Common Denominators and New Paradigm for Trauma care in MCIs

D1.1

18 August 2022

NIGHTINGALE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 101021957

DOCUMENT SUMMARY INFORMATION

Grant Agreement No	101021957	**Acronym**	NIGHTINGALE
Full Title	Novel InteGrated toolkit for enhanced pre-Hospital life support and Triage IN challenGing And Large Emergencies		
Start Date	01/10/2021	**Duration**	36 months
Project URL	https://www.nightingale-triage.eu		
Deliverable	Definition of functional and non-functional user requirements		
Work Package	WP1		
Deliverable type	Report	**Dissemination Level**	Public
Due Date of Deliverable	31/08/2022	**Actual Submission Date**	18/08/2022
Deliverable Identifier	D1.1	**Deliverable Version**	Final
Lead Beneficiary	UPO		
Authors	Marta Caviglia (UPO), Eric Weinstein (UPO), Joseph Cuthbertson (UPO)		
Co-authors			
Reviewers	Roberto Diaz (TREE), Sten Lennquist (MRMID), Carl Monthan (MRMID)		
Security Assessment	☒ Passed	☐ Rejected	☐ Not Required
Status	☐ Draft	☒ Peer Reviewed	☒ Coordinator Accepted

DISCLAIMER

NIGHTINGALE has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101021957. The sole responsibility for the content of this document lies with the authors. It does not necessarily reflect the opinion of the European Union. The European Commission is not responsible for any use that may be made of the information contained herein.

HISTORY OF CHANGES

Version	Date	Changes
0.1	10/05/2022	Initial version
0.2	18/07/2022	First draft
0.3	15/08/2022	Revised draft
1.0	31/08/2022	Final version

PROJECT PARTNERS

No.	Logo	Partner	Short name	Country
1		INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS	ICCS	Greece
2		TOTALFORSVARETS FORSKNINGSINSTITUT	FOI	Sweden
3		LEONARDO – SOCIETA PER AZIONI	LDO	Italy
4		C4CONTROLS LTD *[TERMINATED]*	C4C *[TERMINATED]*	UK *[TERMINATED]*
5		INTRASOFT INTERNATIONAL SA	INTRA	Luxembourg
6		INOV INSTITUTO DE ENGENHARIA DE SISTEMAS E COMPUTADORES, INOVACAO	INOV	Portugal
7		EXUS SOFTWARE MONOPROSOPI ETAIRIA PERIORISMENIS EVTHINIS	EXUS	Greece
8		UNIVERSITAT POLITECNICA DE VALENCIA	UPV	Spain
9		ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS	CERTH	Greece
10		DEVERYWARE	DW	France
11		PARTICLE SUMMARY	PARTICLE	Portugal
12		TREE TECHNOLOGY SA	TREE	Spain
13		EUROPAISCHE GESENLLSCHAFT FUR TRAUMA -UND AKUTCHIRURGIE - ESTES	ESTES	Austria
14		INTERNATIONAL MRMID ASSOSIATION	MRMID	Sweden
15		UNIVERSITA DEGLI STUDI DEL PIEMONTE ORIENTALE AMEDEO AVOGADRO	UPO	Italy
16		ASSISTANCE PUBLIQUE HOPITAUX DE PARIS	APHP-SAMU	France
17		UNIVERSITA CATTOLICA DEL SACRO CUORE	UCSC	Italy
18		MINISTERO DELL' INTERNO	MININT	Italy
19		AZIENDA SANITARIA LOCALE N 2 SAVONESE	ASL2	Italy
20		MAGEN DAVID ADOM IN ISRAEL	MDA	Israel
21		CARR COMMUNICATIONS LIMITED	CCL	Ireland
22		ASSOCIAZIONE CITTADINANZATTIVA ONLUS	CA	Italy
23		INTERDISCIPLINARY CENTER (IDC) HERZLIYA	IDC	Israel
24		ASTRIAL GmbH	ASTRIAL	Germany

LIST OF ABBREVIATIONS

Abbreviation	Definition
CBRNE	Chemical, Biological, Radiological, Nuclear, and high yield Explosives
EFG	External Focus Group
EMDM	European Master of Disaster Medicine
EU	European Union
FRs	First Responders
IFG	Internal Focus Group
MCIs	Mass Casualty Incidents
PHLSDC	Prehospital Life Support and Damage Control
PHP	Prehospital Processes
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RT	Round Tables
TS	Translational Science
UAB	User Advisory Board
WADEM	World Association for Disaster and Emergency Medicine
WGs	Working Groups

Executive Summary

The deliverable describes the translational methodology adopted to devise updates and obtain common agreements to mass casualty triage, prehospital life support and damage control (PHLSDC) interventions and prehospital processes (PHP) protocols, methods, guidelines and operational practices among the EU and international emergency medical and non-medical practitioners' community.

Nightingale Users' Partners, User Advisory Board (UAB) Members, and international experts in the field of disaster and emergency medicine including members of professional scientific societies (such as European Society for Trauma and Emergency Surgery – ESTES, and the World Association for Disaster and Emergency Medicine - WADEM) have been actively involved in the process. Three different working groups (WGs) have been created under the leadership of UPO to address the abovementioned topics.

