
A SYSTEMATIC LITERATURE REVIEW OF USE OF BIOLOGICAL AGENTS AND BIOTERRORISM STUDIES (2002 – 2016)

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ABSTRACT

The subject of disaster management is gaining increasing attention not only in India but also in the international arena, with a significantly progressive focus on the aspect of developing, augmenting and guaranteeing the disaster resilience of communities/nations.

A total of over 400 books, journal articles, weblogs and newspaper items were scrutinised, and only a select few entries were synthesized, shortlisted for inclusion in the current literature review. A focused and deliberate attempt was made to specially review available literature which dealt with the subject of biological terrorism, so as to get a deeper insight into this facet of disaster management.

One aspect that was very evident during the process of the literature review – was that despite there being an overabundance of study material available on the internet about “terrorism” – specifically after the gruesome “9/11” episode – the aspect of bioterrorism, was however not given the same amount of exposure as had been provided to other forms of terrorism.

Keywords: Disaster Management; CBRN City Preparedness; Biological Agent; Biological Warfare; Bioterrorism; Local Government.

INTRODUCTION

The subject of disaster management is gaining increasing attention not only in India but also in the international arena, with a significantly progressive focus on the aspect of developing, augmenting and guaranteeing the disaster resilience of a communities/nations (United Nations International Strategy for Disaster Reduction, 2005b, 2005a).

The “inadvertent” release of a biological agent obviously cannot always be checked, but by empowering oneself to recognise the indicators leading up to such an event – sufficiently early, some if not all, such accidents may be averted. What is more worrying is the “premeditated” release of a biological agent, which has the proclivity to be the causative factor for an MCI. An evaluation of non-state actors coupled with an examination of their intent/capability to carry out a super terrorist attack would be germane to this discussion.

A conscious analysis of literature indicates that many radical terrorist organisations like the Lashkar-e-Toiba (LeT), its pseudo front Jamat ul Dawa (JuD) and Indian Mujahideen (IM) have chalked out a roadmap to acquire weapons of mass destruction/biological weapons, respectively in the near future (Jamal, 2014; Nanjappa, 2013). To aid in this quest, a well thought out blueprint has been put into action whereby, medical professionals are being covertly employed, laboratory kits are being procured and small-scale hospital setups are being established (Balasubramanian, 2014).

In the year 2010, the IM (Assam) was purportedly behind a message wherein they had threatened to release a biological agent, in case their demands were not fulfilled (Nanjappa, 2013). Some intelligence reports have indicated that the Maoists in the Naxalite affected corridors of India have hired Chemical Engineers to utilize Methane and other Nitrogen compounds to create “incendiary” effect on the patrols and other security forces (Balasubramanian, 2014). It is well appreciated that these threats need not be followed through – due to a mismatch of “intent” vs. “capability” but it is serious enough to be considered as a wakeup call for policy planners (Athavale, 2008).

In common parlance, Chemical and biological WMD are a “poor man’s atom bomb”. Technological innovations have brought this facet of super-terrorism, more easily accessible, at a fraction of the cost of conventional explosives or a nuclear device. It is indeed appalling to note that a high-tech biological agent production facility is possible to be established with an outlay of just US \$ 10,000 by procuring normal lab equipment either offline/online. What is even more astounding is that a small room could easily contain this entire clandestine operation.

Adman Al Zawahiri a key player of the “Al Qaeda” group has initiated a clandestine programme called the “Yoghurt Project” wherein an attempt is being made to produce chemical and biological weapons. This project too was commenced with a meagre start-up budget of USD 2,000 to 4,000 (Cullison, 2004).

The minuscule financial outlay to any terrorist organisation to effect mass casualties amongst the public is another aspect which heavily tilts the balance in favour of any inimical terrorist organisation, LA, AC utilising biological agents to cause MCI. The NDMA guidelines pertaining

to managing Biological Disasters (National Disaster Management Authority, 2008) have calculated that the cost to cause casualties per square km by conventional explosives vs. biological agents varies in the ratio 2000: 1. Moreover, it has also been deduced that the payload coverage per kilogram of biological agents is superior and far more efficient than any other weapons system.

It is indeed heartening to note that most Administrative bodies of cities in India, have in some way or the other included the aspect of disaster management in their existing policies and future plans. A careful analysis of the available documentation and personal interaction of the author with selected administrative authorities— brings out the following important aspects—

- Considerable focus has been laid on the vulnerabilities and mitigation mechanisms, relevant to few natural hazards like droughts, earthquakes and floods.
- The issue of CBRN threats to the city residents has been given scant attention in nearly all the documents perused.
- There is usually absolutely no mention of the eventuality of a biological agent release and how the same would be tackled in the available documents generated by various administrative authorities.

The available literature and practices in the realm of disaster management – with special reference to CBRN incident management are inadequate – at best.

Etymology. The term ‘Disaster’ originates from the French word *désastre* and the Italian term *disastro*, both of which have their roots in the Greek depreciative prefix (dus) “bad”; (aster), “star”. The essence of the term disaster (“bad star”), both in Latin and Greek) bears its origins in an astrological theme which refers to the annihilation or deconstruction of a star (Government of India, 2011).

