono a dare in caso di mancanza, insufficienza o distruzione di servizi sanitari a seguito dell'impatto di un evento disastroso. Questa analisi può guidare sforzi di preparazione rivolti verso scelte che siano efficaci in termini di personale addestrato adeguatamente ed equipaggiamento appropriato.

Key Words: Civil-Military Interaction, Disaster Medicine, Haddon Matrix, Natural Disaster, Public Health emergency.

Key Messages:

- Disasters are complex and unconventional events: their impact and the subsequent response operations cannot be analysed effectively by means of traditional Epidemiology.
- The Haddon Matrix can be used by Armed Forces participating in Disaster Relief operations with CMI as a structured After-Action Report tool aiming for a more effective preparedness posture.

Introduction

"Disaster" and "catastrophe" are often used as synonyms. The first derives from the French "*désastre*", in turn coming from the Latin prefix *dis-* ("in lack of" or "bad") and *-aster* ("star"): litterally "under a bad star", recalling a natural calamity striking unexpectedly under a malevolent celestial influence. "Catastrophe" comes from the late Latin *catastrŏpha*, which in turn derives from the Greek καταστροή,

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"upheaval", referring to the unexpected and painful outcome of an unfortunate event. Defining the concept of "disaster" is not an easy task. The event must be first "quantified" in scale and contextualized in time and space, the latter not merely in a geographical sense, but also in a specific sociocultural *milieu*. The noun "disaster" is a sponge word: it takes a different meaning based on the context in which it is used: disasters "*can be more easily recognized than defined*" (1). A high magnitude earthquake causing hundreds of victims is undoubtedly a disaster. However, a car crash causing less than ten injuries can be considered a disastrous event if it takes place in a rural area served only by a small first aid facility. Therefore, regardless of the scale considered, any event capable of overwhelming or destroying both the response capacity and the social structure of the affected area, is often acknowledged as a "disaster" (2, 3). Such complex; unconventional events do not fit into traditional epidemiological studies. The subsequent multisectoral response is also a complex operation, based upon the highly regulated interplay among national and often foreign military and non-military actors, as well as multiple organizations (4, 5, 6). Disaster Relief operations with CMI support need flexible and appropriate After-Action Reports for analysis. We are currently witnessing a paradigm shift: from regulatory frameworks designed merely for natural or man-made events, towards the development of more flexible guidelines and principles applicable to a broad range of contexts, including complex Public Health emergencies. The recent COVID pandemic highlighted the relevance of CMI operations within the field of Public Health: globally, Armed Forces readily supported their civilian counterparts, both in national and international contexts (7). These combined efforts were protracted in time, challenging sustainability. More typically, the Military offers highly specialized supporting capacities within a neatly defined window in terms of space and time (8, 9). The Military are often employed by governments as actors of the response to a disaster: while this is expected in national contexts, the deployment of Foreign Military Assets (FMA) can give birth to conceptual frictions (10). A potential controversy stems from the fact the Military cannot abide by all the Humanitarian Principles: they are the ultimate expression of a government and therefore can seldom be considered neutral nor independent. The security of humanitarian actors and their possibility of access to the affected areas depend upon a clear distinction of roles played by military and non-military actors within the area of operations. Given this potential conceptual controversy due to the employment of FMA, the UN recommends their involvement only as a "*last resort*": CMI should be involved only when the civilian response is overwhelmed, or when demand is too high for available civilian/humanitarian assets (11, 12). However, recent Disaster Relief operations might suggest that military assets can be readily employed if they are the best option for a rapid and effective response in the peculiar context in which the disaster stroke. The UN and NATO are constantly working towards more structured guidelines for CMI: this "synergy" between military and non-military actors can give a relevant contribution to humanitarian-led Disaster Relief worldwide (13, 14).

The Haddon Matrix

The Haddon Matrix is a theoretical model developed in the 1970s by Dr. William Haddon Jr with the aim of finding solution-oriented preventive strategies and reducing morbidity/mortality related to road accidents (15). Recently, several works proposed the application of such analytical tool to a broad range of Public Health interventions connected to Disaster Medicine. With its "*divide and conquer approach*", the Matrix allows to open and literally break down a complex and unconventional problem into its smaller components. The grid gives a big picture of the multiple constitutive elements: such analysis favors a gradual and thorough understanding of the underlying etiological mechanisms. This process identifies phase-targeted interventions and preventive strategies addressing single components of a more complex issue (16). A logical consequence of this analysis is an appropriate and structured resource allocation in preparation for future events.

