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Systematic Review

On-Site Health Management Requirements in Radiological and Nuclear Disasters: A Systematic Review

Saeed Nazari*[1], Faeze Baniyaghoobi[2], Mahboobeh Afzali[3], Farshid Alazmani Noodeh [4], Mansoureh Jafarkhani [5]

[1] PhD of Health in Disasters and Emergencies, AJA University of Medical Sciences, Tehran, Iran.
[2] Department of Military Nursing, Faculty of Nursing, Aja University of Medical Sciences, Tehran, Iran.
[3] Assistant Professor in Nursing Education, Emergency Medical Department, Paramedical Faculty, Aja University of Medical Sciences, Tehran, Iran.
[4] Assistant Professor, Department of Critical Care Nursing, Faculty of Nursing, Aja University of Medical Sciences, Tehran, Iran.
[5] Master of Clinical Psychology, NEZAJA Health, Relief and Treatment Department, Tehran, Iran.

***Corresponding Author**: Saeed Nazari; PhD of Health in Disasters and Emergencies, Department of Health in Disasters and Emergencies, AJA University of Medical Sciences, Tehran, Iran.; E-mail: Saeed.Nazari93@yahoo.com.

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Abstract

Introduction: Radiological and Nuclear disasters are emergencies which can result in injury, illness, or death. On-site health management are underprepared to respond to recognize key factors which underlie the On-site health management Radiological and Nuclear response is crucial to provide evidence-based knowledge to inform policies and above all clinical practice. Thus, this study aimed to extract the effective components and factors in the dynamic On-site health management and Emergency on the Scene systems.

Methods: A systematic review was accomplished in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses. The seven-stage structure was used in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement .The coverage index was strict in terms of the environment, participants (first responders), condition (Radiological and Nuclear responses), and proceedings (diagnosis, decontamination and detection). Twenty databases and topic-specific journals were searched. Researches were critically appraised using Mixed Methods Appraisal Tool. Studies were thematically coded and synthesized using NVivo 10.

Results: Totally, 1065 articles were extracted through the systematic review. After studying the titles, abstracts and contents of the extracted articles, 20 were selected for the final analysis. Data were grouped into 4 themes: of preparedness in Scene, Medical Triage System, Contamination Survey, and Management of uninjured.

Conclusion: The results of this systematic review presented an overall view of the effective components in the dynamic On-site health management and Emergency on the Scene systems. Key factors infrastructure the dynamic On-site health management and Emergency on the Scene system to plan, prepare, and respond to emergencies effectively has legal, practical, and spiritual implications. Further, with the Known concerns from this review, in terms of both knowledge and behaviors propoSEl that a systems approach is required to comprehend the On-site health management and Emergency on the Scene Nuclear and Radiological response in the future.

Keywords: Nuclear and Radiological, Incidents, and Disasters, Emergency on the Scene.

Introduction

The probability of similar or more severe nuclear wars or incidents in the future can't be ruled out.[1] The atomic explosions at Nagasaki and Hiroshima caused thermal injury to between one-quarter and one-half of the survivors.[2] With other incidents and disasters, a nuclear and radiological incident will immediately destroy the substruction needed for medical treatment and killing large numbers of medical personnel within a few kilometers of the hypocenter.[3] It will seriously damage the roads and transportation services many escapements will be blocked.[4] The relief and rescue team will be exposed to dangerous radiation. There will be

enormous strains on the available medical personnel, hospitals and blood banks.[5] As a drill to prepare for such nuclear victims, we assessed the available relevant literature and regulated a plan for effective discharge of duty by properly aware surgeons.[6] Truly speaking combined injuries (radiation, bums and other trauma) are an unknown field for bum surgeons.[7] In a mass casualty event, uninjured individuals should be initially handled in a triage site or at decontamination centers and not directed/sent straight to the emergency department of hospitals.[8] However gaps stay that we are working to fill, we will indicate the progress that has formerly been made and describe a number of ingredients that are being proactively developed. Due to any radiation event can have a period of victims, including those with external exposure resulting in the indoor contamination or acute radiation syndromes with the medical response plan must be varied, as well as cover any type of Nuclear and Radiation event.

Methods

The seven-stage structure was used in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. This collected structured guidance on the extension of appropriate research questions, as well as on the eligibility of search criteria, and the identification, selection, retrieval, appraisal, and synthesis of relevant papers according to title and abstract. References were fended at the first stage by setting the database items to English abstract, post 2005, worldwide, and any study type. The search began by scoping and exploring concepts related to the research question. The results were reviewed for relevance and additional keywords were added from retrieved references Table 1. The search was divided into four areas to mixed concepts of environment (A), areas of recognition (A + B), context (A + B + C) and types of patients (A + B + C + D).

A. On-site emergency management (OM), Incident and Emergency and Emergency in Field, Emergency on the Scene (ES).

B. Detection, decontamination, and diagnosis.

C. Nuclear, Radiological, Mass-casualty Incidents, and MCI.

D. Walking wounded, priority of victims

In this study, the systematic review method was used. The study period was from January 20, 2022 to November 2022. The search was run on 20 databases: ProQuest, ASSIA, Chemical Database service, Ergonomics Abstracts, Google Scholar, Health Management Technology (EBSCO), Medline (Ovid SP), PsychInfo (EBSCO), Referex (Materials and Mechanical Engineering), SAE digital library, Science Direct, Toxline and Web of Science, PubMed, CINHAL, Blackwell, Iranmedex, SID, Cochrane Database of Systematic Reviews, Scopus (Elsevier). Table 2.