A disaster could be comprehended as a severe disruption of the normal, routine working of a societal framework that causes widespread environmental, material and/ or human losses, which generally outstrips the distressed societies organic coping mechanism. Disasters, both natural and man-induced are as old as mankind. These have been perpetual companions of human beings since time immemorial. To evaluate the dynamics of Disasters, as applicable to the Indian sub-continent, a Committee on the subject of Disaster Management was constituted in 1999. A key output of this committee was a list of types of disasters – which had been categorized into five major sub-groups (Government of India, 2011). These are enumerated graphically hereunder: —

Accident Related Disasters	•Biological related Disasters	•Nuclear, Industrial and Chemical Related Disasters	•Geological Related Disasters	•Climate and Water Related Disasters
<ul style="list-style-type: none"> ▪ Air, Road and Rail Accidents. ▪ Boat Capsizing. ▪ Electrical Disasters and Fires. ▪ Festival Related Disasters. ▪ Forest Fires. ▪ Major Building Collapse. ▪ Mine Flooding. ▪ Oil Spills. ▪ Serial Bomb Blasts. ▪ Urban Fires. ▪ Village Fire. 	<ul style="list-style-type: none"> ▪ Biological disasters and epidemics. ▪ Cattle epidemics. ▪ Food poisoning. ▪ Pest attacks. 	<ul style="list-style-type: none"> ▪ Chemical and Industrial Disasters. ▪ Nuclear Disasters. 	<ul style="list-style-type: none"> ▪ Dam Failures/Dam Bursts. ▪ Earthquakes. ▪ Landslides and Mudflows. ▪ Minor Fires. 	<ul style="list-style-type: none"> ▪ Cloudburst. ▪ Cyclones. ▪ Droughts. ▪ Floods and Drainage Management. ▪ Hailstorm. ▪ Heatwave and Cold Wave. ▪ Sea Erosion. ▪ Snow Avalanches. ▪ Thunder and Lightning. ▪ Tornadoes and Hurricanes. ▪ Tsunami.

Table 1: Categories of Disasters: High Power Committee on Disaster Management

(Government of India, 2011)

Natural hazards have always attracted greater attention and focus from the government authorities and NGO’s – with scant attention being given to the management of man-induced disasters. A familiar example of this mindset is evident, in the fact that whenever the term “Disaster Management” is used by a layman, it is primarily with reference to a natural disaster e.g. Floods, Earthquake, Landslide etc.

As per the World Economic Forum, Weapons of Mass Destruction (WMD) continue to be the top threat in terms of impact, both in 2017 and 2018 (World Economic Forum, 2017, 2018). Moreover, the likelihood of terrorist attacks, man-made environmental disasters and WMD - figure in the top right quadrant of the Global Risk Matrix – 2018 (World Economic Forum, 2018), thus amply bringing out the importance and topical nature of the current literature review. All the aforementioned three aspects are deeply intertwined in the contours of the current review.

However, despite the importance given to WMD’s as indicated above, the impact of anthropogenically induced disasters - specifically the Chemical, Biological, Radiological and Nuclear (CBRN) suite of events - are usually pushed to the back of our sensibilities, possibly because of the rather low probability of occurrence in the entire threat spectrum. This may be partly true, but the threat assessment graph for the likelihood of use of CBRN weapons vis a vis.

conventional explosive – on the twin variables of Achievable Impact vs Degree of Difficulty of Use; shows an ever-increasing likelihood of use of CBRN weapons.

Substantially deviating from the beaten path of how the subject of disaster is usually tackled, a deliberately focused look was attempted in this literature review on the various aspects related to management of release of biological agents and the subject of bioterrorism.

REVIEW OF LITERATURE

A deliberate study and research of the subject were undertaken from Sep 2015 onwards by the author and a host of reference material and existing literature reviewed to understand the various facets of the issue under assessment.

Various important international conventions, protocols and major national policy framework documents, guidelines were referred to and these formed the bedrock of the understanding of the institutional framework of Disaster Management (DM) in India. These are listed hereunder, with alphabetical seniority: —

- **International Conventions and Protocols.**
 - Hyogo Framework Protocol for Action, 2005 – 2015.
 - Sendai Declaration, 2015 – 2030.
 - Sendai Framework: Disaster Risk Reduction.
- **Policies, Guidelines and Plans: India and States.**
 - Capacity Building in Disaster Management – District Level Guidelines.
 - Community-Based Disaster Management (CBDMD) – National Policy Guidelines (Draft).
 - Disaster Management – National Profile.
 - Disaster Management Act – 2005
 - Disaster Management in India – Emerging Issues and Responses.
 - Disaster Management in India.
 - Disaster Management Plan – Chandigarh.
 - Disaster Management Profile – Haryana.
 - Disaster Management Profile – Punjab.
 - Disaster Management Terminology.
 - Disaster Response in India.