The Matrix is composed of four columns and three rows ***(Tab. 1)***. The four columns are named after the so-called "determinant factors":

1. **Host**: subject/s at risk, potential victim/s showing susceptibility to the studied injury mechanism.
2. **Agent**: "impacting force", either animate as a biological vector, or inanimate as a form of energy (thermal, radiant, chemical or electrical energy, but also the magnitude of an earthquake).
3. **Physical environment**: the actual environment where the disastrous event takes place, whose constitutive elements do participate to the mechanism of injury.
4. **Socio Cultural environment/ Organizational culture**: the set of norms, practices, guidelines of the community stricken by the impact of the disastrous event, the socio political *milieu* around the mechanism of injury. This involves also an organizational perspective and a legal stand-

Tab. 1 - Overview of the Haddon Matrix with CMI in the fourth column.

INFLUENCING FACTORS				
TEMPORAL PHASES (continuum)	**POTENTIAL HOST**	**AGENT/VECTOR**	**PHYSICAL ENVIRONMENT**	**SOCIAL ENVIRONMENT/ ORGANIZATIONAL CULTURE**
PRE-EVENT (T-1) Readiness phase	Risk assessment: 3 major potential risks in the following 6 months Identification of the principal medical problem due to the characteristics of the most probable scenarios Analysis of risk perception Risk communication Primary prevention interventions: vaccination prophylaxis, focused training based on principal medical problem continuous study and research simulation training based upon probable scenarios Community education: building capacity of timely response to early warning systems	Properties of impacting agent: biological (animate vector) chemical physical (es. magnitude of an earthquake) radiological inanimate agent: form of energy (es. thermal, radiant, chemical, electrical) mass destruction weapons potential of engineering of agents to produce unexpected intentional effects Knowledge of different types of agents Existence of functioning early warning systems	Existing infrastructure (Hospitals), their number and location in the potentially affected area Vulnerability analysis (supply and creation/augmentation of logistic chains for water/food/medicines other resources) Coexisting factors of sociocultural vulnerability: presence of conflict in the same area At risk populations in areas that are difficult to access Proximity to high-risk areas (hydrogeological, seismic…) Operability of communication systems Telemedicine State of transport infrastructure Presence of and relative distance from airports/heliports Distance from the sea	Diffusion of culture of preparedness Risk assessment: 3 major potential risks in the following 6 months Analysis of risk perception Preparedess posture Operational surveillance Effective management of supply chains Readiness of supply chains Allocation of resources according to budget Interagency training involving all the actors of the potential Response Operation (large scale simulations and training involving CMI): from single Armed Forces to international level Continuous study and research Simulation training based upon probable scenarios Preparation planning based on lessons learned Structured analysis of previous operations Choice of appropriate material (type, quantity) and preparation of logistic chains Preparation of personnel (study, research, training) Knowledge of measures to contain the spread of secondary infectious diseases Individual and collective protective measures Identification of key resources and eventual gaps in organization Liaison for eventual international and interagency response Already tested Incident Command System (chain of command, knowledge of roles) Comunicazioni: testare i sistemi (accordi anticipati con le Forze Armate per comunicazioni in emergenza) Interagency planning of emergency response (establishment of intermediate objectives, timing and entity of response) Inclusion of CMI in planning considerations
EVENT (T0) Crisis	Crisis communication Public Health interventions on affected community (secondary prevention) based upon principal medical problem Crisis triage decontamination post-exposure prophylaxis isolation/quarantine Management of trauma and Crush Syndrome	Disease or trauma caused by agent Identificationof principal medical problem: planning and resources defined accordingly Number of victims/casualties Technical capacity to identify the causative agent	Preparedness posture of infrastructure Rapidly accessible economic resources, supplies Clinical, surgical, diagnostic, hospitalization Surge capacity Increase in hospitalization capacity (eventual use of hospitalization capacity of military naval units or field hospitals in adjunct)	Response to impact: implementation and adherence of emergency response plans (previously established and tested) Interagency First response according to previous planning (national/international level, civil response, necessity of military support) Activation of Incident Command System Emergency communications (with eventual military support) Management of communication towards media and journalists