The multi-stage approach featured three different scoping reviews, aiming to analyse and map available evidence on Mass Casualty Incident (MCI) Triage, PHLSDC interventions and PHP as part of a broader, integrated and coordinated health system response. In a subsequent step, the three WGs synthesized the obtained results into a series of statements that underwent an internal and external quality check though dedicated focus groups.

Three Modified Delphi studies have then been performed to subject the statements to the attention of international experts. Statements that had reached the expert consensus were then discussed during the Users Round Table (RT) organised by ESTES and co-chaired by ESTES and UPO on the 25th of April 2022 during the ESTES Congress in Oslo, Norway. Outputs of the RT allowed for subsequent translation of consensus statements into an initial set of evidence-based recommendations on triage, PHLSDC and PHP.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 Introduction

The EU-funded Novel Integrated Toolkit for Enhanced Pre-Hospital Life Support and Triage in Challenging and Large Emergencies (NIGHTINGALE) project aims at improving disaster preparedness and response by providing technological solutions that will support first responders (FRs), including civil protection agencies, fire brigades, police, search and rescue teams, and volunteers, augmenting their response capabilities during emergencies.

One of the core objectives of this Horizon 2020-funded project is to perform a thorough study and analysis of the existing guidelines and widely operated protocols for triage, prehospital life support and damage control (PHLSDC) interventions, and pre-hospital processes (PHP), in order to extract evidence-based knowledge, gaps, and challenges, and ultimately devise common denominators. The latter will both support the development of a novel integrated toolkit for emergency response and provide recommendations to enhance operational capacities during the managements of mass casualty incidents (MCIs). As a matter of fact, the current landscape across EU prehospital MCI management is heterogeneous in terms of methods, guidelines and processes adopted by FRs from different countries and between different agencies. As a result, response to MCIs often lacks common agreement and homogenisation (i.e., common denominators in processes, pre-hospital life support and triage across agencies, disciplines, and nations). D1.1 strives to report on definition and agreement on common denominators, to ultimately provide an initial set of recommendations that will support the technical partners of the project in the development of new technological solutions. A revised/final list of recommendations, initially defined in D1.1 following a sound evidence-based approach hereafter described, will be then produced at the end of the NIGHTINGALE project, taking into consideration the different interaction (validation/testing/evaluation) laid down in the project.

The deliverable will inform the work in the following tasks:

- **Task 1.2** *Social, Legal and Ethical Landscape for MCIs handling and Action's Impact Assessment*:
- **Task 1.4** *Overarching scenarios, definition of use cases and testing and validation activities specific planning*:
- **Task 1.5**. *Definition of functional and non-functional user requirements.*
- **Task 1.6**. *Technical Requirements, Specifications and Toolkit Architecture.*
- **Task 1.7**. *User and Technical Validation Protocol, KPIs and Plan.*

2 Methodology

The intrinsic and defining characteristic of MCIs is their unexpected and uncontrolled occurrence that, coupled with the large number of casualties exceeding the resources normally available, strains and often overwhelms the local response systems [1,2]. Other than testing the health care sector and involved response agencies, MCIs pose a challenge also for the academic world, as the possibility to perform research with high level of evidence, such as randomized control trials and

conventional prospective studies, is extremely rare in such unpredictable circumstances [3]. Additionally, data collection during MCIs is often fragmented and not supported by a standardized reporting methodology, further challenging research scientists who frequently prefer leaning towards retrospective survey-based methodologies and lessons learned [3,4].

The use of translational science (TS) applied to disaster medicine research represents a promising approach to transfer evidence-based knowledge into implementations and interventions, engaging different perspectives gathered from researchers, practitioners and other stakeholders equipped with transdisciplinary and extensive competencies.

Recently, the different steps outlined in the TS methodology have been successfully adapted and applied in disaster medicine research aiming to produce new knowledge and to transfer evidence-based data into recommendations and guidelines, as advocated by the scientific community [5,6]. Such steps, which are not to be seen as separate blocks but rather represent a continuum in the research activity, have been analysed and implemented in the NIGHTINGALE project as presented in table 1.

Table 1. Description of the different steps of the TS methodology adapted for the NIGHTINGALE project.

TS phase	Methodology	Description
T1	Scoping Review	Identification of current approaches and data examining MCI Triage, PHLSDC and PHP (potential for intervention)
T2	Modified Delphi Study	Consensus statements as a basis for the development of evidence-based tools and guidelines (translation to end-users: efficacy of the intervention)
T3	Implementation	Creation of evidence-based tools and guidelines (translation into practice): recommendations
T4	Study Outcomes	Validation, evaluation and outcomes assessment of the tools and guidelines (translation to community)

2.1 Translational Science Approach

This report provides a thorough and comprehensive description of the TS methodology applied to provide an answer to the T0 question "*Can sudden onset disaster mass casualty incident prehospital triage, life-support and damage control and processes meet the NIGHTINGALE objectives?*".

The first three TS stages feature a multi-stage consensus-building approach, engaging different stakeholders with the expertise and perspectives involved in the project. The NIGHTINGALE consortium encompasses twenty-three partners of which eight are first response organizations, including professional medical, scientific, or technological societies, academic research centres, health care facilities, emergency medical service, firefighter law enforcement agencies, and from the volunteer sector, thus, representing the end-users of the final product.