- Disaster Risk Management and Role of Corporate Sector.
- Disaster Risk Reduction and Disaster Management Toolkit for Urban Planning.
- Disaster Trends in India.
- Effective Disaster Management System in Mumbai.
- Harnessing Technology for Disaster Risk Reduction and Capacity Building.
- High Powered Committee Report – 2001.
- India Development Report – 2011.
- India Disaster Report – 2011, 2012, 2013.
- Introduction to CBRNe – A Primer.
- National Disaster Management Policy – 2009.
- National Disaster Management Authority (NDMA) – Hospital Safety Guidelines.
- NDMA – Incident Response System.
- NDMA Handbook of Civil Defence – Part 1 and 2.
- Revamping Civil Defence – Approach Paper.
- Role of NGO's in Disaster Management – Guidelines (Draft).
- State Disaster Management Plan Preparation – Guidelines.
- Understanding Disasters.
- Working Group Report on Disaster Management – 12th Five Year Plan (2012-17).

Search Strategy

The Literature Review was conducted under the following heads for ease of assimilation:

- Disaster – Prevention, Mitigation and Preparedness.
- Bioterrorism.
- Biological Studies.
- Biological Weapons Program.
- Planning for a Biological Attack.
- Impact of a Biological Attack.
- Preparedness Level of a City.

The literature review was assisted by the availability of a large variety of e-journals and associated online resources from Chitkara University, Chandigarh and Punjab University, Chandigarh. A methodical review of the following databases, listed in alphabetical order, was undertaken using varied combinations of keywords such as disaster management, CBRN, CBRN city preparedness, biological agent, biological agent detection, biological warfare, bioterrorism, local government and government, WMD, Mass Casualty Incident (MCI), smart city initiative *etc.*

- EBSCO Host Online Database.
- Emerald Management First.
- Encyclopaedia Britannica Online.
- IEEE Xplore Digital Library.
- Indianjournals.com.
- J-Gate Engineering and Technology.
- J-Gate Social and Management Sciences.
- Proquest including Proquest Indian Journals.
- SAGE.
- Science Direct.
- Scopus Online (Citation Database).
- The Times of India (1838-2003).
- UGC Infonet Journals.
- UN Conferences and Events.
- UNESCO Social & Human Sciences Online Periodicals.
- United Nations Library Database.
- Web of Science (Citation Database).
- Web OPAC.

This search resulted in allowing the author to conduct a macro level review of study material on the subject available in the digital and print format. A total of over 400 books, journal articles, weblogs and newspaper items were scrutinised. From this exhaustive compilation, a select few

entries were synthesized, shortlisted for inclusion in the current literature review. Some of the material shortlisted – dealt with only the medical and health aspect of bioterrorism and was hence excluded from the literature review – being out of the scope of the existing study. Any information which was once included and happened to be replicated by other articles was also not considered again. A focused and deliberate attempt was made to specially review available literature which dealt with the subject of biological terrorism, so as to get a deeper insight into this facet of disaster management.

One aspect that was very evident during the process of the literature review – was that despite there being an overabundance of study material available on the internet about “terrorism” – specifically after the gruesome “9/11” episode – the aspect of bioterrorism, was however not given the same amount of exposure as had been provided to other forms of terrorism.

Institutionalised Approach to Disaster Management (DM) In India

In India, management of disasters has traditionally been reactive and relief centric – with actions being initiated only after the disaster had struck. This has of late, been replaced with a more pre-emptive, cohesive, and all-encompassing approach which has its basis in the three pillars of – Preparedness, Prevention and Mitigation. This thought was instrumental in the passing of the DM Act – 2005 on 23 Dec 2005 by the Indian government (Ministry of Law and Justice : Legislative Department, 2005).

The fountainhead for all issues related to management of disaster India is the NDMA. This national edifice is chaired by the Prime Minister who is assisted by the state Chief Ministers (heading the State Disaster Management Authorities (SDMAs)), the District Commissioners (heading the District Disaster Management Authorities (DDMAs)). These agencies have been established, organized and staffed with the aim of spearheading, adopting a comprehensive approach to DM (National Disaster Management Authority, 2009).

