Rakesh Kumar Sharma & Kunal Sharma

Preventing Chemical, Biological, Radiological and Nuclear Disaster

Abstract: The purpose of this review is twofold. First, it provides a better understanding of the national guidelines to mitigate CBRN emergencies. The second purpose is to provide a preparedness response strategy in CBRN events. Admittedly, it is beyond the scope of this paper to provide a detailed preventive mechanism for every possible CBRN event. This paper provides the basic elements enshrined in the NDMA's CBRN guidelines to provide proper strategy to prevent and mitigate CBRN disasters.

Key words: CBRN, Threat, WMD, Prevention, Risk Reduction, Surveillance, Contingency Planning

1. INTRODUCTION

Disasters involving Chemical, Biological, Radiological, and Nuclear (CBRN) materials cause severe damage to lives, property and the environment, and thereby adversely affect the very foundation of humanity and sustainable development. Threats related to CBRN use are evolving rapidly on account of fast technology developments and the changing political milieu. Preparing India to address the threat of CBRN is a formidable challenge because anticipating such attacks and dealing with the shattering consequences of the CBRN agents involved, are difficult and complex propositions. Major prevention measures include stricter techno-legal regimes, and deterrence of proliferation, capability development & deployment. With the increase in the likelihood of the CBRN confrontations, the need to raise medical preparedness in particular is far greater today than

ever before. Utilization of information, knowledge, professional experience, and abilities is one approach to ensuring a high degree of expertise and competence in the CBRN area. The exchange of information on the national spectrum may include emergency response plans, gained experiences from exercises, research results regarding CBRN agents, CBRN detection methods, knowledge regarding forensic awareness at crime scenes, and improved analysis methods of forensic evidence.

CBRN substances have a wide range of hazardous effects, such as combustibility, corrosiveness, or associated toxicity, etc. [Sharma, 2010; Bland, 2006] explained CBRN incidents as those incidents that cause injury or illness to living organisms triggering into mass casualty events. They also have the potentiality to damage / disrupt the environment. CBRN disasters include issues of chemical and biological terrorism including those emanating as secondary disasters [Salem, 2003]. Approaches are described to brave the challenges of CBRN from the Occupational Health point in literature [Bobetich, 2005]. CBRN emergencies may result in occupational exposure, fire, explosion, release of toxicants. CBRN disasters are caused either by ignorance, negligence, incompetence, accident, malicious intention or deliberately as in Warfare. There is an imperative threat from a variety of CBRN agents that can be used to kill or incapacitate the military/paramilitary forces and the undefended civilian targets with associated consequences on livestock, crops, water bodies, military assets and civilian structures including environment. CBRN threats are no longer hype or horror, but a stern reality throughout the world. India being no exception is equally prone to CBRN emergencies.

2. CBRN THREAT PERCEPTION AND CHALLENGES

A summary of the CBRN threat matrix is schematically presented in **Figure 1**. It is pertinent to mention that naturally occurring biological hazards also include emerging and reemerging infectious diseases. Moreover, the intentional use of micro-organisms (either natural or genetically modified) or toxins derived from living organisms has been used to produce death or disease in humans,

animals, or plants [Cieslak *et al*, 2018]. Toxins can be classified both in Chemical Warfare agents as well as Biological Warfare agents categories owing to their hybrid nature.

Threat perception is further compounded by activities of hostile countries, non-state actors, and terrorists. Another dimension is state-sponsored assassination or attempted assassination using CBRN agents. CBRN Weaponry is going to be the ultimate weapon in the terrorist's arsenal. Alexander and Klein (2006) elaborated the challenges for preparation for a chemical, biological, radiological or nuclear terrorist attack. The emergence of state-sponsored terrorism, proliferation of CBRN weapons & their means of delivery, and recent increases in less discriminate attacks, all point toward a growing probability of occurrence of mass casualty incident triggered by CBRN materials.