Table 1: Search Strategy.

Approach and search terms
"Nuclear & radiological disaster" [tiab] OR "Nuclear & radiological emergency"[tiab] OR "Nuclear & radiological terrorism"[tiab] OR "Nuclear & radiological attack"[tiab] OR "Nuclear & radiological event"[tiab] OR "Nuclear & radiological threats"[tiab] OR "Nuclear & radiological crisis"[tiab] OR "Nuclear & radiological risk"[tiab] OR "Nuclear & radiological hazards " [tiab] OR "Nuclear & radiological catastrophe"[tiab] OR "Nuclear & radiological incident"[tiab] OR "Nuclear & radiological Incident"[tiab] OR "Nuclear & radiological hazard[tiab] OR "Mass Casualty Incidents" [Mesh] OR "Nuclear & radiological Terrorism" [tiab] OR agent[tiab] OR Nuclear & radiological terrorism [tiab] OR Disaster [tiab] OR Incident [tiab] OR Emergency [tiab] OR Incidents [tiab] OR Event [tiab] OR Threat [tiab] OR Agent [tiab] OR tragedy [tiab] OR "Mass Casualty Incidents"[tiab]
AND (("Emergency Medical Response Nuclear & radiological" OR "Medical Response Nuclear & radiological" OR "Disaster Medical Nuclear & radiological" OR "Disaster Nuclear & radiological" OR "Disaster Medical Response Nuclear & radiological" OR "Emergency Medical Nuclear & radiological" OR "Medical Assistance Nuclear & radiological" OR "Disaster Response" OR "Disaster Assistance Nuclear & radiological" OR "Disaster Medicine" OR "International Disaster Response" OR "International Disaster Response Nuclear & radiological")) **AND** (("Stablishing" OR "Structure" OR "Organization"))

Table 2: Search results.

Database	Results
Abstracts in technology and engineering (ProQuest)	0
ASSIA (NHS evidence)	1
Chemical Database service	1
Ergonomics Abstracts	0
Google Scholar	321
Health Management technology (EBSCO)	1
Medline (Ovid SP)	221
PsychInfo (EBSCO)	12
Referex- Materials & Mechanical Engineering	2
SAE- digital library-technical papers	0
Scopus (Elsevier)	8
Science Direct	388
Toxline	16
Web of Science	44
PubMed	20
CINHAL	10
Blackwell	8
Iranmedex	2
SID	3
Cochrane Database of Systematic Reviews	25
Total	1065

Identification of relevant papers (inclusion/exclusion)

The articles were tried to be only research related to OM; OM staff (including surgeons, anesthetists, Nurse, operational managers, and OM Chiefs); Articles with contents of mass casualty incident (MCI) due to intentional release of nuclear and radiological materials, triage in OM and diagnosis, decontamination, as well as use of PPE. Articles that included guidelines, textbooks, and literature were excluded. Scientific studies on the effects of nuclear and radiological substances on the body, i.e., physiological and chemical processes, were excluded. Psychological or psychosocial effects of Nuclear and radiological incidents were excluded. Finally, research reporting on activity in hot zones was excluded.

Selection and retrieval

The search have been extracted 1,065 papers that were excluded by title and abstract, and checked for duplication, as a result in 166 papers. Articles that didn't attach to the involvement criteria were disregarded. This resulted in the quality of 57 articles being assessed with the Mixed Methods Appraisal Tool (MMAT).

Appraisal

The quality assessment of the studies was done using the Joanna Briggs Institute (JBI) checklist. The included papers (n=57) were appraised using the MMAT to assign a quality score on a 5-point scale from 0 to 4 (100% of criteria met). Seven papers scoring 0 or 1 (<25%) and thirty papers scoring 1 or 2 (<50%) were discarded, as the quality was too poor for inclusion. This resulted in a final number of 20 studies (Figure 1[53]).

Synthesis

The residual studies (n=20) were retained for qualitative synthesis. There were 4 emerging themes of preparedness in Scene, Medical Triage System, Contamination Survey, and Management of uninjured. Some papers provided information for more than one theme.