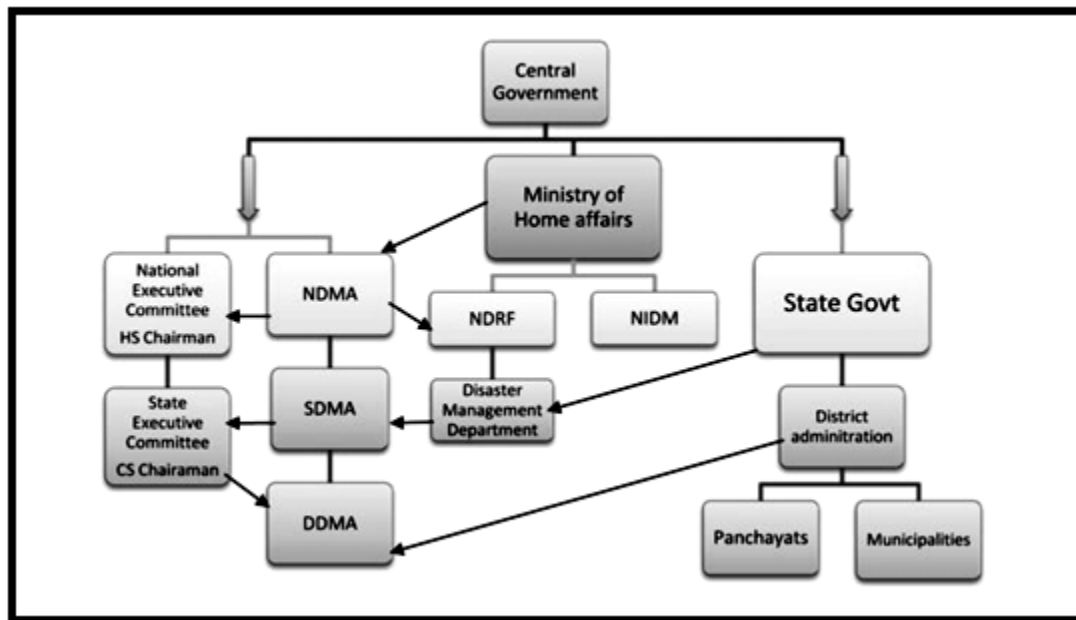


Figure 1: Institutionalised Approach to Disaster Management in India

(Ministry of Home Affairs, 2013)

Books Reviewed

Croddy (2002) explains in great detail that, Chemical and Biological weapons are usually inexpensive, easy to conceal, and can be operationalised with devastating effect – with rudimentary scientific knowledge – by just a few people. The message of “Be Informed – Not Afraid” is topical and contemporary. The early twentieth century saw the world focusing primarily on Nuclear weapons, but it is a foregone conclusion that the 21st century is bound to be the century of Chemical and Biological weapons. The book presents a pragmatic assessment of the threat we face from chemical and biological warfare. The author exploits his wide-ranging knowledge about the technology and history of CBRN warfare to appraise key biological/chemical agents and elucidate their attributes and effects on humans (Croddy, 2002).

Mauroni, a defence consultant with extensive experience in military chemical and biological defence issues provides a balanced view, rooted in grim facts about this controversial issue. The author covers nearly a century worth of hostilities (World War I: 1914 to 1918 till the Iraq War: 2003 to 2011) and adequately covers the multifarious hues of Chemical and Biological Warfare. He succinctly compares the aspect of CBRN warfare with super terrorist activities, elaborates upon suitable CBRN defensive measures and proposes a set of responsibilities for the government of the day, towards this important issue (Mauroni, 2007).

The National Disaster Management Authority (2008), have enunciated specific guidelines for tackling Biological Disasters. The authority provides well-researched information which could be utilised by the government and private organisations to frame Standard Operating Procedures (SOPs) at various operational echelons. The contents of each Chapter are effectively summarised to familiarise the layman with the important facets of managing Biological Disasters. These events could manifest as pandemics/epidemics caused due to the unintended release of the contagious microorganism(s) being used as biological agents, such as Anthrax, Smallpox, *etc.* It is pertinent to note that mass destruction can be easily caused by the reckless use of biological agents (National Disaster Management Authority, 2008).

Bhatia (2009) has compiled “invited chapters on bioterrorism and biological warfare” which plugs the wide chasm in the knowledge base of students and practitioners of the subject of Disaster Management. The author attempts to bridge the gap in the lack of information about the subject of bioterrorism and Biological Warfare and these could well be noteworthy aids for policymakers in the country. The author provides a wide variety of “opinions and different scientific dimensions of the bio-threats” which are imperative to satisfactorily cope with a “disaster or traumatic event, information to responders, health professionals, states, planners and provides educational materials for public awareness may be developed to combat bioterrorism events” (Bhatia, 2009).

