1. INTRODUCTION

There is a significant concern increased in the recent times about the use of chemical, biological, radiological and nuclear (CBRN) agents by terrorists, non-state actors or hostile rogue nations\textsuperscript{1,2}. The existing diagnostic and remedial measures need to be optimised to curtail health effects of the use of CBRN weapons of mass destructions (WMDs), which can result in huge number of casualties\textsuperscript{4-7}. Medical preparedness is an important link in disaster management. As a result; there is a common consensus amongst various CBRN training institutions to devise ways to enhance efforts to upgrade medical preparedness for effective management for handling such emergencies\textsuperscript{8}. The frequency with which CBRN emergencies occur is too limited to allow training during actual patient care but when they occur, their severity and criticality demand immediate and full attention to the patient’s care. Medical simulation creates a real time scenarios, in which person undergoes straining session that can be shown in detail like the health effects of such exposures and the way to treat/manage them. Trainees can proficiently master the skills relevant to clinical practice without undue risk to the life of emergency victims\textsuperscript{9,10}. It also permits errors of either diagnosis or treatment and observe the consequences that may follow thereafter. There is a potential for significant learning from errors in simulation, and this learning can be successfully implemented during the real time incidents, without any harm to either victims or medical responders.

Chemical, biological, radiological and nuclear (CBRN) emergency are becoming an impending threat. Effective preparedness needs to be raised for prompt response of CBRN incidents. During mass casualty incidents the strategy of the first responders must be beyond the triage, evacuation and medical first aid. Response process is advanced by the presence of CBRN contaminants and it becomes more complex when the rescue operations have to be performed immediately after the incident. Methodological approach is required to identify and decontaminate the CBRN victims. To manage CBRN emergencies, skill based training of appropriate degree is a key to the right level of preparedness. Intervention by first responders requires specialised inputs in knowledge, skills and aptitude. In India, CBRN defence training has traditionally been a military oriented domain, involving the quick reaction team, quick reaction medical team, rapid action medical team, etc. The training concept discussed in this study contemplates around standardised simulated CBRN casualty referred to as CBRN human patient simulator (HPS), which conceptualised in the division of CBRN Defence, Institute of Nuclear Medicine and Allied Sciences, Delhi. HPS provides an opportunity to learn about the health impact of CBRN contaminants and practise medical management. Simulation as training and planning tools, offers repeatability, controllability, possibility for evaluation and provides a platform to learn from costly mistakes. Group training and demonstrations conducted on the HPS offers an additive benefit to enhance performance as a team and also help to reduce errors. This paper provides the information on the potentials of simulation based training of emergency response teams in the management of CBRN victims.
been consistently imparting trainings in medical management of radiation injuries. Since 1st July 2010, it has been declared as a single window for CBRN emergency management training to military, paramilitary and elite forces. This review reports the evaluation of HPS as an integral part of training imparted to the CBRN responders at INMAS, Delhi.

2. HUMAN PATIENT SIMULATOR

Human patient simulator is an interactive mannequin that is basically meant for medical simulation in case of CBRN emergencies. It is almost full-sized ‘patient’ with life-like features as airways, pulmonary system, cardiovascular system, trauma patient monitoring, etc.

Preparing a training module for medical management of CBRN casualties is a complex activity because the scenario involves strange medical crisis, physical conditions, extenuation, etc. The necessity of decontaminating to the victims prior to initiating specific treatment and the criticality involved in physically safeguarding paramedics from secondary cross-contamination has influenced the need for preparedness of the medical professionals for specialised training.

3. CBRN PATIENT SIMULATION TRAINING CENTRE

A simulation training centre has been set up at the Division of CBRN Defence, INMAS, Delhi, to impart learning of the physiological functions, familiarisation with medical examination techniques, mastering basic life support techniques, while attending victims of CBRN based MCI. The simulation offers identification and addressing of rare and complicated clinical CBRN emergencies that are not usually encountered during medical practices. The training concept includes a standardised simulated victim suffering in a typical CBRN Emergency. The medical simulation technology training is primarily being conducted on the HPS with the help of moulage kit (Fig. 1). This kit provides material needed to create different types of wounds and rashes on HPS skin. Moulage kit includes synthetic life like wounds that accurately replicate muscle, tissues and subcutaneous fat, etc.

To create beta burns induced by radiation on HPS skin, we use a light coating of petroleum jelly sprinkle with talcum powder and red powder, to create smallpox, we use melt pound of flesh and then leave it to cool until its thick consistency occurs. After performing treatment on HPS, created smallpox and radiation burns can be removed with the help of soap and water or cold cream. For creating skin rashes due to anthrax we take a stipple sponge and dip it into the Ben Nye Crème CL-14 Blood Red and apply the stipple sponge to the HPS’s arm and make it into a rash. With ‘pound of flesh’ or Ben Nye Scar Effects Gel, we make a doughnut type asymmetrical circle. After adding more colours to the outer edges, spread it with fingers, to make the rash look more inflamed and rose (swollen). Pro Colour Ring Bruise #505-B or the Ben Nye F/X Wheel EW-1 can also be used to bruises brown colour for the darker colour. The simulator is a digitally enhanced mannequin that is sophisticated with mathematical models of human physiology – cardiovascular, respiratory, neurological and pharmacologic that imitates human response in multi-layered, real-time ways that are vital to a truly objective learning experience. The patient simulator blinks, breathes and have heart beat, pulse and respiratory sounds etc. Training with HPS allows us to prepare and identify opportunities to improve, standardise the medical management strategies and better serve the victims and community. Monitors are attached to display vital signs which can provide virtual simulation of almost every major physiological function (Fig. 3). HPS can be used for creating scenarios from simple physical examination to interdisciplinary major trauma management.