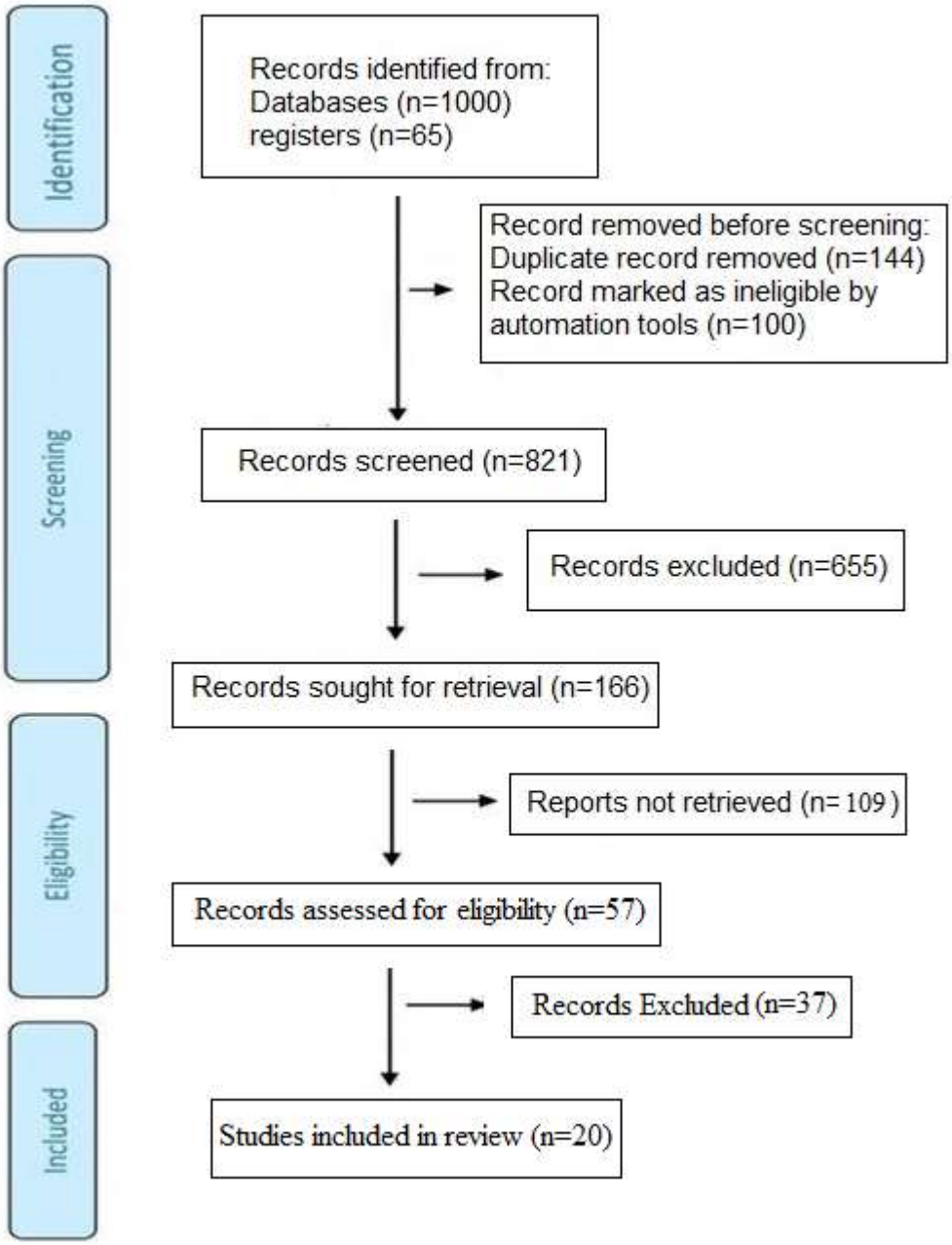

Figure 1: PRISMA 2020 flow diagram for new systematic review which included searches of databases and registers only

Table 3: Characteristics of selected studies.

No	Author (s) / Year	Type of study	Title	Data Collection Method, Sampling, Sample Size	Result	Conclusion
1	John L. Hick et al 2013	Research synthesis	Health Care System Planning for and Response to a Nuclear Detonation(54)	• Document analysis	• Sheltering • Essential information • Evacuation • Availability of medical assistance • Concomitant trauma, burn, and radiation injuries in the severe damage zone • Alternate care locations • Radiation victim triage • Health Care Facility Response • Regional Coordination of Medical Resources	Preplanning enables proper decision making, effective communication, maintenance of a command/coordination structure, optimal resource management despite initial scarcity, and thoughtful application of medical triage guidance.
2	Aruna C. Ramesh and S. Kumar 2010	Qualitative methodology	Triage, monitoring, and treatment of mass casualty events involving chemical, biological, radiological, or nuclear agents(55)	• Semi-structured interviews • Purposeful sampling • Content analysis	• Decontamination Considerations • Responding to a Chemical, Biological, Radiological, or Nuclear Event • Scene management • CBRN casualty management zones • Personal protective equipment • Hazard monitoring strategies	Procedures for triage and decontamination are merely guidelines. Both triage and decontamination should be conducted in a flexible manner depending on the medical resources available, patient counts, and distribution of severity.
3	C. Norman Coleman and et al. 2009	Mix method study	Medical Response to a Radiologic/Nuclear Event: Integrated Plan From the Office of the Assistant Secretary for Preparedness and Response, Department of Health and Human Services(56)	• Semi-structured interviews • Purposeful sampling • Content analysis • Document analysis 14 documents	• Triage and on-site treatment • Using Protective action guidelines • Transportation • Fatality management • Medical expert care • Using Medical countermeasures and management guidelines	The response to radiation event will require unprecedented cooperation among federal agencies, local/regional/state/tribal planners, health care providers, professional medical societies, and international partners. A just-in-time medical management system, Radiation Event Medical Management must be available.
4	X HU, et al. 2020	Qualitative study	Exploring the non-technical competencies for on-scene public health responders in chemical, biological, radiological, and nuclear emergencies: a qualitative study(57)	• One-on-one in-depth interviews • 20 participants • Expert members of National Medical Response Teams for CBRN disasters, officials at emergency management authorities, and scholars of academic institutions related to CBRN emergency • Using thematic analysis	• Situation awareness • Communication skills • Collaboration • Resource management • Task management • Cultural competency • Austere environment skills, • Physical stamina	Non-technical competencies affect performance of health response to Chemical, Biological, Radiological, and Nuclear (CBRN) disasters. Austere environment skills and physical stamina are priority non-technical competencies for on-site public health responders in CBRN events. Effective CBRN health emergency training should integrate and synchronize courses based on non-technical/technical competency.