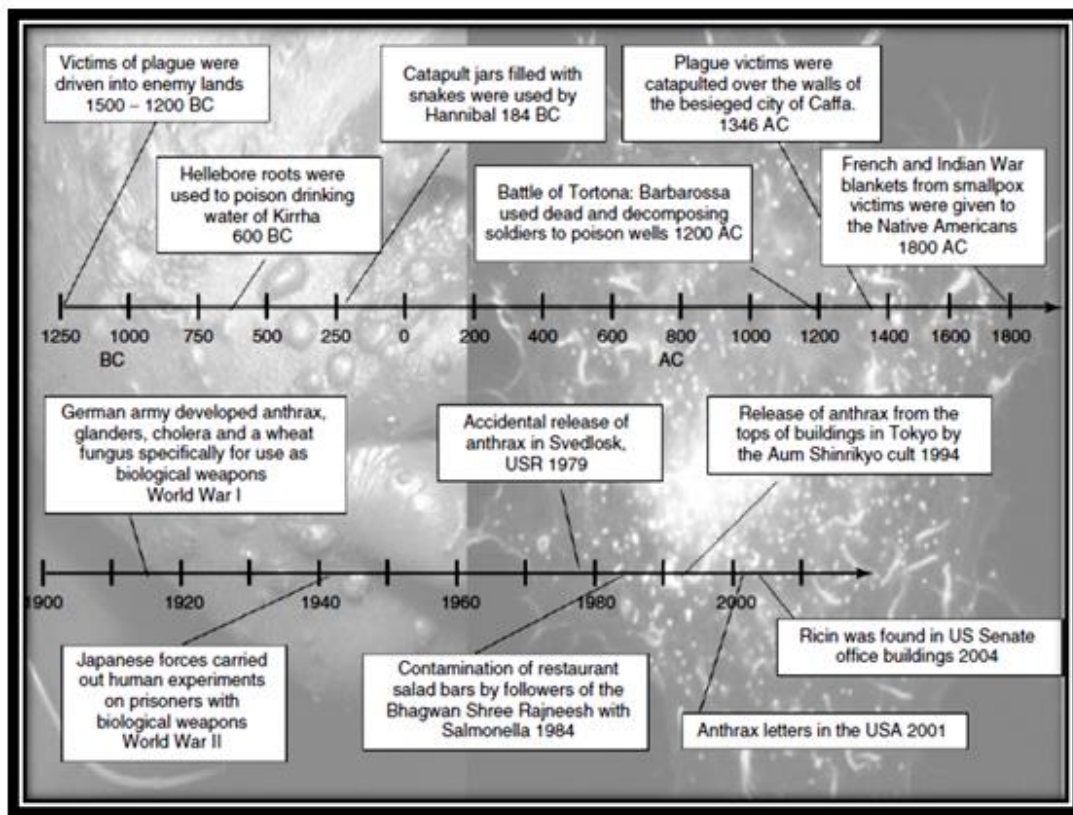


Figure 2: Timeline of Some Significant Examples of the Application of Biological Substances

(Richardt & Sabath, 2013)

The subject of CBRN WMD and their potential overt and/or covert use – have always been shrouded in secrecy. Richardt and Sabath (2013) discuss various issues about CBRN incidents and opine that CBRN terrorism is a prominent threat in the 21st century. They correctly point out that in order to find workable solutions to these imponderables it is important to understand our history. The emergence of bioterrorism can be attributed to the fact that several countries actively engage in “offensive biological weapons research and its use”. Moreover, it is also seen that a number of terrorist organisations have also shown a proclivity for using biological agents for terrorist activities (Richardt & Sabath, 2013). Some of these incidents are presented in the Table below.

Time	Event
Autumn 1984	Followers of the Bhagwan Shree Rajneesh contaminated restaurant salad bars with <i>Salmonella</i> in Oregon; 751 people were intentionally infected with the agent, which causes food poisoning
1985	Iraq began an offensive biological weapons program, producing anthrax, botulinum toxin, and aflatoxin. Iraq disclosed that it had bombs, Scud missiles, 122-mm rockets, and artillery shells armed with the B-agents. They also had spray tanks fitted to aircraft that could distribute agents over a specific target
1994	A Japanese sect of the Aum Shinrikyo cult attempted an aerosolized (sprayed into the air) release of anthrax from the tops of buildings in Tokyo
1995	Two members of a Minnesota militia group were convicted of possession of ricin, which they had produced themselves for use in retaliation against local government officials
2001	Anthrax was delivered by mail to US media and government offices. There were four deaths
2002	Six terrorist suspects were arrested in Manchester, England; their apartment was serving as a "ricin laboratory"
2003	British police raided two residences around London and found traces of ricin, which led to an investigation of a possible Chechen separatist plan to attack the Russian embassy with the toxin; several arrests were made
2004	Three US Senate office buildings were closed after the toxin ricin was found in mailrooms that served the then Senate Majority Leader Bill Frist's office

Table 2: Emergence of Bioterrorism

(Richardt & Sabath, 2013)

The West Bengal National University of Juridical Sciences in association with the National Disaster Management Authority has authored a compendium dealing with natural and artificially occurring disasters in India and in a methodical chronological manner, have enunciated Chapter wise all the laws related to specific types of disasters being discussed. Germane to the subject at hand are Chapters 1, 8, 12 and 15 which deal with General Acts (Central Level), Biological Disasters, Epidemic Diseases and Pest Attack respectively (National Disaster Management Authority, 2015). In addition, this compendium also provides at one place the various guidelines prepared by the NDMA on varied subjects related to Disaster Management.

Scholarly Academic Journals Reviewed

Alexander and Klein (2006) opined that terrorism has steadily changed its medium of spreading terror from “conventional weaponry and explosives” to more unconventional means which include CBRNe WMD, with the media hungry terrorists exhibiting an unmatched zeal for using unconventional means to cause destruction. The article indicates that the answer does not lie in a knee-jerk reaction but at the same time turning a blind eye and adopting an ostrich-like attitude towards this threat would be counterproductive. Hence, it follows that the community and its stakeholders, must necessarily prepare and ensure requisite measures are put in place to combat such an event, as and when it occurs (Alexander & Klein, 2006).

Bennett (2006) specifies that the US is susceptible to both domestic and international terrorist attacks – even without any major aggravation. This is true now for nearly all countries in the world, including India. To be able to react to any such event, medical institutions are prepping to be able to manage the onslaught of casualties – resulting due to an MCI. However, it is well established that most of our health facilities are woefully ill-prepared to manage an MCI caused due to a CBRN incident. Unfortunately – this might lead to untold misery and loss of life which would obviously be unacceptable to all governments of the day (Bennett, 2006).

Miller and Selgelid (2008) have eloquently deliberated about the dual-use impasse which is a natural by-product of the ongoing research in biological/other sciences. Science and its discoveries are often fraught with the prospect of having the potential to be simultaneously used for good or bad objectives. The aforementioned dilemma can be classified as ethical in nature both for the researcher as also for the government/organisation funding the research. The authors have also evolved a detailed classification of those areas of research and experimentation which may create ethical dilemmas. They also explore appropriate solutions to the vexatious predicaments posed as a result of the dual-use quandary elaborated above (Miller & Selgelid, 2008).