INFLUENCING FACTORS				
TEMPORAL PHASES (continuum)	**POTENTIAL HOST**	**AGENT/VECTOR**	**PHYSICAL ENVIRONMENT**	**SOCIAL ENVIRONMENT/ ORGANIZATIONAL CULTURE**
EVENT (T0) Crisis	Evacuation from affected area Resettlement of displaced population Food and water: supply and hygiene Essential goods Support to displaced population/to pulation in isolation or quarantine Personal protective equipment (PPE) Psychological support	Response to the impact: contrast interventions Acute impact on health of affected population (ex. trauma, spread of infection) Acute impact on mental health of affected population and of personnel Management of immediate consequences (ex. Crush Syndrome)	Telemedicine Resettlement of displaced population/support of population in isolation or quarantine Emergency access to transportation Possibility of evacuation	Surge capacity: role of CMI Possible level of CMI: cooperation, coordination, coexistence (depending on the situation of peacetime or coexisting conflict in the area of operations) Surge of support capacity Evacuation Food and water: supply and hygiene Essential goods Rapid implementation of secondary prevention interventions to prevent secondary Public Health emergencies (sanitary conditions) Prevention of possible spill-over Possibility of access to and egress from affected area Restore access to affected areas/communication systems/transport infrastructure if damaged/destroyed Restore access to hospital infrastructure/field hospitals Possibility of egress and evacuation by land, air, sea Early Transition: from CMI response to local civil response
POST-EVENT (T+1) Management of sequelae	Risk communication Analysis of risk perception Mitigation of impact Recovery/reconstruction/ reorganization Management of sequelae (both physical and psychological) Psychological support to survivors and personnel Post-event surveillance for early detection of secondary Public Health emergencies	Long-lasting impact of agent Management of sequelae (both physical and psychological) Reaction of the agent towards mitigation/elimination/ reconstruction efforts Eventual persistence of the agent in the affected area	Application of lesson learned and After Action Report as a guide during reconstruction in order to lessen vulnerability of infrastructure	Risk communication After Action Report Analysis and application of lesson learned: improvement of surge capacity and overall organization (from single hospital level, up to the level of governmental organizations or Armed Forces) Continuous Follow-up Management of eventual persistence of the agent in the affected area Management of sequelae Post-event surveillance for early detection of secondary Public Health emergencies Reconstruction Mitigation Prevention Economic impact on affected community Focus on building local capacity for early transition and better resilience

point, such as, for instance, the existence of restrictions against harmful behaviors in a given context (16).

The three rows of the grid reflect the temporal sequence of events. Sometimes the impact of the disastrous event is punctual, clearly defined in time. In case of a slow-onset disaster, an index starting event can be arbitrarily defined, or a sequence of events can be established. The rows are filled following the continuum of the various phases of the traumatic mechanism, each requiring specific Public Health interventions:

1. **Pre-event (“*pre-crash*”)**: the phase

preceding the impact during which primary preventive strategies can prevent or reduce harmful effects derived by the impact/contact between the agent and a susceptible host. This phase also includes readiness, preparedness posture towards a potential impact, risk evaluation and risk communication.

2. **Event ("*crash*")**: moment - or period - of actual impact of the agent. The interaction of a given form of energy or of a biological vector with susceptible structures of the host initiates the so-called "crisis" phase. This period includes crisis communication, evaluation of damage, triage and emergency medical treatment of victims, counselling and psychological support, Public Health actions such as, in the case of an infectious disease outbreak, post-exposure prophylaxis, isolation, quarantine.
3. **Post-event (*post-crash*")**: management of the consequences, either immediate or long-term. This phase comprises an acute response phase, immediately following the impact. Once the process of damage has started all the efforts should be focused on the chances of rescue. There is also a later phase of recovery/reconstruction, management of long term physical and psychological sequelae, mitigation of the effects of the impact. A systematic analysis should be performed by means of a structured After Action/Event Report. The evaluation of lessons learned allows for subsequent renewed preparation for future events (16).