5	Jerrold T. Bushberg et al. 2007	Mix method study	Nuclear/radiological terrorism: Emergency department management of radiation casualties(58)	• Semi-structured interviews • Purposeful sampling • Content analysis • Document analysis ٢٢ documents and guidelines	• Reducing exposure • Protection from contamination • Detection and measurement of radiation • Hospital Plan • Call for additional support; staff from Nuclear Medicine, Radiation Oncology, Radiation Safety (Health Physics). • Establish triage area • Establish area for decontamination of uninjured persons • Survey hands and clothing with radiation survey meter. • Control contamination	N a radiological emergency, medical stabilization and treatment of the patient take priority over decontamination efforts. Radiation exposure and contamination are not likely to be significant hazards to staff. Staff can protect themselves from radioactive contamination by using universal precautions while treating these patients. As opposed to patients who arrive contaminated with chemical or biological agents, radioactive contamination is easy to detect.
6	S.F. Ashley et al.2017	Thematic analysis	Considerations in relation to off-site emergency procedures and response for nuclear accidents(59)	• Semi-structured interviews • Purposeful sampling • Content analysis • Comparative analysis of instructions and guidelines	• Sheltering • Evacuation • Administration of stable iodine • The Convention on Nuclear Safety • National approaches to dealing with civil contingencies • Covers protection of employees and the public from work activities and under its specific regulations	Reviews UK guidance on emergency preparedness and response to nuclear accidents. Current UK approach examined and compared to international approaches. Considers the effect of events at Fukushima Dai-ichi on such guidance. Details the UK's approach to performing an economic assessment of a nuclear accident. Outlines factors influencing health and economic perspectives of a nuclear accident.
7	A. Robert Schleipman et al. 2004	Interventiona l study	Radiation Disaster Response: Preparation and Simulation Experience at an Academic Medical Center(60)	• Multiple training sessions to the Emergency Medicine Department • In simulation room • 45 persons involved	• Significant lapses in communications and logistics • Lack of coordination in the flow of patients through the HAZMAT trailer • Insufficient staff to treat acute patients in a radiation control area • Additional personnel needed for transport • Insufficient radiation safety personnel to control each decontamination room	Nuclear Medicine personnel are particularly well qualified to assist Health Physics and Emergency Medicine personnel in the preparation for, and management of, mass casualty radiation emergencies. Simulation exercises, though resource intensive, are essential to an institution's determination of response capability, performance, and coordination with outside agencies
8	Jamie K. Waselenko, et al. 2004	The Strategic National Stockpile (SNS)	Medical Management of the Acute Radiation Syndrome: Recommendations of the Strategic National Stockpile Radiation Working Group(61)	• Participants were selected on the basis of their established expertise in the field	• Physical examination • Neurologic examination • Individual biodosimetry • Triage and Emergency Care • Medical Management of the Hematopoietic Syndrome • Supportive Care • Precautions for Health Care Workers	Medical management of patients exposed to intentional or accidental radiation is complex and demands many resources. The primary responsibility for optimizing outcome resides with hospital staff and physicians and other health care facilities. Careful documentation of clinical signs and symptoms and estimation of individual radiation dose are required for medical triage.