Bhardwaj (2010), erstwhile Member of the National Disaster Management Authority (NDMA), India has indicated that when faced with an MCI situation initiated by CBRN agents, it is advisable to utilise the limited resources and provide maximum succour to as many victims as humanly feasible (Bhardwaj, 2010). Additionally, the author recommended a vision for CBRN Disaster management in India as follows—

- Prevent CBRN incidents by adopting realistic, pragmatic, technically oriented security measures.
- Once a CBRN event does occur, the government must ensure time critical response to mitigate the effects of the incident on men, material and the environment.

Kumar, Goel, Chawla, Silambarasan and Sharma (2010) have discussed in detail the general principles, varied means and a wide variety of relevant aspects of CBRN decontamination. These are relevant to understanding the large quantum of the administrative load which will occur in the face of a CBRN event of even a minor magnitude (Kumar, Goel, Chawla, Silambarasan, & Sharma, 2010).

Ramesh and Kumar (2010) have authored an outstanding compilation of practical tips and pointers – specifically aimed at the actions of first responders with respect to “triage, decontamination, and treatment”. The authors’ make a forceful argument to indicate that there are a large variety of triage and decontamination protocols available the world over but it is essential to follow any particular method which meets with the requirements of the emergency at hand with special reference to number of casualties, their severity and the quantum of resources available (Ramesh & Kumar, 2010).

Thavaselvam and Vijayaraghavan (2010) of the Defence Research and Development Organisation (DRDO) Establishment, Gwalior have given a detailed account of the various biological agents which could be used as agents of bioterrorism. They have observed that complete preparation against biological agents will only be achieved with dedicated training/research facilities which provide comprehensive knowledge about the agent and its manifestations, field diagnostic capabilities and an upgraded public health system. This line of thought is contemporary and indicates the direction in which our efforts towards ensuring prevention, mitigation and preparedness, against potential biological threats, must progress (Thavaselvam & Vijayaraghavan, 2010).

Any large-scale bioterrorist incident like the deliberate release of aerosolized anthrax is bound to result in heavy civilian morbidity and mortality. Robison (2012) of the US Army suggests that concrete measures are imperative to improve relations between the civil hierarchy and the armed forces. These alliances, coupled with an appropriate rapid response to such a calamitous event – must be upgraded to enhance the overall preparedness of the Nation against such devastating incidents (Robison, 2012).

Tishler (2013) has evaluated specific factors which would decide the terrorists’ choice of a C, B, R, or N weapon once they have decided to use unconventional weapons. The study concludes that in the 21st century, the likelihood of a biological incident far outstrips the probability of a nuclear event (Tishler, 2013). This is something that we definitely need to be wary of, both now as also in the future.

Mazzone (2013) has pithily discussed and argued that the complex polity of world nations coupled with the looming threat of unprecedented violent actions by non-state actors – makes the

task of maintaining law and order in urban areas an uphill task. The situation is further complicated when one factor in the use of CBRN weapons – against whom the defence matrix is still in its infancy, especially in developing countries like India. He states that “...advances in science and technology have made the threat of a CBRN attack a distinct possibility”. This paper overviews terrorism in general and deliberates upon the current and future assessment of non-state actors and the probability of their using CBRN weapons (Mazzone, 2013).

Rebera and Rafalowski (2014), draw on their long-term professional CBRN experience to propose that in the aftermath of a CBRN incident, the First Responders will have to make several on the spot ethical decisions with far-reaching human consequences. In most cases, various guidelines and Standard Operating Procedures (SOP’s) will guide these decisions, but they might be inadequate to arrive at apt time critical ethical decisions. The paper outlines a methodology for arriving at ethical decisions when faced with the trauma and incalculable ambiguity of a CBRN event (Rebera & Rafalowski, 2014).

Jindal and Roy (2014) state that India is becoming increasingly vulnerable to CBRN threats – primarily due to its unique geo-strategic position, peculiar geo-climatic milieu coupled with its socio-economic vulnerability – to the entire CBRN palette. The biological threat is probably the most potent and looms large over the massively overburdened public health system of our country. Moreover, the bio-attack response is an exceedingly low priority area both for the hospitals and the government. The authors opine that most of the focus is on tackling the C, R, N components of the threat – whereas the damage potential from the B component is the most pronounced and hence, there is a necessity for a major shift in policy (Jindal & Roy, 2014). The following recommendations are presented for tackling the increasing probability of biological disasters—

- Delink bio-threat from the general CBRN palette, and ensure significant structural and functional changes in the response mechanism.
- Specialized cadre for dealing with bio-threats.
- Ensure enhanced surveillance capability and formulate a bio-threat mitigation node.

Ackerman and Pinson (2014) have deliberated at length, the dangers which are inherent to any society, region or country from “potential Lone Actors or Autonomous Cell (LA/AC)” engaging in destructive CBRNe. This is even more important in the connected world that we live in, where the media coverage that they are likely to garner will probably be more than that achieved by “formal terrorist organisations” perpetrating a simple explosion or adverse incident. The fact that they are a real and present danger – in terms of their “potential for mass disruption” is amply brought out by the authors (Ackerman & Pinson, 2014).