Furthermore, the project is supported by external experts in the field of MCIs, also comprised among the end-users group. As a key preliminary step, end-users have been divided into three working groups (WGs) to address the three overarching topics of triage, PHLSDC, and PHP. Each WG was

coordinated by a team leader, responsible for setting deadlines, organizing virtual meetings, and ensuring the progression of the work. By design 3 WGs followed the same methodology for the T1 scoping review, sharing similar search terms with utilizing subject specific search terms, developing subject specific databases that lead to subject specific but similar T2 modified Delphi methodology studies. This approach, replicated in parallel three times, enabled the modified Delphi consensus statement results to be synthetized for the T3 phase (Figure 1).

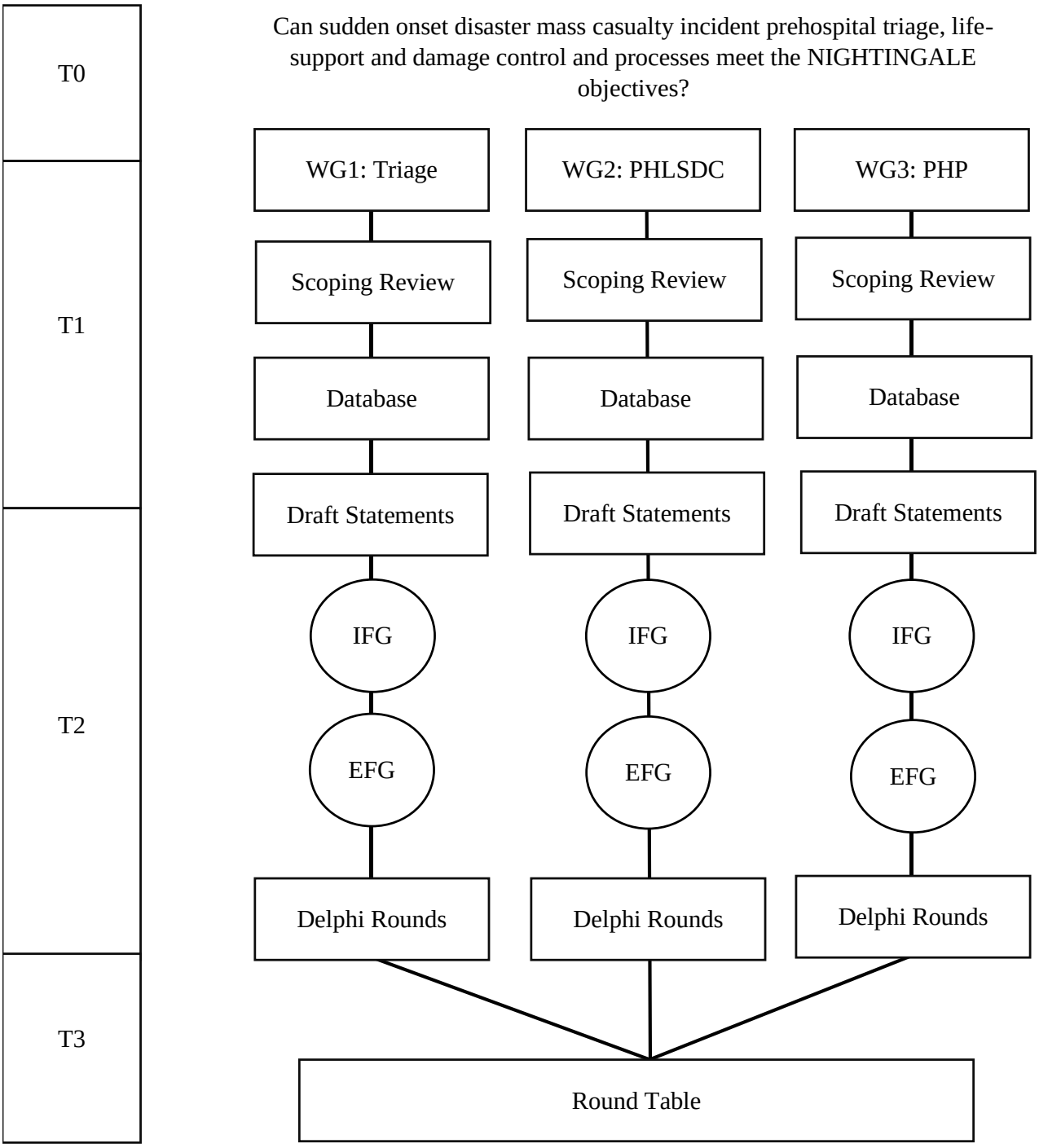

Figure 1. Schematic reproduction of the Translational Science phases from T0 to T3 applied to the NIGHTINGALE project. WG= work group; PHLSDC= prehospital life support and damage control; PHP= prehospital processes; IFG= internal focus group; EFG= external focus group

2.1.1 T1: Scoping Review

The need to perform a literature review stemmed from the limited published evidence produced by systematic reviews, translation science or other scientific processes supporting consistent MCI Triage, PHLSDC interventions, and PHP response policy and guidelines. Existing practice greatly varies between nations, states, institutions (medical and non-medical), and settings (e.g., conflict zones and humanitarian crisis), and this variance is further confounded by a lack of ethical consistency in and standardization of evaluation, terminology, education and training, validation, and verification of evolving technology. The identification and consequent application of ethical evidence-based MCI Triage, PHLSDC interventions and PHP as part of a broader, coordinated health system response is of paramount importance to enable FRs to:

- optimize resource utilization to minimize morbidity and mortality of the injured
- upgrade the continuous evaluation of the injured in the MCI
- perform life-saving and damage control interventions
- enable priority transportation from the scene to definitive care with credible patient tracking utilizing technology, artificial intelligence, drones and other verified means.