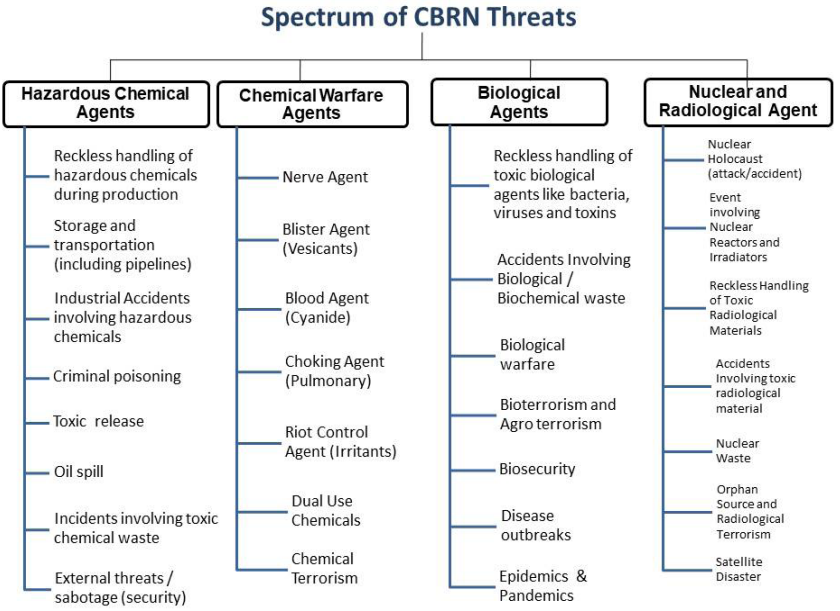

Figure 1: Possible CBRN Threats in India

The terrorist's intention in use of Weapons for Mass Destruction (WMD) will be to create both mass casualties as well as impact the society by causing mass disruptions [Cavallini *et al*, 2014].

Thus, CBRN threats are no longer a hype or myth but are real and imminent, rather a stern reality today. The CBRN threat perception settings are evolving at a very fast pace. But, it must be remembered that both predictable surprises and improbable scenarios are likely to emerge every time. This is precisely the reason why even the most meticulous planning may fail in real-time situations.

The National Policy on Disaster Management 2009 aims to prevent CBRN disaster from occurring at the first instant. But, in the event of unfortunate occurrences, various stakeholders shall undertake certain pre-planned and established Structural and Non-structural measures so as to mitigate the incidence and limit its consequences to health, life and environment. The degraded environmental resources are responded to, remediated and restored. Collaborative efforts will be needed to mitigate the potential impact of their mass casualty incidences wherein, the biggest challenges will be overwhelming of resources and stretching national capacities to their maximum extent followed by rehabilitation and recovery issues.

3. A BRIEF HISTORY OF MAJOR CBRN DISASTERS

Chemical attacks were extensively used in 1915. After World War I, new agents that were more lethal and potent than previously used chemicals were developed as Chemical Warfare agents. Second World War ended after nuclear attacks over the cities of Japan, *i.e.,* Nagasaki & Hiroshima on 6th and 9th August 1945, respectively. On 2nd December 1984, the biggest chemical accident happened in Bhopal, India, wherein approximately 40 tonnes of methylisocyanate (MIC) got released, exposing more than 5,00,000 people [Broughton, 2005]. Review studies indicate human health effects that resulted from exposure to emitted gases [e.g., Dhara and Dhara, 2002].

The Chernobyl disaster was a nuclear power plant accident that occurred on 26th April 1986, at the No.4 nuclear reactor in Plant, near the city of Pripet in the Soviet Union [Bonte, 2018]. It was classified as *Level 7* on 'The International Nuclear and Radiological Event Scale (INES).' The nuclear accident at the Fukushima Daiichi Nuclear Power plant in Okuma, Fukushima Prefecture in Japan that occurred on 11th March 2011 was a consequence of an earthquake of

magnitude 9.0 on a Richter scale that generated ~14m high tsunami. All three cores largely melted in the first three days. This accident also received a Level 7 rating on the INES, due to high radioactive releases. A comparison of the Chernobyl and Fukushima nuclear accidents and review of the environmental impacts of nuclear incidents is available in literature [Steinhauser, 2013].

Chemical weapons are banned under customary international law, the 1925 Geneva Protocol and the 1997 Chemical Weapons Convention (CWC). But, Chemical weapons have been allegedly used extensively in Syria since 2013 by both state and non-state actors [Trapp, 2017].

H1N1 virus triggered pandemic flu in January 2009. This perilous swine flu pandemic lasted for about 19 months, and was the second of two pandemics involving an influenza virus (Spanish flu pandemic was the first). We are presently witnessing the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV2) and the associated Coronavirus Disease (COVID 19) (declared global pandemic on 11th March 2020 by WHO). COVID has been stressing the public health infrastructure and economies all around the world and disrupted various contours of our personal and professional life [Gennaro, 2020].