A third dimension can be added to the Matrix: the depth can allow the insertion of outcome measures of effectiveness derived from Health Economics (17). A seemingly insurmountable component of the broader issue might result in more manageability when considered in a different phase. Filling the cells of the Matrix equals finding a list of possible strategies towards a broad range of Public Health threats, such as the evaluation of preparedness of hospital infrastructures against earthquakes (18), the organization of mass gatherings (19), possible countermeasures against asymmetrical warfare and terrorism (20), the COVID pandemic and the preparedness posture of a given community (21).

Application of the Haddon Matrix to Military After Action Reports for Disaster Relief operations with CMI

To the best of our knowledge, the Haddon Matrix has never been used by Armed Forces as a structured After-Action Report analyzing the contribution of CMI to Disaster Relief operations. CMI can be included in the fourth column, under the heading "Organizational Culture". We propose two hypothetical applications of the Haddon Matrix as After-Action Report: the first is a model focused on the response to an elevated magnitude earthquake ***(Tab. 2)***, while the second concerns the response implemented towards an infectious disease outbreak ***(Tab. 3)***. Given its flexibility, the Matrix can be seen as a multidimensional analytical tool allowing a multisectoral brainstorming process and continuous improvement towards a more effective and focused preparedness posture. The whole set of discrete items filling the cells outlines a continuum from preparation to implementation of the response after the impact, recovery/reconstruction and mitigation (22). This structured analysis defines which capabilities should be prioritized in preparation against future events, in terms of both cost effectiveness and appropriateness. Armed Forces should focus their preparation efforts on skills that might be used for support in multiple scenarios, from natural/man-made disasters to terrorist attacks or infectious disease outbreaks with pandemic potential (23). This analysis allows the individuation of eventual gaps: Military capacities and skills are often called in to fill these gaps. Specific military assets are surge capacity with enormous logistical reserves, highly trained personnel rapidly deployable, aeromedical evacuation with biocontainment flights for highly infectious patients, an already functioning hierarchical structure with clear chain of Command, versatile and highly capable communication systems, readily deployable field hospitals, military ships with reconfigurable assets. Finally, the items filling the cells can be used as Intermediate Objectives as Process Indicators during or after Disaster Relief operations with CMI in response to similar, future events (24).

Discussion

The Matrix appears as a useful analytical tool for Armed Forces taking part in CMI operations for Disaster Relief. Applying such a theoretical instrument results in more focused organization of logistic chains, appropriate choice of assets apt for the specific type of event, identification of useful training and study/research activities. Organizational gaps identified thanks to the Matrix can be filled by ad hoc exercises and simulations involving all the actors involved at national but also international level. The synergy between military and civilian support actions gives a combined effect that is greater than the sum of the single contributions (25).

Tab. 2 - Example of the Haddon Matrix with CMI in the fourth column: Disaster Relief after a major earthquake.