As such, to identify and map the available evidence, we chose to perform a scoping review, an approach that allowed the identification of key concepts, key characteristics and current approaches in MCI management and provided a database of triage, PHLSDC and PHP themes and subthemes.

The T1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses scoping review [7] phase started in November 2021 and ended in January 2022. The 3 WGs followed the same study protocol using a set of core search terms and inclusion and exclusion criteria specific for NIGHTINGALE, then adding search terms and inclusion and exclusion criteria specific for each WG (Triage, PHLSDC, PHP). The search was performed under the direction of a medical informaticist with identified search result article's titles and abstract initially screened following the inclusion/exclusion criteria by two independent reviewers. Included articles then underwent full text review following the same methodology by two independent reviewers. Any disagreement between the two independent reviewers screening the title and abstract or full text was settled by consensus. Results of the process are summarized in Table 2 following the PRIMSA flowchart.

Table 2. Results of the 3 PRISMA scoping reviews

	Triage	**PHLSDC**	**PHP**
Tot. articles	304	332	304
Title/Abstract included	41	216	109
Full text included (final)	29	38	170*

** 61 added from additional references*

The final articles that were included after this step proceeded to the data extraction phase utilizing the database created specific for each WG with themes and subthemes specific for each WG, developed according to NIGHTINGALE objectives (Table 3). Such data and information included statements, figures, graphs, and tables deemed as important to address the subject matter. At the

end of the process, each WG created a set of draft modified Delphi statements based on the abovementioned databases (Tables 5 and 6).

Table 3. Topics, Themes and Subthemes of the Scoping Review Database

Topic	Themes	Subthemes
Triage	Education	Just-in-time training, initial curriculum, maintenance curriculum
	Simulation Training	Tabletop, full scale exercise, Virtual Reality, Computerized
	Patient's History	Mechanism of Injury, Time since injury, Ischemia time Exposure to environment time, Comorbidity, Medications, Allergies, Bystander information/intervention
	Physical examination	Initial cursory, Primary, Secondary
	Equipment	Cardiac monitor, Pulse oximeter, BP cuff, Advanced monitoring (cardiac output), Sensors (wristband, etc.), Ultrasound, Temperature
	Patient Tracking	Triage tag, RFID, arm bands, wristbands, geolocalization, other
	Patient record	Electronic, paper, phone, radio
	Re assessment	Warm ischemia, tourniquet time, compartment syndrome, time on backboard, response to IV fluids, response to medications, new complaints
	Outcomes of decisions	Treatment prioritization Evacuation prioritization
	Reporting within the transfer of care	Electronic, paper, phone, radio
PHLSDC	Education	Just-in-time trainings, initial curriculum, maintenance curriculum
	Simulation Training	Tabletop, full scale exercise, Virtual Reality, Computerized
	Patient's History	Mechanism of Injury, Time since injury, Ischemia time Exposure to environment time, Comorbidity, Medications, Allergies, Bystander information/intervention
	Physical examination	Initial cursory, Primary, Secondary
	Equipment to perform LSDC	Airway adjuncts, needle decompression, stop the bleeding, IV fluids, decontaminating, antidotes, splinting, spine motion restriction
	Equipment	Cardiac monitor, Pulse oximeter, BP cuff, Advanced monitoring (cardiac output), Sensors (wristband, etc.),

		Ultrasound, Splinting, Bandages, Spine motion restrictions, Medications, other
	Patient record	Electronic, paper, phone, radio
	Re assessment	Ischemia time, tourniquet time, compartment syndrome, time on backboard, response to IV fluids, response to medications, new complaints
	Outcomes of decisions	Treatment prioritization Evacuation prioritization
	Reporting within the transfer of care	Electronic, paper, phone, radio
PHP	Education	Just in time, initial curriculum, maintenance curriculum
	Terminology of MCI Processes	Incident management system, Incident command system, Mass Casualty response
	Policy/Planning framework	Government, Non-governmental, vulnerable populations
	First Responders	Volunteers' management/activation/notification
	Activation(Incident notification	Government request, organization activation, bystander information/intervention, staff call, surge plan
	Command system/Authority	Government, non-governmental
	Resource augmentation/allocation	Logistics, field medical post, mass fatality management, family reunification, telemedicine
	Safety	Decontamination, PPE
	Casualty distribution	Real time, coordinated/planned, patient tracking, distribution matrix
	Communication/Situational awareness	Artificial intelligence, electronic, radio, phone
	Reporting/Documentation	Electronic, paper, phone, radio
	Recovery/staff care	Mental health, debriefing, patient experience, staff welfare

2.1.2 T2: Modified Delphi

In the T2 stage, a modified Delphi study was performed, which consisted of engaging different perspectives and determining expert group consensus through an iterative process of repeated rounds of voting. Differently from the traditional Delphi approach, the pre-selected data retrieved from the T1 scoping review was discussed in different focus groups, replacing the more standard approach of a fully open questionnaire to collect quantitative or even qualitative data from experts [8]. In our context, the use of a modified Delphi technique ensured several advantages, including the possibility to provide guidance from experts and guarantee the focus of the study, the possibility to clarify any redundancy or problems regarding comprehension, grammar or syntax of each statement produced by the WGs, and the possibility to quickly refine solid and evidence-based statements

within the NIGHTINGALE consortium. Active involvement of users is essential for detailing and validating the requirement of the final NIGHTINGALE tools. To gather necessary information on intended users and their task, desktop research and literature review has been performed.