India is aiming to develop a dynamic action plan to reduce risk, improve mitigation strategies, conserve the environment and continue pursuing sustainable existences based on the good practices and lessons gleaned from aforementioned major CBRN disasters

4. CBRN TECHNO-LEGAL REGIMES

The Disaster Management Act (DM Act,2005), received the assent of The President of India on 23 December 2005. Incidents involving CBRN agents are labeled as *Level 3* (L3) Disasters irrespective of their severity, size, location, actual or potential impact on public health, welfare, and infrastructure. Ministry of Home Affairs is the nodal ministry for Disaster Management and Terrorism. Ministries of Environment, Forest and Climate Change; Health and Family Welfare; and Atomic Energy Commission,

are the designated nodal ministries for Chemical, Biological, and Radiological & Nuclear Disasters, respectively.

4.1 National Disaster Management Authority Guidelines on CBRN Disasters

The National Disaster Management Authority (NDMA), India established under the DM Act, 2005, has issued various guidelines to enhance preparedness to protect its population against CBRN risks. The 'National Disaster Management Guidelines' directly or indirectly related to CBRN Disasters are as follows:

(1) Chemical (Industrial) Disaster Management. ISBN 978-81-906483-6-3, April 2007, New Delhi

(2) Medical Preparedness and Mass Casualty Management. ISBN 978-81-906483-6-3, October 2007, New Delhi

(3) Pandemic Preparedness beyond Health. ISBN 978-81-906483-6-3, April 2008, New Delhi

(4) Management of Biological Disasters. ISBN 978-81-906483-6-3, July 2008, New Delhi

(5) Management of Nuclear and Radiological Emergencies February 2009, New Delhi. ISBN 978-81-906483-7-0, February 2009, New Delhi

(6) Management of Chemical (Terrorism) Disasters. ISBN 978-81-906483-6-3, June 2009, New Delhi

(7) Psychosocial Support and Mental Health Services. December 2009, New Delhi

(8) Minimum Standards Relief (Shelter, Food, Drinking Water, Medical Cover and Sanitation).2010, New Delhi

These national documents call for a practical, participatory, understandable multi-disciplinary and multi-sectoral approach involving all stakeholder clusters, aimed at refining and strengthening the national mechanisms in this field, from stages of planning to field operations. These guidelines contain all details required by the planners and implementers.

4.2 List of Important Legislations and Rules related to CBRN

There exist a number of administrative, regulatory and legal arrangements in India for CBRN risk management including prevention, control, response and mitigation. A summary of CBRN Relevant Statutes is given in the following paragraphs. Public Health Emergencies Act (Draft) being drafted by MoHF&W intends to replace the Epidemic diseases Act, 1897, and provides for effective management of public health emergencies including bio terrorism.

4.2.1 Chemical Disasters

(1) The Environment (Protection) Act, 1986 (amended 1991), and the following Rules thereunder:
   (a) The Environment (Protection) Rules, 1986 (amended 2004).
   (b) The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (amended, 1994 and 2000).
   (c) The Hazardous Wastes (Management and Handling) Rules, 1989 (amended 2000 and 2003).
   (d) The Hazardous Waste (Management, Handling and transboundary Movement) Rules, 2008
   (e) The Environment Impact Assessment Notification, 2006.
   (f) The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996.
   (g) The Environment Impact Assessment Notification, 2006
   (h) Bio-medical Wastes (Management and Handling) Rules, 1998 (amended 2000)

(2) The Factories Act, 1948 (amended 1987)
   (a) State Factory Rules

(3) The Inflammable Substances Act, 1952

(4) The Motor Vehicles Act, 1988 (amended 2001, 2019)
   (a) The Central Motor Vehicles Rules, 1989 (amended 2005, 2019)

