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EDITORIAL

CBRN News: Emerging challenges for Risk Management in Chemical, Biological and Radiological Research and Development

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The challenges associated with effective risk management, and the risks of proliferation and developing offensive and defensive capability when working with Chemical, Biological and Radiological agents have recently been highlighted on the world stage. Work in any of the primary dimensions of CBRNE research and production carries a myriad of potential and actual risks that require careful control, and to avoid individual through to population impacts. Failures in risk controls can result not only in personal injury but also expose the wider population to significant and persistent risks.

In 2019 it has been alleged that a new class of missile – codenamed Skyfall in Western countries – suffered a critical accident during testing in the Archangelsk region in Russia. Of most importance is the belief that the new class of missile may rely on a miniaturised form of nuclear propulsion to give it effectively unlimited range and special manoeuvring capabilities. The accident and setback was reported as an accident by the Russian Ministry of Defence and resulted in the deaths of a number of research scientists (1). However, nearby radiological monitoring stations reported a brief burst of gamma radiation, and in the subsequent days surrounding villages were evacuated and officials alerted to potential consequences of radiological contamination (2). Outside of Russia the event has generated much debate and concern regarding the consequences of the weapons design, and implications if a larger accident were to occur. This kind of weaponry has the potential to cause accidental contamination of neutral territories that it overflies, such as if the weapon malfunctioned or crash landed. Despite not necessarily being designed to carry a nuclear payload, the destruction of a nuclear propulsion source on attack could lead to secondary atmospheric fallout and terrain contamination from radiological materials of the target and surrounding area. The handling of a nuclear propulsion system during testing of weaponry is also of concern – in this instance some sources have suggested that the accident occurred during a recovery operation for the weapon system (3). Extensive testing of such a propulsion system is a feature of weapons development, and how the risks associated with working with nuclear powered propulsion in the context of its use in weaponry are mitigated are not clear.

Recent reporting has emerged of a previously unknown and large airborne release of Ruthenium-106 in Central Asia in 2017. Initially identified as an increase in radio-isotope concentration in air, causation for the release was not previously admitted by any facility or organisation known to handle this hazard. Subsequent analyses have shown that the most likely cause for the incident was a large release from the Mayak reprocessing facility in Russia in late September 2017 (4) probably as a consequence of preparation of another large radiological source for scientific experimentation. It has been predicted between 100 and 300 teraBequerels of Ruthenium-106 was released in this incident (5). Atmospheric dispersion modeling and particle pathway back-propagation identified likely release from Mayak over a short period of time, followed by spread throughout Russia, through Southern Eastern Europe and subsequently into parts of Western Europe and Central Asia. While the nature of an event capable of producing such radio-isotopes is unclear, and the public health consequences of the release of relatively short-lived Ruthenium-106 deemed to be not significant, the event has highlighted the potential for regional and global effects from a single release event. Other recent events in the biological domain are also of concern. The recent explosion and fire at the Vector facility in Siberia (6, 7) highlight the potential for accidents to occur in critical facilities. According to accounts provided by Vector, and subsequent reporting around the world, a gas cylinder inside a facility undergoing repairs and maintenance exploded causing a significant fire, blowing out many windows, and resulting in one casualty sustaining severe burns. While assurances have been provided that biological agents were not present in the facility in the time, the Vector facility routinely conducts research into high risk biological hazards such as Ebola virus, and is one of two official repositories for Smallpox in the world. Were such an accident to occur in the facility where research involving high risk pathogens was being conducted, the exposure of workers to pathogens or the dissemination of pathogens outside of the facility is a possibility due to blast effects, carriage of the pathogen outside of the facility, or loss of pathogen control (8). The implications of highly transmissible agents such as Smallpox spread in the global population are much more significant than in the pre-eradication era due to the lack of general population immunity, rapid and cheap international travel, geopolitical environment, and challenges in providing adequate preventive and medical care to the exposed or affected in a timely way (9).