9	Andrea L dicarlo et al 2021	Qualitative study	United States medical preparedness for nuclear and radiological emergencies(62)	• Semi-structured interviews • Purposeful sampling • Content analysis	• Exposure And Symptom Triage • Assist responders in making the initial triage • Treatment-Transport • Surge capacity for management of radiation injury • The Radiation Injury Treatment Network	Progress made in advancing preparedness has involved a number of subject matter meetings and tabletop exercises, publication of guidance documents, assessment of available resources, clear establishment of anticipated concepts of operation for multiple radiation and nuclear scenarios, and identification/mobilization of resources.
10	Elham Anbari, et al. 2017	Research synthesis	From investigation of hospital protocols and guidelines to designing a generic protocol for responding to chemical, biological, radiological, and nuclear incidents(63)	Review of international protocols, guidelines, and papers revealed that since the late 19th century	• Most of the countries had various protocols, guidelines, and handbooks for hazardous materials or CBRN incidents. • Hospital response management plan • Equipment • Recommended supplies • Antidotes for decontamination (radiological/nuclear, chemical, biological);	In the majority of international protocols, guidelines, handbooks and also international and Iranian books and papers, there is an emphasis on the importance of incident command system, determining the safety degree of decontamination zones, maps of decontamination zones, decontamination process, triage classifications, personal protective equipment, and supplies and antidotes for decontamination; these are the least requirements for such incidents and also consistent with the provided generic protocol
11	Koerner, John F, et al.	Qualitative study	The Medical Decision Model and Decision Maker Tools for Management of Radiological and Nuclear Incidents(64)	• Semi-structured interviews • Purposeful sampling • Content analysis	• Recognizing the complexity of the science • Risk assessment • Multitude of potential response assets • Collaboration with other government and non-government experts	The medical decision model process could facilitate onsite decision making that includes using the deliberative reach back process from science and policy experts and describes the tools now available to facilitate timely and effective incident management.
12	Hu X, Chen H, Yu M 2020	Qualitative study	Triage, monitoring, and treatment of mass casualty events involving chemical, biological, radiological, or nuclear agents(65)	• Semi-structured interviews • Purposeful sampling • Content analysis	• Scene management • CBRN casualty management zones • Personal protective equipment • Hazard monitoring strategies • Mass Casualty Triage	Dealing with a CBRN event always starts at the local level. Even before the detection and analysis of agents can be undertaken, zoning, triage, decontamination, and treatment should be initiated promptly.
13	Cham E. Dallas, et al. 2017	Institutional review	Readiness for Radiological and Nuclear Events among Emergency Medical Personnel(66)	418 paper survey was distributed at various medical and disaster conferences and medicine courses in Japan and in the U.S	• Familiarity with Nuclear/Radiological Contamination Risks • Having equipment available to detect the radioactivity • Personal protective equipment • Type of decontamination	Despite some educational coverage in courses and a limited number of disaster events, it is concluded that there is a lack of comfort and knowledge regarding nuclear and radiological events among the medical community. It is recommended that considerable development and subsequent distribution is needed to better educate and prepare the medical community for inevitable upcoming radiological/nuclear events

14	Hassan Farhat, et al. 2022	Cross-sectional study	Exploring pre-hospital healthcare workers' readiness for chemical, biological, radiological, and nuclear threats in the State of Qatar: A cross-sectional study(67)	Online satisfaction survey Aiken's content validity coefficient (CVC) Cronbach's α coefficient was determined to explore the survey's reliability	• Educate personnel • Familiarize HMCAS personnel with the Emergency Response Guidebook • Improve the coordination between HMCAS emds and pre-hospital responders	With the increasing risks of hazmat-CBRN incidents, continuously improving the created training packages are needed to cope with the hcws' requirements. Therefore, assessing trained participants' opinions through a valid and reliable tool can help ensure the continuous improvement of these packages.
15	Ingram, Robert J. 2018	Cross-sectional study	Emergency Response to Radiological Releases Have We Communicated Effectively to the First Responder Communities to Prepare Them to Safely Manage These Incidents?(68)	• Online questioner • 950 participants • SPSS • Data analysis •	• Technical knowledge of the materials • Detection and identification capabilities • Self-protection • Medical effects • Countermeasures to overall public and environmental safety and health • Protective actions including sheltering-in-place • Informed evacuation • Public messaging	Nuclear and radiological incident plans and protective actions need to be included and communicated to members of the public (and responders) in all media streams
16	Fereshteh Davari and Arash Zahed 2015	Descriptive qualitative study	A management plan for hospitals and medical centers facing radiation incidents(69)	• Experimental observations • Sources like Safety manuals released by the International Atomic Energy Agency • Interviews with ۴۵experts • Delphi method for polling • Brainstorming	• Create an appropriate physical space. • Supply requirements. • Human resources needed. • Training of human resources. • Hospital Disaster Committee.	With respect to the great importance of preparedness against nuclear incidents adoption and regular practice of nuclear crisis management codes for hospitals and medical centers seems quite necessary.
17	Jeffrey L. Arnold et al. 2005	Qualitative study	Recommended Modifications and Applications of the Hospital Emergency Incident Command System for Hospital Emergency Management(70)	• Expert panel	• An Incident Consultant in the Administrative Section of the HEICS to provide expert advice directly to the Incident Commander • Consultation on mental health • Operations Section to coordinate the management of contaminated or infectious patients • Information Technology Unit • Application of the HEICS not only to healthcare facilities, but also to healthcare systems	Several new leadership positions in the HEICS, new applications of the HEICS, and at least three levels of HEICS competencies for hospital healthcare workers are recommended. The HEICS should be viewed as a work in progress that will continue to mature as additional challenges arise and as hospitals gain further experience with its use
18	C. Hendrickx et al. 2016	Content analysis	Principles of hospital disaster management: an integrated and multidisciplinary approach(71)	• Analysis of 38 document, guideline, structure • Cost benefit analysis	• Multidisciplinary approach • Telecommunication • Staff Shortage • Disturbance of Supply Chain & Disposal of Waste • Pharmacy • Food & drinking water • Laundry • Disposable medical equipment • Waste • Reception plan • Evacuation plan • Isolation plan • Relocation plan • Education, training, drills, research	An integrated and multidisciplinary approach, however, includes risk assessment, preparedness, response, and recovery, and these all involve several disciplines. Individuals must understand their particular assignments and functions within an institution transformed into a crisis organization. Training and drill policies are a dynamic process, and lessons learned during drills will contribute to the creation