Starting in January 2022, the set of draft statements was presented to 3 different internal focus groups (IFGs), one per WG, with each lead by that specific WG and comprised of key stakeholders of that WG: NIGHTINGALE User Advisory Board (UAB) members, NIGHTINGALE end-users, including partners and external experts.

During each IFG, draft statements were reviewed with the responsibility to make them clear, concise, and consistent to the overall aim of the project. To remove bias from the statement creation process 3 external focus groups (EFGs), each specific to the specific WG, comprised of experts not engaged in the NIGHTINGALE project were subsequently held in February and March 2022 to openly discuss the presented statements to assure that each were clear and concise to be presented to the modified Delphi panel. Final statements were then forwarded to the modified Delphi specific to that WG. Administration and analysis of the 3 modified Delphi studies was performed using Stat59 (STAT59 Services Ltd; Edmonton, Alberta, Canada).

Delphi experts recruited included operational FRs, academic researchers identified among the authors of included papers, alumni of the European Master of Disaster Medicine (EMDM) and members of the professional scientific societies, the European Society for Trauma and Emergency Surgery (ESTES) and the World Association for Disaster and Emergency Medicine (WADEM) as experts in the field of either triage, PHLSDC and PHP in MCIs. Demographic characteristics of the recruited experts are presented in Table 4.

Table 4. Demographic characteristics of Delphi Experts

	Triage, n (%) 18 experts	**PHLSDC, n (%) 22 experts**	**PHP, n (%) 22 experts**
Years of expertise in this field:			
• <5	3 (16,7%)	2 (9,1%)	1 (4,5%)
• <10	7 (38,9%)	5 (22,7%)	3 (13,7%)
• <15	2 (11,1%)	3 (13,7%)	4 (18,2%)
• <20	4 (22,2%)	5 (22,7%)	4 (18,2%)
• >=20	2 (11,1%)	7 (31,8%)	10 (45,5%)
Where is the location of your primary Mass Casualty Incident Response education, training, planning or operations employment? (World Bank Regions)			
• East Asia and Pacific	2 (11,1%)	2 (9,1%)	-
• Europe and Central Asia	11 (61,1%)	13 (59,1%)	14 (63,6%)
• Middle East and North Africa	1 (5,6%)	3 (13,7%)	5 (22,7%)
• North America	3 (16,7%)	4 (18,2%)	2 (9,1%)
• Sub-Saharan Africa	1 (5,6%)	-	1 (4,5%)
Primary employment			
• Governmental Organization	7 (38,9%)	11 (50%)	9 (40,1%)
• Non-Governmental Organization	3 (16,7%)	2 (9,1%)	2 (9,1%)
• Private sector	2 (11,1%)	4 (18,2%)	2 (9,1%)
• University	4 (22,2%)	4 (18,2%)	7 (31,8%)

• Other	2 (11,1%)	1 (4,5%)	2 (9,1%)
Current profession (multiple choice allowed):			
• Administration and Support	3	4	4
• EMT/Paramedic	2	-	3
• Education/Training	9	15	2
• Fire Fighter	-	-	2
• Nurse	-	-	2
• Physician	16	21	16
• Public Safety	-	1	2
• Research	7	8	14
• Response/Field operations	7	9	10
• Simulation coder/designer/creator	1	5	3
• Other	3	1	2

Experts participated in three modified Delphi rounds, in which they were asked to rank the statements using a seven-point linear numeric scale and to review their choice if consensus was not reached in the first round. Formal feedback of group ratings was shared with experts during the second and third round to reconsider their vote until stability was reached (Tables 5 and 6).

Table 5. Triage, PHLSDC and PHP Statements that achieved consensus

Topic	Statements
Triage	1. Triage is an ongoing and repetitive process throughout the continuum from the initial assessment through definitive care.
	2. Each jurisdiction should develop clinical guidelines for priority transportation decisions to match the patient to the appropriate definitive health care facility
	3. Each triage system should develop a continuum of repeated assessments of available vital signs and monitor data.
	4. Each jurisdiction should require that all first response agencies utilize the same triage system for any MCI response in that jurisdiction.
	5. Each triage system should allow for dynamic triage decisions based on changes in available treatment and transportation resources.
	6. Each triage system should allow for dynamic triage decisions based on changes in patient conditions.
	7. Each triage system should be inclusive to all ages.
	8. Each triage system should be inclusive to all populations.
	9. Each triage system should be simple, easy to remember, amenable to quick memory aids and just-in-time training for trained first responders.
	10. Each triage system should be practical for use in an austere environment.
	11. Each triage system should require that the assigned triage category for each patient be visibly identifiable and/or by patients being sent to a specific assigned location as a group of similar triaged patients.
	12. Each jurisdiction should develop clinical guidelines for priority life support and damage control intervention.
	13. It should be possible to perform the initial assessment without diagnostic equipment.
	14. Each first response agency should develop protocols for the use of monitoring equipment.
	15. Patients categorized or considered as expectant should be provided with treatment and/or transport as resources become available.