Accidents within high risk pathogen research and development facilities occur more frequently than realised by decision makers and by the broader public health community. Reports of numerous work, health and safety events occurring in major hazard biological research facilities (10-13), or the mishandling of anthrax specimens prior to transport between research facilities in the US and elsewhere in the world (14), are examples. Of significance for risk management, these events have occurred despite stringent and detailed policies and procedures in place. The difficulties of attempting to control a laboratory release of pandemic influenza in various major cities in the world was recently modelled, the results indicating the extreme challenges involved in managing such events (12). This highlights a persistent challenge in capturing potential hazard and risk causal pathways that lead to catastrophic events well prior to events occurring, be they due to failure to adhere to policies or due to the emergence of unexpected safety system fail states.

No safety system is infallible or risk free. By increasing the types and intensities of exposure of complex safety systems to hazards, the rate in which failures of risk controls and safety systems will occur, in parallel, increases. Where the consequences of such a failure is catastrophic to individuals and to populations, the argument for safely increasing work intensity involving such hazards is arguably unjustifiable or should prompt risk management system redesign and improvements. Equally, operational and design assumptions in many legacy systems are now beginning to be challenged (e.g. temperature, weather and population demands) leading to modes of utilisation that exceed design and operational limits of safety systems, often unknowingly to the end user. Many major safety systems for CBRNE facilities were designed and built when funding, maintenance and supporting systems were substantively different. How the Chemical, Biological and Radiological research and development facilities around the world manage both legacy and new and emerging risks is becoming more and more important. Competition between nation states is adding pressure to proliferate, innovate and match perceived and actual balances of capability. This is often in areas of trans-disciplinary research where safety data is necessarily limited in the initial phases of work. This also appears to be driving activity in domains and locations where risk control systems are not necessarily adequate, modern or suited to the task at hand.

About the author

I am an Associate Professor at the School of Public Health and Community Medicine at UNSW and retain military responsibilities as Staff Officer Grade 1 in Public Health, Occupational Medicine and CBRNE to Army Headquarters. I am a practicing vocationally registered General Practitioner, an Occupational and Environmental Medicine Physician, and a fellowship candidate for the Academy of Wilderness Medicine.

My doctoral research focussed on the central autonomic anatomy and integrative neurophysiology relating to the cardiovascular response to noxious inescapable physiological stimuli such as severe haemorrhage and visceral pain. Utilising my research background and subsequent clinical training, through the ADF I have been fortunate to have extensively deployed into a variety of complex and austere combat environments and have gone on to undertake advanced training in Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) Medicine and Senior Medical Officer training. Consequently, I was appointed as Senior Medical Officer for Special Operations Command for 2014 and was the Officer Commanding and Senior Medical Officer to the ADF CBRNE medical incident response element at Special Operations Engineer Regiment from 2012-2015.

I have extensive experience in the conception, design, planning, delivery and operations of health support systems and capability in remote and austere contexts; incorporating the management of exotic or novel hazards and risks. Extensive actual experience in planning for and management of major disasters, mass casualty and multiple casualty situations. I also have extensive overseas and domestic operational experience in command, personnel management, force protection, health protection systems, resilient systems design and test and evaluation. Direct responsibility and experience with leading deployable expeditionary medical support.

I am regularly consulted and participate in the development and review of national and international clinical and operational CBRNE policy and doctrine. I am additionally a peer reviewer for the journals Military Medicine (AMSUS) and Journal and Military and Veterans Health (AMMA). I also continue to conduct CBRNE medical, and general medical education and ADF GP Registar training within my military capacity, along with civilian instruction of the Major Incident Medical Management System (MIMMS) framework with MIMMS Australia.

My interests lie in health and medical systems innovation and research. I retain linkages with key national civilian and military education, research and development organisations and retain an active involvement in a wide variety of projects and initiatives supporting national public health preparedness goals. My current research effort and interests touch on complexity science, agent based and deterministic modelling, emergent complex adaptive systems phenomena, test and evaluation of systems, policy research, epidemic modelling, exotic and emerging infections, disaster preparedness and response, organisational resilience in health care, development of robust socio-technical systems in health care, and the modelling, simulation and investigation of public health interventions and systems.

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