Ellis (2014) of the U.S. Air Force Counter Proliferation Centre, envisions the frightening likelihood of “Lone Wolves and Autonomous Cells” procuring and exploiting CBRN weapons. Since traditional military hardware of the CBRN variety is always stocked in very high-security areas, the attention of the lone wolves naturally gravitates towards easily accessible biological contaminants, industrial chemicals, and radioactive materials which they could use ingeniously for causing an MCI. The article goes on to deliberate upon those capabilities which would be crucial to “prevent, protect, respond, and recover” from an unforeseen CBRN terrorist acts (Ellis, 2014).

Chilcott (2014) opines that deliberate preparation and frequent exercising of all stakeholder’s capabilities along with their organic/inorganic resources is essential to implementing an effective response following a CBRN incident. In order to manage the incident in a well-coordinated manner – critical actions are necessitated to be implemented expeditiously which include evacuation, decontamination and transfer to a safe non-contaminated area. This should necessarily be followed up by a dedicated generalised health investigation plan if it is known that the contaminant utilised was capable of producing protracted health effects (Chilcott, 2014).

The Asan Report (2014) edited by Jiyoung – generated at the end of the “Science and Technology to Prevent and Respond to CBRN Disasters: US and South Korean Perspectives” workshop consists of six well-researched Chapters dealing with the prospective answers to preventing and mitigating disastrous situations involving CBRN agents; since they have the potential to cause MCI coupled with deleterious long-standing effects (Jiyoung, 2014).

- “Approach to Chemical Biological Radiological and Nuclear Disasters: Role of Science and Technology in Korea” by Whang Joocho, Kyung Hee University, Korea.
- “Science and Technology as a Solution to CBRN Disasters” by W Craig Vanderwagen, Martin, Blanck & Associates.
- “Science and Technology Solutions to Preventing and Responding to CBRN Disasters” by Kavita M. Berger, American Association for the Advancement of Science.
- “Science, Technology and the Prevention of CBRN Disasters: Mitigating Intention to Do Harm” by Diane Di Euliis, US Department of Health and Human Services.
- “Understanding the Environmental Effects of the Fukushima Disaster through Science and Technology” by Cho Kun-Woo, Korea Institute of Nuclear Safety.
- “Wide Area Radiological Incident Response Improvement through the Science and Technology Community” by Sang Don Lee, US Environmental Protection Agency.

Sandstrom, Eriksson, Norlander, Thorstensson, and Cassel (2014) have indicated a deep and abiding concern in all societies for the potential threat posed by CBRN WMD. The speed of

onset of these weapons is such that it necessitates an extremely swift, versatile and dynamic response. In the absence of such a precipitous reaction, the effects on the health and social well-being of the general public would be exceedingly severe and harmful. To ensure preparedness for such events, “Exercise cards for CBRN emergency response table-top exercises” have been prepared, which are a low-cost training aid of immense use to the disaster management practitioner (Sandstrom, Eriksson, Norlander, Thorstensson, & Cassel, 2014).

Sabol, Šesták, Polívka, and Mroz (2015) conducted an EU based study about combating all types of CBRN threats with the aim of minimizing the concomitant hazards by embracing suitable “prevention, preparedness and response measures”. The objective being to establish regional CBRN Centers of Excellence (CoEs) to bolster institutional capacities, mitigate CBRN risks/related terrorism incidents, and effectively reduce instances of unauthorised CBRN proliferation (Sabol, Šesták, Polívka, & Mroz, 2015).

Steinhausler (2015) while examining the probability of occurrence of a CBRN incident, reported that use of CBRN agents by terrorists to perpetrate unconventional attacks is steadily on the rise. The fact that this would be a high-impact event and affect the target population for many years to follow must temper the response of the government and spur it to achieve self-sufficiency against all aspects of reacting to a CBRN event. To ensure that such a level of preparation is achieved by the EU a sum of about €1,350 million was allocated for CBRN related security research from 2007–2013. The study (Steinhausler, 2015) also reported on the following—

- Findings of a holistic gap analysis amongst First Responders of EU Member States, with respect to the effective and efficient management of a disaster/catastrophe, with an oblique focus on CBRN incidents.
- CBRN counterterrorism research achievements in the EU.

Calder and Bland (2015) examined the phenomenon of disaster management and opined that despite the remote likelihood of the occurrence of a CBRN incident – due to the disastrous outcome likely as a consequence of the chemical / biological terrorism incidents, it is imperative to “plan and train” for any such eventuality. This is even more pertinent, since the first responders, will have to possess the specialised knowledge and be suitably equipped to mitigate the effects of such a disaster. They have further commented that such incidents necessitate early identification of the agent used so as to be able to decide the correct course of action to treat and prevent the disease caused as a result of the exposure. Also pertinent is the fact that a CBRN incident will have a disparate effect on the efficient management of casualties during the aftermath of any such incident (Calder & Bland, 2015).