INFLUENCING FACTORS				
TEMPORAL PHASES (continuum)	**POTENTIAL VICTIM**	**AGENT/VECTOR**	**PHYSICAL ENVIRONMENT**	**SOCIAL ENVIRONMENT/ ORGANIZATIONAL CULTURE**
PRE-EVENT (T-1) Readiness phase	Risk assessment: 3 major potential risks in the following 6 months Identification of the principal medical problem due to the characteristics of the most probable scenarios Analysis of risk perception Risk communication Primary prevention interventions: *focused training based on principal medical problem (Traumatic injuries, Crush Syndrome)* *continuous study and research,* *simulation training* Community education: building capacity of timely response to early warning systems	Properties of impacting agent: magnitude of an earthquake Knowledge of the type of impacting energy Anticipation of expected consequences Existence of functioning *early warning systems*	Existing infrastructure (Hospitals), their number and location in the potentially affected area Vulnerability analysis (supply and creation/augmentation of logistic chains for water/food/medicines other resources) Coexisting factors of sociocultural vulnerability: presence of conflict in the same area At risk populations in areas that are difficult to access Proximity to high-risk areas (hydrogeological, seismic…) Operability of communication systems Telemedicine State of transport infrastructure Presence of and relative distance from airports/heliports Distance from the sea	Diffusion of culture of preparedness Risk assessment: 3 major potential risks in the following 6 months Analysis of risk perception Preparedess posture Operational surveillance Effective management of supply chains Readiness of supply chains Allocation of resources according to budget Interagency training *involving all the actors of the potential Response Operation* (large scale simulations and training involving CMI): from single Armed Forces to international level *Continuous study and research* *Simulation training based upon probable scenarios* Preparation planning based on lessons learned Structured analysis of previous operations Choice of appropriate material (type, quantity) and preparation of logistic chains Preparation of personnel (study, research, training) Knowledge of measures to contain the spread of secondary infectious diseases Individual and collective protective measures Identification of key resources and eventual gaps in organization *Liaison* for eventual international and interagency response Already tested *Incident Command System* (chain of command, knowledge of roles) Comunicazioni: testare i sistemi (accordi anticipati con le Forze Armate per comunicazioni in emergenza) Interagency planning of emergency response (establishment of intermediate objectives, timing and entity of response) Inclusion of CMI in planning considerations
EVENT (T0) Crisis	Crisis communication Public Health interventions on affected community (secondary prevention) based upon principal medical problem: trauma *Crisis triage* *Management of trauma and Crush Syndrome* *Evacuation from affected area Resettlement of displaced population*	Traumatic injury caused by agent Identification of principal medical problem: planning and resources defined accordingly Number of victims/casualties	Preparedness posture of infrastructure Rapidly accessible economic resources, supplies *Clinical, surgical, diagnostic, hospitalization* *Surge capacity*	Response to impact: implementation and adherence of emergency response plans (previously established and tested) *Interagency First response* according to previous planning (national/international level, civil response, necessity of military support) Activation of *Incident Command System* Emergency communications (with eventual military support) Management of communication towards media and journalists

INFLUENCING FACTORS				
TEMPORAL PHASES (continuum)	**POTENTIAL VICTIM**	**AGENT/VECTOR**	**PHYSICAL ENVIRONMENT**	**SOCIAL ENVIRONMENT/ ORGANIZATIONAL CULTURE**
EVENT (T0) Crisis	Food and water: supply and hygiene Essential goods Support to displaced population PPEs Psychological support	Technical capacity to identify the causative agent Response to the impact: contrast interventions Acute impact on health of affected population (ex. trauma, spread of secondary infections) Acute impact on mental health of affected population and of personnel Management of acute consequences (ex. Crush Syndrome)	Increase in hospitalization capacity (eventual use of hospitalization capacity of military naval units or field hospitals in adjunct) Telemedicine *Resettlement of and support to displaced population* Emergency access to transportation Possibility of evacuation	*Surge capacity:* role of CMI Possible level of CMI: cooperation, coordination, coexistence (depending on the situation of peacetime or coexisting conflict in the area of operations) Surge of support capacity Evacuation Food and water: supply and hygiene Essential goods Rapid implementation of secondary prevention interventions to prevent secondary Public Health emergencies (sanitary conditions) Possibility of access to and egress from affected area Restore access to affected areas/communication systems/transport infrastructure if damaged/destroyed Restore access to hospital infrastructure/field hospitals Possibility of egress and evacuation by land, air, sea Early Transition: from CMI response to local civil response
POST-EVENT (T+1) Management of sequelae	Risk communication Analysis of risk perception Mitigation of impact Recovery/reconstruction/ reorganization Management of sequelae (both physical and psychological) Psychological support to survivors and personnel Post-event surveillance for early detection of secondary Public Health emergencies	Long-lasting impact of agent Multiple, repetitive seismic activities Management of sequelae (both physical and psychological)	Application of *lesson learned* and *After Action* Report as a guide during reconstruction in order to lessen vulnerability of infrastructure	Risk communication *After Action Report* Analysis and application of lesson *learned:* improvement of *surge capacity* and overall organization (from single hospital level, up to the level of governmental organizations or Armed Forces) Continuous *Follow-up* Management of long term consequences and eventual multiple, repetitive seismic activities Post-event surveillance for early detection of secondary Public Health emergencies Reconstruction Mitigation Prevention Economic impact on affected community Focus on building local capacity for early transition and better resilience

From a medical standpoint, there is a crucial necessity: training and equipment must be tailored to the main medical problem that the actors will probably encounter, based upon the result of risk analysis highlighting the most probable event in the studied area. The value of the Matrix as a theoretical model resides in its applicability to a broad range of Public Health threats, whose complexity will likely escalate due to, among other reasons, increasing scale and frequency of catastrophic events triggered by climate change. Armed Forces need systematic performance analysis tools, not just unstructured lessons learned or cumbersome, qualitative frameworks focused merely on the civilian standpoint

Tab. 3 - Example of the Haddon Matrix with CMI in the fourth column: Disaster Relief during a global pandemic.