	16. Efficient use of transport assets may include mixing categories of patients and using alternate forms of transport.
	17. Use of ultrasound may be incorporated in the continuum of prehospital care.
	18. The field trauma score may be used to guide lifesaving and damage control interventions.
PHLSDC	1. Each first response agency should develop crush injury treatment guidelines, education, and training to achieve and maintain competencies.
	2. Each medical first response agency should develop clinical guidelines, education, and training to achieve and maintain competencies to utilise intraosseous access to achieve rapid vascular access.
	3. Each medical first response agency should develop permissive hypotension clinical guidelines, education, and training to achieve and maintain competencies.
	4. After lifesaving interventions are performed the continued monitoring of the patient can be assigned to a provider of lesser training (i.e., physician to paramedic or Emergency Medical Technician (EMT), paramedic to EMT or first responder with medical training)
	5. Pain management should be considered for the injured and when performing interventions.
	6. Each first response agency should utilise a formal evidence-based framework for post incident evaluation that defines and assesses key performance indicators.
	7. Each jurisdiction should document life support and damage control intervention in a patient care record.
	8. Each jurisdiction should create guidelines to utilise spontaneous first providers/bystanders
PHP	1. Each jurisdiction should define MCI response terminology utilized by all first response agencies in this jurisdiction
	2. Each jurisdiction's prehospital processes should be applicable to all ages.
	3. Each jurisdiction's prehospital processes should be applicable to all populations.
	4. Each jurisdiction should develop search and rescue guidelines.
	5. Each jurisdiction should develop MCI CBRNE decontamination education, training and competencies.
	6. Each jurisdiction should develop communication technology backup for all first response agencies in the jurisdiction.
	7. Each jurisdiction should develop contingency plans for casualty collection points (i.e., advanced medical posts, field hospitals, alternate care sites, repurposing health care facilities) to meet the demand of MCI response
	8. If available each jurisdiction should apply technology to recognize and locate emergency response vehicles at all times.
	9. Each jurisdiction should develop a single patient identification method utilized across all first response agencies
	10. Transport information management systems enhance coordination of patient distribution
	11. Information management systems enhance coordination of resources (i.e., staff, stuff, structures).
	12. Each jurisdiction should have a contingency to manage transport disruption caused by MCI (i.e., earthquake destroying road/rail)
	13. Evaluation of an exercise or actual MCI event should be completed by all participating first response agencies.
	14. Each jurisdiction should apply evidence based key performance indicators to evaluate and improve the MCI response.
	15. Each jurisdiction MCI plan should be designed to be consistent with the jurisdictional incident management system.
	16. The MCI response plan should be based on the jurisdiction hazard vulnerability and risk analysis.

	17. Each jurisdiction MCI response plan should include a structured debrief of the exercise or actual MCI by all participating first response agencies where possible.
	18. Each jurisdiction should ensure MCI response plan education, training and competencies are consistent across first response agencies
	19. Assessment, observation and monitoring technology and devices that have capacity for storing and transmitting data enhance MCI response.
	20. Each jurisdiction MCI response plan should be designed to be consistent with the jurisdictional health authority legislation and regulations.
	21. Unmanned Aerial Vehicle (UAV) technology enhances MCI response situational awareness.
	22. Unmanned Aerial Vehicle (UAV) technology enhances MCI response operations.

Table 6. Triage, PHLSDC and PHP Statements that did not achieve consensus

Topic	Statements
Triage	1. Patients should be assigned a triage category as defined by the first response agency according to their condition after any lifesaving interventions.
	2. Each first response agency should develop specific education, training, and competencies for their specific jurisdiction triage system.
	3. Each triage system should be based on the jurisdiction hazard vulnerability and risk analysis.
	4. The shock index may be used to guide lifesaving and damage control interventions.
	5. The pulse pressure may be used to guide lifesaving and damage control interventions.
	6. The heart rate variability may be used to guide lifesaving and damage control interventions.
PHLSDC	1. Each first response agency should develop crush injury incident recognition guidelines, education, and training to achieve and maintain competencies.
	2. Materials for crush injury resuscitation should be included on every medical first response vehicle.
	3. Each first response agency should develop life threatening haemorrhage control guidelines, education, and training to achieve and maintain competencies.
	4. Each first response agency should develop life threatening haemorrhage first provider/bystander training and education programs that interface with the first response agency.
	5. Each first response agency should develop CBRNE incident recognition, education, and training to achieve and maintain competencies.
	6. Each first response agency should develop CBRNE incident clinical guidelines, education, and training to achieve and maintain competencies.
	7. Each first response agency should develop an awareness of the need for specific CBRN antidotes and to deliver these to the scene.
	8. When feasible, the medical first response agency should develop blood product use clinical guidelines, education, and training to achieve and maintain competencies and to deliver these to the scene.
	9. Each medical first agency should develop tranexamic acid (TXA) clinical guidelines, education, and training to achieve and maintain competencies.
	10. Each first response agency should develop mass hypothermia monitoring and treatment guidelines.
	11. First responders should only perform interventions within their scope of practice.