3.1 Training Set up

HPS has unique capability to display symptoms indicative of CBRN agents. Trainees can readily visualize the result of their decisions and actions. Errors can be created deliberately to arrive at best options as well as numerous alternative options. Identical situations can be prescribed to different teams of trainees and responses can be evaluated for comparative analysis that can also decode advance training needs of responders.

Actual medical equipment can be utilised and consequence limitations can also be understood simultaneously. The personnel can be exposed to multiple situations and the best selections can be identified with creation of real life clinical situations. The interaction among members of the teams can be analysed and extra attention can be paid to identify weak- links. In the team training methods can be evolved for effective team work, quality leadership and coordination/communication. The simulation response can be documented properly and used later for assessment and accreditation.
3.2 Importance of HPS for CBRN Learning and Training System

- HPS represents an advanced technology, mimics a real patient and adds authenticity which leads to the better learning opportunity than a text book, indicating that students perceived a huge difference between watching and performing.
- Once the simulation session begin, trainee forget that they are working on a simulated patient and responded to the situation as if it was real.
- Patient’s condition can improve or deteriorate with interventions as the scenario progresses and at any point of time scenario can be stopped and restarted to clear the doubt and confusions of the learners.
- Includes many trainees for single CBRN scenario learning.

For example: Five trainees worked together on each scenario, two inside participated and three were there as observer.
- HPS provide better opportunity to experience working as an Autonomous practitioner.
- The experience enabled to recognise the importance of a sound knowledge base to effective clinical judgement and decision making.
- Trainees get opportunity to work independently and the experience enabled them to coordinate effectively in the real time CBRN emergency.

4. DISCUSSION

During training, the mannequin will be connected with a laptop and a monitor for creating disaster scenario. Input will be provided with the help of its inbuilt software to the HPS and it will behave according to the instructions. Symptoms like vomiting, nausea, lachrymal secretion, dilation of pupil, excessive salivation and nasal discharge, increased/decreased temperature, blood pressure, heart beats etc. are introduced through digital commands. Typical of a CBRN attacks can be simulated on HPS. Later on, the trainees can perform desired activities to bring it back into normal condition.

The effects of ‘Sarin’ gas like constriction of pupil size, wheezing in chest and convulsion etc, can be demonstrated on HPS. The iris acts as a diaphragm, like a shutter on a camera, regulating the amount of light that enters through the pupil. The pupil appears as a black hole at the center of the iris. It
is the opening through which light enters the eye (Fig. 4). CBRN HPS is a valuable tool to meet training needs for CBRN medical management.

![Effect of Sarin instillation on the eye of the rabbit](image)

**Figure 4.** Traditionally, effects of Sarin on eye of rabbit is shown by instillation it in the eye and same in HPS.

5. CONCLUSION

The medical preparedness for handling mass casualty incidents emerging out of CBRN incidents is not limited to triage or preliminary treatments. As CBRN emergencies becomes a looming threat and medical system needs to be prepared to treat the casualties of such a mass casualty event. Obtaining specialised training about the medical aspects of CBRN agents is an important part of medical preparedness for both military and non-military medical institutions. Division of CBRN Defence at INMAS is actively working on their critical areas to develop a state-of-art CBRN simulation based training facility requisite for training of all responders /stakeholders in changing disaster dynamics. Workshops to train medical first responders and other emergency functionaries / stakeholders are held at periodic intervals, such courses are needed to be made mandatory for the medical responders and paramedics tasked with CBRN response. The ongoing training program combined with hospital drills shall provide an optimal solution for the treatment challenge and addresses the practicing needs of the training medics/paramedics.

REFERENCES

doi: 10.1016/j.cie.2014.04.020

ACKNOWLEDGEMENT
The author would like to thank the entire team of the Division of CBRN Defence and Director, INMAS for their fruitful inputs.

CONTRIBUTORS
Ms Sima Gautam Graduated in Computer Science and Engineering from Uttar Pradesh Technical University Lucknow, India in 2007. Currently pursuing MTech (Modelling and simulation) from DIAT, Pune, India. Presently working as a Scientist ‘C’ in the division of CBRN Defence at the Institute of Nuclear Medicine & Allied Sciences, New Delhi, India. Her research interests include: Applications of the modelling and simulation in CBRN Defence.

Mr Navneet Sharma Graduated in Pharmaceutical Science from the UP Technical University Lucknow, India in 2011. He had completed his masters in Pharmaceutics from the JSS University, Mysore, India in 2013. He is now a doctoral fellow at the Institute of Nuclear Medicine & Allied Sciences, New Delhi, India, and pursuing his PhD on the development and evaluation of topical nanoformulation for CBRN decontamination.

Dr Rakesh Kumar Sharma Completed his Masters in Pharmaceutical Chemistry from Panjab University, Chandigarh, India, in 1981 and received his PhD from the University of Delhi, Delhi, India in 1999. Presently he is Director of Defence Food Research Laboratory, Mysore, India. His Research interests include nanomaterials synthesis, characterisation and application in drug delivery systems.

Dr Mitra Basu had completed his MBBS+MD from PGIMS Rohtak, Haryana, India. He had also completed MBA in health care from prestigious FMS university of Delhi, India. Currently he is Scientist ‘F’ and head of Division of CBRN Defence at the Institute of Nuclear Medicine and Allied Sciences (INMAS), New Delhi, India.