						of various new ideas and approaches.
19	Mario Marengo et al. 2022	Qualitative study	Radiation Safety and Accidental Radiation Exposures in Nuclear Medicine(72)	• Field visit • Data control	• Risks and Incidents in Radio pharmacy • Quality Management and Fundamentals of Patient Safety • External Exposure of Staff From Radioactive Materials • Risks and Incidents in Radionuclide Therapy • Incident Reporting and Investigation	It is therefore important that all stages are performed according to procedures that are understood, agreed, and adhered to by all staff groups involved and that all actions are supported by regular QA/QC procedures. Staff must be familiar with how all aspects of the service operate.
20	Christina Beinke et al 2022	Mix method	Contribution of Biological and EPR Dosimetry to the Medical Management Support of Acute Radiation Health Effects(73)	• Clinical Retrospective • Content analysis of 18 guideline, protocols, structure	• Dosimetry and electron paramagnetic resonance (EPR) spectroscopy in the medical management support • Medical management improvement • Increase screening capacity • Rapid triage • A comprehensive assessment	Until a reliable bio indicator of effect with regard to the risk of developing ARS and for routine use is available, dose information including dose heterogeneity as well as dose distribution is crucial for medical treatment planning. Local dose assessment might be indispensable to guide medical treatment in high local irradiation scenarios. The application of several complementary methods is strongly recommended for medical treatment and decision-making support, because most scenarios are of a rather complex nature and each case has its own characteristics.

Results

According to published articles and texts from the International Atomic Energy Agency (IAEA)[9-11], the US Centers for Disease Control and Prevention (CDC)[12], the US Department of Homeland Security[13], and the North Atlantic Treaty Organization (NATO)[14], Australia[15], the British Public Health Organization[16], the Japanese Red Cross[17], Canada[18], Pakistan[19], Turkey[20], Ireland[21], Norway[22], and Spain[23] entered the study. A quantitative synthesis was not carried out based on the variation in study types, sample populations, study aims, and multi-faceted nature. Included articles were coded in NVivo 10, for thematic analysis. Obvolute themes between researches were coded and then grouped into main themes, which highlighted key factors relevant to the research question, as outlined below.

Preparedness in scene

In a mass casualty event, uninjured individuals should be initially handled in a triage site or at decontamination centers and not directed/sent straight to the emergency department of hospitals. On-site command and control are promptly established. Responders to an emergency must be prepared to deal with multiple hazards[19-22]. The medical response at the scene is well coordinated with other response organizations, particularly radiological response, in terms of cooperation, command and control and communication links[20]. The medical responders at the Incident scene promptly address the immediate medical consequences of an acute event involving trauma, internal and external contamination and acute radiation syndrome. Consider areas

established by first responders who arrived earlier or establish action areas[23,24].

Follow guidance and instructions from radiation protection officers to protect yourself and victims from radiation exposure or contamination. Life-saving medical first aid is given priority over decontamination[25]. The radiological response at the scene is well coordinated with other response organizations, particularly medical response, in terms of cooperation, command and control and communication links[17-20]. The transfer of responsibility at the site, if it occurs, is carried out seamlessly and effectively while minimizing the spread of contamination[21]. Immediate conventional hazards are promptly mitigated. Notification of public health is demonstrated. An effective media management strategy for dealing with the threat is identified[23]. Media management measures at the scene are implemented[26]. Table 4.

Medical Triage System

Use a convenient triage system.

START (Simple Triage and Rapid Treatment)[11,27];

Jump START [9,28,29];

SALT (Sort, Assess, Life-Saving Interventions, Treatment and/or Transport)10,11,30,31;

SAVE (Secondary Assessment of Victim Endpoint)[17-27,32];

MASS (Move, Assess, Sort, Send)[14-17,27,33];

STM (Sacco Triage Method) [9,34].

Categories: triage systems typically have 4 or 5 categories, some identified by color only; check system used for the exact meaning of the categories in that system. (This category does not apply in all systems) These systems and categories were created typically for trauma triage or critical care assessments, not specifically for emergencies involving radiation or trauma and radiation [16,22, 35]. Table 5.

Contamination Survey

A head-to-toe radiation survey method is the standard radiation protection working practice [17-21]. But for the first few hours after a mass casualty event, performing a testing survey of only the head, face, shoulders, and hands is acceptable, because these are the most likely locations of contamination [18,19,22].

Field decontamination Includes remove contaminated clothing and wash hands and face with soap. Removal of outer clothing has been shown to eliminate approximately 90% of a person's contamination. A simple wash with soap and water typically removes at least 90% of the skin contamination. Removal of the clothes and a quick wash remove about 99% of the total contamination [15,18.]

Full decontamination Includes Completely remove victims' clothes and place them in a bag, Shower with water and detergents (if available), Hair should be very carefully washed and provide decontaminated people with new clothing [9,14.] Table 6.