	12. Each first response agency should develop smoke inhalation education and training to achieve and maintain competencies.
	13. Each medical first response agency should develop clinical guidelines, education, and training to achieve and maintain competencies to treat the specific patient with hypotension due to haemorrhage and a declining level of consciousness without clear evidence of a head injury.
	14. Each medical first response agency should develop blunt and penetrating chest trauma education and training to achieve and maintain competencies.
	15. Deployable technology should employ evidence based physiologic parameters and undergo clinical evaluation before utilisation.
	16. Each medical first response agency should evaluate the use of the motor Glasgow Coma Score (mGCS) in certain clinical scenarios in preference to the total Glasgow Coma Score (tGCS).
	17. Each jurisdiction should utilise a patient consent process for interventions.
PHP	1. Each jurisdiction should develop search and rescue education, training, and competencies.
	2. Each jurisdiction should develop MCI CBRNE decontamination guidelines
	3. Each jurisdiction should define futility of care.
	4. Each jurisdiction should develop education and training for community response to active shooter events.
	5. Each jurisdiction should develop first responder plans, education, training and competencies for active shooter events.
	6. Where possible jurisdiction should apply telemedicine technology and processes to support the MCI event response.

MCI = Sudden Onset Disaster Mass Casualty Incident as defined by the Health Authority of that response agency
First Response Agency = Any pre-hospital or hospital, government or non-government, organization, group, hospital, or health care delivery system that would provide medical care in an MCI response.
Medical First Response Agency = Any pre-hospital or hospital, government or non-government, agency, organization, group, hospital, or health care delivery system that would provide medical care in an MCI response
Jurisdiction = The lead command and control health authority of the MCI response
First provider/bystander = person immediately affected by the MCI, not injured, or minimally injured, a bystander, who presents to the first response agency to assist and now becomes a first provider. This person may or may not have medical or first response training, regardless, without verification of credentials is to not be expected to perform medical assessments and will be only instructed to perform basic first aid interventions or assist with non-medical tasks
CBRNE= Chemical, Biological, Radiological, Nuclear, and high yield Explosives

2.1.3 T3: Implementation

In the T3 stage, statements that attained consensus at the end of the 3 Delphi rounds were presented to the NIGHTINGALE end-users in a round table held on the 25th of April 2022 during the ESTES Congress in Oslo, Norway. The overall aim of the meeting was to translate the statements into practice, producing recommendations and exploring ways of applying them in a MCI response. To achieve the abovementioned objective, the twenty end-users participating to the event were assigned to a specific group in charge of discussing the statements according to themes and subthemes (Table 7).

Table 7. Overarching topics used in the T1-Scoping Review and T2-Modified Delphi Study and their translation into themes and subthemes for the T3-Implementation phase.

T1 and T2 overarching topics	T3 themes	T3 subthemes
• **Triage** • **PHLSDC** • **PHP**	Health Authority	Education and training, competences, regulations, ethics, triage, logistics, coordination, command and control, transportation, vitals, technological equipment

Specifically, the three different group discussions revolved around the same subthemes listed in Table 3 but applied to three different levels of control (strategic, operational, and tactical) represented by the three overarching themes of health authority, operations, and technology. Each group was tasked to translate the statements into a series of recommendation on policy, education and training activities and practical guidelines clear enough to function as measurable denominators, thus meeting one of the core objectives of the NIGHTINGALE project and to serve as a base for the implementation of the novel toolkit for emergency response.

At the end of the one-day discussion, the list of recommendations produced was presented in a plenary meeting to the NIGHTINGALE consortium, which also included technical partners in charge of developing the novel toolkit. The results achieved with the T3 stage will provide a foundation for all the core objectives enlisted in the NIGHTINGALE grant agreement. Once integrated with the outputs of other parallel project tasks (such as the definition of end-user needs and requirements, the definition of use cases, and the identification of KPIs and validation protocols) the operational guidelines produced will guide technical partners in developing the NIGHTINGALE toolkit.

2.2 Recommendations

Hereafter the initial list of recommendations developed during the implementation phase is presented, categorised into themes of education, governance, and capability:

2.2.1 Education

Recommendation: an educational and training framework is required to support the specific MCI triage protocol of each jurisdiction

Recommendation: an educational and training framework is required to support first responders in the use of Ultrasound in prehospital care and to assist the decision-making and prioritization process in MCIs

Recommendation: an educational and training framework is required to support first responders in the use of Unmanned Aerial Vehicles (UAVs) in a MCI response

2.2.2 Governance

Recommendation: a governance framework is required to:

- establish policy to describe definitions, standards of care, standardized tools, criteria for transfer of care, criteria for escalation of care, unaccompanied child treatment guideline
- enable communication networks and regulation of technology including UAV and ultrasound
- an occupational health and safety, legal and ethical framework for care in use of technologies that observe, monitor, register and exchange personal data and the medical record of the care of the patient
- measurable, evidence based key performance indicators for MCI response
- a data base on MCI lifesaving and damage control interventions and the continuum of management from the initial evaluation until the patient is transported to definitive care to inform research, key performance evaluation, lessons learned and quality improvement
- policy to allow for the accountability using real time tracking of emergency response vehicles across different response agencies.
- guide further research to understand the importance of the field trauma score amongst other patient care datasets derived from clinical parameters to guide prehospital patient care and priority transportation decision making

Recommendation: triage system design is contextual to age, gender, culture

Recommendation: the patient identification number should be standardized and easily recognized from all first response agencies and readily incorporated into the definitive care patient medical record

Recommendation: each jurisdiction should complete a mandatory hazard vulnerability risk analysis that is periodically updated to lead to specific adapted MCI response planning with active engagement of local stakeholders to collectively identify the hazards and risks and to incorporate each stakeholder in the MCI response

2.2.3 Capability

Recommendation: technology must be inclusive to all jurisdictions proposing specific features (field trauma score, revised trauma score, Glasgow Coma Scale…) when needed.