INFLUENCING FACTORS				
TEMPORAL PHASES (continuum)	**POTENTIAL VICTIM**	**AGENT/VECTOR**	**PHYSICAL ENVIRONMENT**	**SOCIAL ENVIRONMENT/ ORGANIZATIONAL CULTURE**
PRE-EVENT (T-1) Readiness phase	Risk assessment: 3 major potential risks in the following 6 months Identification of the principal medical problem due to the characteristics of the most probable scenarios Analysis of risk perception Risk communication Primary prevention interventions: *vaccination prophylaxis, focused training based on principal medical problem: spread of infectious disease* *continuous study and research* *simulation training* Community education: building capacity of timely response to *early warning systems*	Properties of impacting agent: biological (animate vector) outbreak of zoonosis? potential of engineering of agents to produce unexpected intentional effects? Knowledge of different types of agents Existence of functioning *early warning systems*	Existing infrastructure (Hospitals), their number and location in the potentially affected area Vulnerability analysis (supply and creation/augmentation of logistic chains for water/food/medicines other resources) Coexisting factors of sociocultural vulnerability: presence of conflict in the same area At risk populations in areas that are difficult to access Proximity to high-risk areas (hydrogeological, seismic…) Operability of communication systems Telemedicine State of transport infrastructure Presence of and relative distance from airports/heliports Distance from the sea Eventual restrictions to international travel Supply of PPEs, autonomous chains of production Checklists and algorithms to counter the spread of the infection	Diffusion of culture of preparedness Risk assessment: 3 major potential risks in the following 6 months Analysis of risk perception Preparedess posture Operational surveillance Effective management of supply chains Readiness of supply chains Allocation of resources according to budget Interagency training *involving all the actors of the potential Response Operation* (large scale simulations and training involving CMI): from single Armed Forces to international level *Continuous study and research* *Simulation training based upon probable scenarios* Preparation planning based on lessons learned Structured analysis of previous operations Choice of appropriate material (type, quantity) and preparation of logistic chains Preparation of personnel (study, research, training) Knowledge of measures to contain the spread of secondary infectious diseases Individual and collective protective measures Identification of key resources and eventual gaps in organization *Liaison* for eventual international and interagency response Already tested *Incident Command System* (chain of command, knowledge of roles) Comunicazioni: testare i sistemi (accordi anticipati con le Forze Armate per comunicazioni in emergenza) Interagency planning of emergency response (establishment of intermediate objectives, timing and entity of response) Inclusion of CMI in planning considerations
EVENT (T0) Crisis	Crisis communication Public Health interventions on affected community (secondary prevention) based upon principal medical problem	Modes of transmission of infection Identification of principal medical problem: spread of infectious disease - planning and resources defined accordingly	Implementation of Incident Command System to control infection spread Preparedness posture of infrastructure Rapidly accessible economic resources and supplies	Response to impact: implementation and adherence of emergency response plans (previously established and tested) *Interagency First response* according to previous planning (national/international level, civil response, necessity of military support) Activation of *Incident Command System* Emergency communications (with eventual military support) Management of communication towards media and journalists