Table 4: On-scene preparedness requirements

primary objectives	**to house a potentially large number of victims, ensure access and exit controls[9-15].**	
	Forwarding patients with life threatening injuries to the emergency departments[10,17].	
	Performing triage (first medical, then radiological)[18].	
	Decontaminating those who need to be[19].	
	Providing minor first aid as required[21].	
Staff	personal	Role
	Emergency medical service team	Tactical coordination of medical first responders and ambulance services. You normally work from the city's emergency response center. You are responsible for providing first aid for injured persons using standard methods for medical first, and also you might be the first responders until arrival of the first responders[17-21].
	Triage physicians	You normally work for the Emergency Department of the hospital. In case of mass casualty, you dispatch to the scene[18,20].
	Triage nurses	You normally work for the Emergency Department of the hospital. In case of mass casualty, you dispatch to the scene with physicians[15-22].
	Medical transport team	You are responsible for transporting the casualties from the scene of the emergency to the Emergency Departments of the hospital[19-23].
	Medical officer	You normally work for the Department of health at the local level. You are responsible for the public health and respond to the public and media[19,21,23].
	Social assistant	You notify the public about possible threats and initiate the response[15-20,22]
	Security staff	You are responsible for the security on the Scene[16-22].
	Social assistants	You notify the public about possible threats and initiate the response[19-21]
	Administrators/Coordinators	You coordinate the EMS and hospital[17-21].
Supplies	Protective clothing[9-15,23]	
	Personnel dosimeter[17-20,22,23]	
	First aid kits[9-14,23]	
	Water (for decontamination)[15-23]	
	Shower stalls[16,20-22]	
	Radiation survey meters[20,23]	
	Soaps and shampoos[9-14,23]	
	Scrub brushes[18,20]	
	Scissors[20,23]	
	Nail clippers[21]	
	Supplies for taking samples[15-17]	
	Communication equipment[16,19,21]	
	Pens, paper, magic markers[10,18]	
	Gloves[17-23]	
	Tape[9,15-19]	
	Shoe covers[16,19-21]	
	Plastic bags (many sizes)[23]	
	Boxes for waste[11-17,22]	
	Liquid collection containers[18]	
	Ropes, signs, labels[21]	
	Change of clothes[20]	

Table 5: Triage Methods for Exposed Patients in the Acute Phase of a Nuclear Disaster.

Immediate (Emergency)	Priority[1]	Red
Delayed	Priority [2]	Yellow
Minor/Minimal(Non-Urgent)	Priority [3]	Green
Expectant	Priority [4]	Blue
Dead (Deceased)	Priority [5]	Black
▪ Triage Methods for Exposed Patients in the Acute Phase of a Nuclear Disaster (Suzuki Y, etal. 2020)		

Table 6: Categories contaminated.

0	**Not contaminated**	**No contamination with/without decontamination[11-17]**
1	Contaminated but decontamination unnecessary	Contamination below acceptable level[9,15,23]
II	Remains contaminated after decontamination	Contamination remains after decontamination and cannot be removed[10,18]
III	Contaminated and needs decontamination	Contamination on face and/or hands or contamination above acceptable level on other area, and decontamination necessary[19-22]

Management of uninjured

Many of possibly contaminated but uninjured individuals may flock to the Advance Medical Care (AMC)of Set up on scene by themselves[9-15,22]. Unfortunately, this may compel the AMC to close and divert AMC personnel away from patients needing urgent medical attention[14,17,20,23]. In a mass casualty event involving radiation emergency, a triage area for uninjured victims should be established at the field hospital level or AMC[16-19,22,23]. Establish reception[14], triage[9-19], decontamination[9-21-23], medical assessment[15-20,23] and treatment areas[15-20]. Observe whether the patient is injured or not, If the patient is injured, give him/her the corresponding medical assistance[17-23]. Remove contaminated clothing and wash hands and face with soap[9-14,19,20]. Re-survey, If the patient is still contaminated, administer additional decontamination procedures on him/her[17]. Assess possibility of internal contamination, if suspected, initiate collection of samples for analyses: Get swabs from body orifices and start 24-hour urine collection. Consult with experts when any Acute Radiation Syndrome (ARS) or internal contamination is suspected. Discharge is indicated when ARS or radiological contamination are ruled out[20,23]. Assess the possibility of exposure to radiation from external sources from medical and event history:

- Where were you? Were you inside a building/house?
- Did you have vomiting or diarrhea? About what time did it start?
- If whole body exposure is suspected, investigate prodromal manifestations of the ARS, and immediately order CBC (carefully observe differential count, mainly lymphocytes)[10,19].

Discussion

This situation of science review has systematically searched for, and reviewed studies on the OM response to Nuclear and Radiological event. It has recognized the OM as a system which depends on key factors when responding to such an event. The themes - Preparedness in scene, Medical Triage System, Contamination Survey, and Management of uninjured were identified as key factors based on research determine the challenges, uncertainties, inconsistencies, and barriers associated with the OM Nuclear and Radiological response.