(5) The Public Liability Insurance Act, 1991 (amended 1992)
   (a) The Public Liability Insurance Rules, 1991 (amended 1993)
(6) The Petroleum Act, 1934
   (a) The Petroleum Rules, 2002
(7) The Insecticide Act, 1968 (amended 2000)
   (a) The Insecticide Rules, 1971 (amended 1999)
(8) The National Environment Tribunal Act, 1995
(9) The Explosives Act, 1884 (amended till 1983)
   (a) The Gas Cylinder Rules, 2004
   (b) The Static and Mobile Pressure Vessels (Unfired) Rules, 1981 (amended 2002)
   (c) The Explosives Rules, 1983 (amended 2002)
(10) The Drugs and Cosmetics Act, 1940 and various Rules framed thereunder
(11) The Poison Act, 1919
(12) The Weapons of Mass Destruction and their Delivery Systems (Prohibition of Unlawful Activities) Act, 2005
(13) The Defence of India Act, 1971 and the Rules framed thereunder
(14) The Civil Defence Act, 1968
(15) The Water (Prevention and Control of Pollution) Act, 1974 and Rules, 1975
(16) The Air (Prevention and Control of Pollution) Act, 1981 and Rules, 1983
(17) The Chemical Weapons Convention (CWC) Act, 2000
(18) Weapon of Mass Destruction Act, 2005

4.2.2 Biological Disasters

(1) Epidemic Diseases Act, 1897
(2) Water (Prevention and control of pollution) Act, 1974 and the Rules 1975

(3) The Air (Prevention and Control of Pollution) Act, 1981 and the rules, 1983

(4) The Environmental Protection Act 1986 and the rules, 1986

  (a) The Manufacture, Use, Import, Export & Storage of Hazardous Micro Organisms Genetically Engineered Organisms or Cells Rules, 1989

  (b) Bio-Medical Waste (Management and Handling) Rules, 1998

(5) The Biological Diversity Act, 2002

  (a) Cartagena Protocol on Biosafety to the Convention on Biological Diversity, 2003

(6) Weapon of Mass Destruction Act, 2005

4.2.3 Nuclear and Radiological Emergencies

(1) Atomic Energy Act, 1962

  (a) Radiation Protection Rules (2004)

  (b) Working of Mines, Minerals and Handling of Prescribed Substances Rules (1984)

  (c) Safe Disposal of Radioactive Wastes Rules (1987)

  (d) Control of Irradiation of Food Rules (1996)

  (e) Factories Rules (1996)

(2) The Civil Liability for Nuclear Damage Act, 2010

5. ARE CBRN DISASTERS PREVENTABLE

The disaster management framework in India has undergone a paradigm shift where the main thrust is on prevention. Prevention is a term that refers to the action of stopping something from happening or arising. The term CBRN includes measures to be deployed and actions that must be taken for preventing their occurrence and escalation. Prevention is the best way to achieve CBRN safety. Being fore-warned is being fore-armed is an age-old saying. Knowledge in advance enables one to be better prepared. The utility of the bio-surveillance portal and an international network of

institutional analysts in detecting biological threats is recorded in literature [Riccardo et al, 2014].

CBRN Safety and protection must be seen as an integral part of everyday life. China points in national strategies to combat against emerging infectious diseases elaborated [Han*et al*, 2017]. The accidents or attacks involving CBRN agents may not be totally preventable but the incidences can be minimized by adopting stringent measures for safety & security, and mitigated by adopting a sound risk management framework based upon the risk and vulnerability assessment, surveillance and environmental monitoring.

6. CBRN NON-PROLIFERATION AS A PREVENTIVE MECHANISM

The sequel of CBRN disasters is so devastating that substantial emphasis is laid on their prevention in the form of loss of life, risks to human health, the environment (particularly vulnerable ecosystems) and economic assets. All attempts are made for preventing such Incidents and Accidents from escalating to a disaster. CBRN accident prevention involves decisions, planning and action to prevent accidents from happening.

Preventing CBRN materials from falling into the wrong hands is a complex challenge given that their dual-use nature that makes them relatively easy to obtain through the healthcare, research institutes and industrial sectors illicitly or by pilferage. United Nations Security Council Resolution (UNSCR) 1540 asserts that propagation of chemical, nuclear and biological weapons, as well as their means of release, constitutes a danger to international peace and security. India is signatory to a number of international arms control, nonproliferation treaties and conventions limiting proliferation of nuclear weapons and banning biological and chemical weapons altogether.