The US Food and Drug Administration established a Medical Countermeasures Initiative in 2010, with the explicit purpose of studying medical countermeasures needed to counter any CBRN threats. Lansdowne et al. (2015) have reviewed the varied countermeasure initiatives as also the current research scenario to analyse how certain important medical devices could be deployed in combating a developing CBRN situation. They also observed that the task of Triage by the first responders in the case of a CBRN incident “presents unique challenges” since clinical manifestations of CBRN agents vary progressively with each stage of triage, thereby rendering “standard patient monitoring medical device and conventional triage algorithms ineffective”. This study also outlines the under mentioned advances in CBRN triage technology, which obviously with suitable field tests could affect pre-hospital triage technology for future CBRN events in a big way (Lansdowne et al., 2015)—

- Decision Support Systems E.g. Chemical Hazards Emergency Medical Management Intelligent Syndromes Tool (CHEMM-IST).
- Diagnostic field devices e.g. Joint Biological Agent Identification System.
- Electronic triage tags e.g. e-Triage.
- Mobile medical applications (“medical apps”) for CBRN disasters.
- Novel technologies.

Ruggiero and Vos (2015) have investigated the CBRN experts’ perceptions about communication during and after a CBRN terrorism incident to include myriad challenges and emulatable good practices. The major challenges in ensuring an efficient communication setup during such a crisis are primarily due to the unprecedented complications such as “resources, competences, and cooperation in preparedness communication” all of which are inexorably entwined with the management of such incidents. The study serves as an empowered instrument to conduct communication preparedness audit during a CBRN terrorism crisis (Ruggiero & Vos, 2015).

Guidotti and Trifirò (2015) in their investigations – particularly on Chemical threats – have arrived at the conclusion that the probability of usage of chemical warfare agents against the civilian population by terrorist outfits – is once again looming large on the horizon. They argue that the projected usage of chemical agents against civilians will probably perpetrate material damages and considerable psychological after-effects on the general public’s attitude. The authors dissect the plethora of misconceptions surrounding the usage of chemical weapons, summarise the pros and cons associated with the usage of chemical weapons in all-out hostilities/terrorist attacks (Guidotti & Trifirò, 2015). Most of the deductions arrived at specifically for the chemical agents examined are also equally applicable for most biological agents.

It is quite obvious that existing health facilities in any location would be taxed the most in case of a disaster resulting in an MCI. To ensure adequate medical care is provided to the patients in real-time, health facilities need to be fully effective during disasters. Nekoie-Moghadam et al. (2016) have conducted an exhaustive evaluation of hospitals on the basis of a total of 14 themes – namely – command and control, communication, coordination, evacuation, human resources, logistics, planning, recovery after a disaster, safety, structural and non-structural preparedness, surge capacity, training, transportation, and triage. The relevance of the article lies in the fact that a detailed study of the factors considered in this review can form the basis of generating a comprehensive tool to evaluate the preparedness of a health facility to combat an MCI situation (Nekoie-Moghadam et al., 2016).

CONCLUSION AND RECOMMENDATIONS FOR FUTURE STUDY

Any system is a collection of a multitude of variables and they are inexorably interlinked and entwined, with the past affecting the present and vice versa (Schoenenberger, Schenker-Wicki, & Beck, 2014). A basic understanding of the System Theory provides us with a conceptual framework to analyse the act of deliberate or accidental release of biological agent and arrive at suitable mitigation mechanisms. Edicts controlling biological open systems are equally applicable to any other system, of any varying form.

The salient principles of the Systems Theory, relevant to the current review are summarised hereunder:

- Parts that make up the system are interrelated.
- The strength of the overall system is dependent on all subsystems working optimally.
- Any Open system exists in an environment and its optimal functioning is based on a smooth give and take of information and material, to and from the immediate environment.
- The Subsystems forming a complete System have porous boundaries – from which both information and materials can pass in either direction.
- The permeability of an open subsystem can be monitored, controlled and regulated.
- A fine balance and synergy must exist amongst subsystems, with the whole being greater than the sum of parts.
- Equifinality vs. “One Best Way”.

In the instant case, the “Disaster Preparedness, Response and Mitigation System” of any city to an act of biological agent release could be seen as being comprised of four major sub-parts or variables. These could be enumerated as – the civil administration; government/private health facilities; essential services and the community. For the main system to function well and

produce desired results the above-mentioned sub-parts must inexorably perform in synergy. These sub-parts will have to necessarily interact with each other in a time critical manner with the inter se boundaries remaining permeable/porous to permit information and resources to be shared with each other without the menace of inter/intra organisational red-tapism. It is only then that the “overall system” would be able to efficiently reduce and/or prevent the unmitigated spread of the repercussions of the deliberate or accidental release of a biological agent.

Further, a corollary to the above discussion is that, to investigate the dastardly act of release of a biological agent of mass destruction, together with the untold devastation that it will obviously cause, it is not important to focus on who released the agent; Instead, it would be eminently preferable to adopt a proactive approach to focus on the preparedness, and security measures and tweak the mitigation mechanisms, rather than focus on the perpetrators (Corlett, 2003).

There is no gainsaying that preparation is key to facing any CBRN event, more so a biological agent release. Substantial damage/destruction will be suffered by the population of any city, due to a biological agent release, and this would be inversely proportional to the quantum of preparation which the city ensures against such an event. Hence, it is even more imperative for the civil administration and related entities of various Disaster Management organisations of states and cities to ensure appropriate levels of preparation, prevention and mitigation – at all echelons.

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