In line with available literature, this review highlights that first responders on scene are not ready to respond to Nuclear and Radiological event as they would natural disasters[14,16,17,19-23], as a result in the OM being underprepared influence respond overall[9,10,15]. A paraphrase is that the OM and ES is a complex system consisting of organizational, technological, and individual factors, which is further complicated by multifaceted Nuclear and Radiological events. However, it is suggested that hospitals should enforcement policies to address the lack of preparedness[20]; a means of higher comprehension the ES as a system is by assumption a systems approach, which accounts for, and makes it better the design of a system and people's relationship with it, rather than concentrating on one person part of it[36,37]. Further, first responders display an unwillingness to respond to Nuclear and Radiological events due to perceived risk, which has formerly been associated with hidden hazards[38] associated with Nuclear and Radiological events, and an hesitance of staff to respond[39], resulting in staff deficiency [40] agree an effective response.

As in other disasters, the stresses of a Nuclear and Radiological events will threaten the capacities of healthcare provider to cope. The emotional and psychological unrest produced can participate with the welfare and operational of even experienced and highly educated applied staff[19,23,36]. To assist them, survey of rescue teams should be accomplished by person(s) fully aware with the psychological reflex to injury and the mobility of groups. Debriefing is normally carried out on days 2 or 3 after exposure to a major stressful event. It will also be advisable to advice the individuals chosen for rescue activities[41].

however, triage diagram exist for trauma, burns, and other events, there are no simple diagram with which to make therapy decisions in a radiation Mass Casualty Incident (MCI)[14,19,21]. military triage includes 4 categories, including minimal treatment for those with minor injury, immediate treatment and delayed treatment for those who need and can advantage from self-preservation interposition, and an expectant category for those with earnest or multiple injuries and a poor chance of survival[12]. however, nuclear and Radiation incident medical Management[9,17.42] health care provides mass-casualty radiation incident medical guidelines, the possible for responder exposure to radiation, along with substruction destruction, may measure the ability of nearby responders to reach and assist injures rapidly. In a major incident, there will be resource limitations. To help address the use of rare resources, the Office of the associate actuary for preparedness and Response cooperated with the Agency for Healthcare Research and quality to prepare a study.[43] The findings from this systematic review can further be used to inform Nuclear and Radiological events guidance. The NATO guidance explains how to safely clinically recognize, respond, and treat exposure which is dependent on presenting symptomologies. Mnemonics for rapidly evaluation casualties, triaging sieves, guidance on the type of PPE needed as well as beneficial contacts are provided in this guidance.[14] The US medical response system includes the local and regional hospitals, a network of hospitals in the National Disaster Medical System[44]. Victims with multiple trauma, burns, and composed injury will be is placed as best as possible in acute care hospitals.[44] The medical management of the acute radiation syndrome, the care of individuals with primary radiation injury will be assisted through the Radiation Injury Treatment Network.[15] Nevertheless, to their bemuse, most respondents had not received the necessary training to identify and work in polluted environments caused by these accidents [45]. Given the conventional work frames of Radiological disaster response teams, the composition of members and the interval during which pre-hospital response teams are actively engaged in the disaster area largely depends on the tasks and service conditions. These teams are comprised of professional health professionals supported by experts with varying skill sets. These teams are methodically trained to be completely self-reliant and have the necessary skills to

engage in disaster-related responses[46].

It is safe to argue that, overall, numerous skill sets are required at the regional and national levels in Nuclear and Radiological disasters, such as fire-fighting services, rescue and treatment, dealing with hazardous substances, and hazard assessment, diagnosis, identification, and monitoring, which should be implemented through regular training routines[47]. Training and exercises for these teams should focus on Incident Control Systems (ICS), scene safety, triage, first aid, methods for wearing and removing PPE, search and rescue, decontamination, corpse management [48], accident assessment, contamination assessment, risk communications, security command and control, evacuation[49], transportation, sample collection, setting up of decontamination stations, working with dosimeters[50], diagnosis of Nuclear agents, toxicology, trauma, risk management[51], clinical and rapid assessment, antidotes, safety, demarcation, reporting method[46], urban rescue missions, in-water operations, tactical medicine, infection control, quarantine, management of suspicious packages, contact management, incident log management, dealing with incidents with mass casualties[52] and effluent management[53].

The link between effective triage and surge capacity featured from this review can contribute to reconsideration of future on-Site Management in radiological and nuclear Incidents and disasters guidance.

Conclusion

Comprehension the key factors infrastructure the dynamic OM and ES system to plan, prepare, and respond to emergencies effectively has main legal, practical, and spiritual implications. OM preparedness and response have obstacles, uncertainties and conflicts in addition to the known challenges. The four themes provide an evidence-based abstract to inform future Nuclear and Radiological guidance, policies, and clinical methods. The themes exclusively identify that the OM and ES Nuclear and Radiological event response is limited unless response planning and preparation is considered at three levels: technological (decontamination, communication, security, practical care and treatment); organizational (policies and methods); and personal (tendency to respond, Science and competence). A nuclear and radiation event includes a radiation scattering device, a radiation exposure device, or an improvised nuclear device. This response will require unprecedented collaboration among response agencies and entities at all local/regional/state/tribal levels, health care providers, professional medical associations, and leading international nations. Further, the complexity of the OM and ES, the multi-dimensional nature of Nuclear and Radiological events complex with the Known concerns from this review, in terms of both knowledge and behaviors proposal that a systems approach is required to comprehend the OM and ES Nuclear and Radiological response in the future.

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