INFLUENCING FACTORS				
TEMPORAL PHASES (continuum)	**POTENTIAL VICTIM**	**AGENT/VECTOR**	**PHYSICAL ENVIRONMENT**	**SOCIAL ENVIRONMENT/ ORGANIZATIONAL CULTURE**
EVENT (T0) Crisis	*Crisis triage* *decontamination* *post-exposure prophylaxis* *isolation/quarantine* *of trauma and Crush Syndrome* *Medical Evacuation towards higher level facilities* *Resettlement of displaced population* Food and water: supply and hygiene Essential goods Support to population in isolation or quarantine PPEs Psychological support	Number of victims/infected patients Technical capacity to identify the causative agent (swabs, lab tests) Response to the impact: contrast interventions Acute impact on health of spread of infection on the affected population Acute impact on mental health of affected population and of personnel Management of immediate consequences: complications (as organ failures)	*Clinical, surgical, diagnostic, hospitalization* *Surge capacity* Eventual use of hospitalization capacity of military naval units or field hospitals in adjunct Telemedicine *Resettlement of and support to displaced population* Emergency access to transportation Possibility of evacuation	*Surge capacity:* role of CMI Possible level of CMI: cooperation, coordination, coexistence (depending on the situation of peacetime or coexisting conflict in the area of operations) Surge of support capacity Evacuation Food and water: supply and hygiene Essential goods Rapid implementation interventions to prevent secondary Public Health emergencies (sanitary conditions) Possibility of access to and egress from affected area/ Restrictions to travel Restore access to affected areas Restore communication systems/transport infrastructure if damaged/destroyed Restore access to hospital infrastructure/field hospitals Possibility of egress and evacuation by land, air, sea Early Transition: from CMI response to local civil response
POST-EVENT (T+1) Management of sequelae	Risk communication Analysis of risk perception Mitigation of impact Recovery/reconstruction / reorganization Management of sequelae (both physical and psychological) Psychological support to survivors and personnel Post-event surveillance for early detection of secondary Public Health emergencies	Long-lasting impact of agent Management of sequelae (both physical and psychological) Reaction of the agent towards mitigation/elimination/ reconstruction efforts Eventual persistence of the agent in the affected area: endemic infection	Application of *lesson learned* and *After Action Report* as a guide during reconstruction in order to lessen vulnerability of infrastructure Replenishment of supplies (PPEs, medical equipment, vaccines, drugs)	Risk communication *After Action Report* Analysis and application of *lesson learned*: improvement of *surge capacity* and overall organization (from single hospital level, up to the level of governmental organizations or Armed Forces) Continuous *Follow-up* Management of eventual persistence of the agent in the affected area: endemic infection Management of sequelae Post-event surveillance for early detection of secondary Public Health emergencies Reconstruction Mitigation Prevention Economic impact on affected community Focus on building local capacity for early transition and better resilience

(26). The novel application of the Haddon Matrix to CMI in support of Disaster Relief operations highlights the importance of systematic analyses. Armed Forces and single organizations strive for self-improvement in terms of readiness, preparedness posture, appropriate and sustainable management of resources. The use of the Military must be appropriate, cost-effective, sustainable. This analytical approach supports the decision-making process by evaluating the appropriateness and cost-effectiveness of choices made, aiming at making better choices in the future. Consequently, Armed Forces can find transversal solutions responding to multiple problems, avoiding useless duplication of efforts (23, 24). Another element of novelty is the application of this theoretical model not just to the CMI response to a natural

disaster - an event characterized by a high degree of definition in terms of space and time - but also to global Public Health emergencies. The COVID pandemic required a multisectoral and protracted intervention which challenged - and often surpassed - sustainability. Disaster Relief operations are choral responses between a myriad actors in diverse possible scenarios, either in peacetime or during conflict. The Military are often crucial actors in the acute phase of the response to disasters. Armed Forces have highly specific and readily deployable assets: they can give a positive contribution to the response. Frameworks and platforms for interaction were initially developed with the intention to facilitate coordination among military and non-military contributors. Such tools and frameworks need to evolve, given the dynamic relations among ecosystems (25). The potential conceptual friction derived from the employment of FMA can be mitigated by anticipatory preparation of coordination instruments such as liaison mechanisms. Interaction is also facilitated by training on a broad, multinational scale. Planning a response based upon guiding principles and flexible institutions, with a clear distinction between military and non-military actors, requires a thorough understanding of humanitarian principles and highlights the central role of CMI.

Conclusion

The frequent coexistence of a disastrous event and a preexisting conflict in the same area of operation do generate rapidly evolving challenges to CMI (26). Responses are progressively moving away from a rigid doctrinal interpretation of the "last resort" UN principle. Since the start of the crisis all the available resources should try to put in place the "best option" for the specific scenario. Military assets in the context of a CMI operation in support of Disaster Relief might be the best option: in this case the Military should act as first responders aiming at a rapid control and resolution of the crisis.

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