India is party to the Biological and Toxin Weapons Convention (BTWC 1972), Biological Weapon Convention (BWC 1972) and Chemical Weapons Convention (CWC 1993). Also, India has joined many protocols and agreements towards effective non-proliferation, CBRN counter terrorism, strategic trade control of dual use goods

and hazardous waste management. As a signatory to BWC India "undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain: microbial or other biological agents, or toxins, whatever their source or production mechanism, of types and in quantities that have no explanation for prophylactic, protective or any other peaceful reasons; and weapons, equipment or means of release designed to use such toxins or agents for hostile intentions or in case of armed conflict. India has also signed and adopted International Health Regulations, IHR (2005) that seeks to protect against, control and provide a mechanism to initiate a public health response to the threat or spread of disease causing Public Health Emergency of International Concern (PHEIC) including that of biological, chemical or radio-nuclear origin.

7. VULNERABILITY ANALYSIS AND RISK ASSESSMENT

Vulnerability analysis and risk assessment needs to be carried out so that appropriate preventive strategies and preparedness measures are instituted appropriately. Integrated Disease Surveillance Systems (IDSP) should aim to perform real-time monitoring to detect early warning signals for instituting appropriate public health measures. Suitable assessment of the personnel, security, specific training and rigorous adherence to pathogen protection procedures are reasonable means of enhancing bio-security. India needs to maintain epidemiological intelligence to pick up early warning signals of emerging and re-emerging diseases of epidemic potential. Counter-terrorism strategies include collection of CBRN surveillance data that can detect early warning signs, environmental monitoring, and risk and vulnerability assessments. Pharmaceutical Interventions (like Chemoprophylaxis), Pre-exposure Immunization (preventive) of first responders and other preventive measures must be taken to enable them to help victims post-exposure. Environmental impact assessment of accidental or intentional releases of potentially hazardous materials in the atmosphere is increasingly supported by the development of modeling tools. This helps in risk zonation at the micro level by employing database management, and synergizing cooperation between various intelligence agencies. An

efficient mechanism needs to be devised to monitor and inspect the stockpiling and transportation of CBRN material. Surveillance at port of entries need be strengthened with appropriate controls. The current COVID-19 outbreak reminds the world about our vulnerability to the deadly CBRN hazards. Non-pharmaceutical interventions (like Social Distancing Measures to reduce direct contact with the affected persons) can delay the onset, compress the epidemic curve and spread it over a longer time, thus reducing the overall health impact. The spread of communicable diseases in many conditions can be controlled or prevented by isolation (home/hospital), quarantine (restrictions in the movement of the affected persons) and containment. The present COVID 19 situation has already put a big question mark on our strategic preparedness.

8. RISK REDUCTION

Risk reduction by prevention/mitigation including minimizing and eliminating risks, is key to pursuing the safe management of CBRN agents. Risk Reduction and Mitigation are important components of the holistic approach to disaster management. Risk Reduction implies dealing with root causes in order to reduce the total risk and lessen the likelihood. Risk Mitigation denotes building capacities to contain damage & reduce the consequences.

The most effective preventive step to deter a CBRN incident is to deny CBRN acquisition or capability development. Easy availability of CBRN agents and scientific weapons expertise, increasing knowledge about genome, virulence etc., in open public domain on the internet, poses a big challenge for preventing CBRN incidents. The internet has a big role in facilitating the malicious use of CBRN materials.

The CBRN Terrorism Threats Risk Reduction Framework includes measures to: (a) dissuade malicious actors; (b) deny material, equipment and expertise; (c) deter (counter-terrorism like epidemiological intelligence gathering mechanism or environmental surveys of chemicals/radioactivity to deter a terrorist attack); (d) detect illicit activities like covert CBRN program, and (e) defend against CBRN attacks with effective consequence management and

attribution. Appropriate financial strategies should be put in place to scuttle their flow of funds.

This will ensure that access to technology, materials, and capability, is greatly reduced. These measures are aimed to preventing and impeding predominantly State actors to acquire or attain capabilities of developing CBRN materials (Proliferation Prevention), to frustrate development of CBRN capabilities by potential actors (Actor-Capability Development Prevention), and to stop or defeat a CBRN device before its actual deployment. An illustration about protecting critical national assets and preparedness for response to hazardous chemical, biological and radiological attacks has been published recently [Sharma *et al*, 2019].

9. CONCLUSION

Integrating prevention & protection against CBRN disasters through the deployment of monitoring and surveillance systems, raising preparedness, honing skills for mitigation, capacity development and training, are the keys for safer world and safer India.

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