Recommendation: technology supporting triage, lifesaving and damage control interventions must:

- continuously measure patient parameters
- enable data sharing to inform/optimise resource decisions/allocation
- include age, gender, past medical history (if known) when considering this relevant accumulating real-time clinical data
- ensure each triage category is clearly different and distinguishable from the other (e.g., separating patients using geographic triage, identification of the triage category placed on the patient, etc.) and is identifiable in different environments (weather, noise, etc.) throughout the day and night; using readily available materials without or with advanced technology); based on the patient course after lifesaving and damage control interventions when a patient may improve or deteriorate and the triage category may change; and the patient triage category is easily recognizable by all FRs

- ensure that clinical data to continuously inform triage decisions are obtainable without equipment and is congruent if technology equipment is used (redundancy)
- enable identification of a patient and keep a real-time record of patient location and triage status, avoiding overlapping of personal data and can be readily incorporated into the definitive care patient tracking system

Recommendation: technology supporting transport must:

- be informed by hospital capacity and capability data utilizing real-time monitoring
- be informed by transport system capacity and capability data utilizing real-time monitoring
- allow timely communication of pre-determined definitive care transportation decisions based on the planning of jurisdiction key stakeholders that developed the MCI response patient distribution matrix based on real-time specific capacities of available definitive care as during the MCI response
- ensure real-time communication of definitive care needs to the MCI response incident management system

2.3 Demand for a validation plan

While endorsing the presented list, Users emphasize the need for the NIGHTINGALE Toolkit to respect the following principles:

- Cost-effectiveness
- Be easy to deploy, maintain, store as well as to educate and to maintain competencies
- Ubiquity, that is the possibility to be deployed anywhere in a jurisdiction or an area
- Production of meaningful data that is superior to data already available

As such, the necessary premise to implement the recommendations produced by Users Partners of the NIGHTINGALE project and translate them into new technological solutions to be introduced in the management of an MCI is the presence of a validation plan. The validation plan, which will be described in detail in task 1.7 "*User and Technical Validation Protocol, KPIs and Plan*", should take into consideration all the different aspects of the MCI response, including: a) Accuracy and quality of the interventions; b) Time and resources allocated; c) Costs (introduction, maintenance, training); and d) Education and training activities required.

Users recognize that the operational guidelines derived from D1.1 might require further revision and integration if the technical solution proposed by the project fail to meet certain aspects of the validation plan.

Conclusions

The deliverable presented the methodology adopted to devise updates and obtain common agreements to mass casualty triage, prehospital life support and damage control (PHLSDC) interventions and prehospital processes (PHP) protocols, methods, guidelines and operational practices among the EU and International emergency medical and non-medical practitioners' community. Users Partners of the NIGHTINGALE consortium, together with UAB members and international experts, followed a sound scientific translational approach to produce a series of evidence and consensus-based recommendations. Such recommendations will be revised and further discussed throughout the course of the project through a series of Round Tables that will take into consideration preliminary results of the implementation phases and validation processes.

References

[1] Lomaglio, L., Ansaloni, L., Catena, F., Sartelli, M., Coccolini, F. (2020). Mass Casualty Incident: Definitions and Current Reality. In: Kluger, Y., Coccolini, F., Catena, F., Ansaloni, L. (eds) WSES Handbook of Mass Casualties Incidents Management. Hot Topics in Acute Care Surgery and Trauma. Springer, Cham. https://doi-org.libproxy.viko.lt/10.1007/978-3-319-92345-1_1

[2] Lennquist, Sten. (2012). Medical Response to Major Incidents and Disasters: A Practical Guide for All Medical Staff. 10.1007/978-3-642-21895-8.

[3] Stratton, S. (2020). 2019: The Year in Disaster Health and Medicine Research. Prehospital and Disaster Medicine, 35(1), 1-2. doi:10.1017/S1049023X20000011

[4] Kubo, T., Yanasan, A., Herbosa, T., Buddh, N., Fernando, F., & Kayano, R. (2019). Health Data Collection Before, During and After Emergencies and Disasters-The Result of the Kobe Expert Meeting. International journal of environmental research and public health, 16(5), 893.

[5] Koenig, K. L., Schultz, C. H., Gould Runnerstrom, M., & Ogunseitan, O. A. (2017). Public Health and Disasters: An Emerging Translational and Implementation Science, Not "Lessons Learned". Disaster medicine and public health preparedness, 11(5), 610–611. https://doi.org/10.1017/dmp.2017.11

[6] Weinstein, E. S., Cuthbertson, J. L., Ragazzoni, L., & Verde, M. (2020). A T2 Translational Science Modified Delphi Study: Spinal Motion Restriction in a Resource-Scarce Environment. Prehospital and disaster medicine, 35(5), 538–545.

[7] Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., et al (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Annals of internal medicine*, *169*(7), 467–473. https://doi.org/10.7326/M18-0850

[8] Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. Journal of advanced nursing, 32(4), 1008–1015.