POSTPRINT VERSION. The final version is published here: Wilson, L., Roffey, P., Lothridge, K., Rowan, S. S. A., & Crispino, F. (2024). Intersection of CBRN, Military Forensic Science, and Counterterrorism. Forensic Science International, 364, Article 112218. https://doi.org/10.1016/j.forsciint.2024.112218

Intersection of CBRN, Military Forensic Science, and Counterterrorism

Dr Lauren Wilson[a,b], Mr Kevin Lothridge[c], Sen Sgt Andy Rowan[d], Dr Paul Roffey[e], Prof Frank Crispino[f]

[a]Australian Government Department of Defence, Defence Science and Technology Group, Sydney, Australia; [b]Faculty of Science and Technology, University of Canberra, Canberra, Australia, [c]Global Forensic & Justice Center at Florida International University, Miami, USA, [d]Operations Support Command, Queensland Police, Queensland Australia, [e]Weapons Technical Intelligence, Forensics Command, Australian Federal Police, Canberra, Australia, [f+-+]Forensic Science Research Group, Université du Québec à Trois-Rivières, Québec Canada
Keywords: Chemical, Biological, Radiological, and Nuclear (CBRN); Improvised Explosive Device (IED); system of system; forensic intelligence; research; training; education.

Highlights

- There has been a parallel decrease in military forensic science and domestic CBRN capabilities over the last decade.
- Recent changes in the political, strategic, and operational environments indicate there is a need for the forensics community to review contemporary practices and for stakeholder awareness to improve operational contributions and effectiveness in the light of current and future challenges.
- Enhance integration of military forensic science, counterterrorism, and CBRN is needed.

Abstract

The wars in Iraq and Afghanistan required that forensic science was used beyond the traditional law enforcement and criminal justice goals and applied to military operations. The 9/11 terror attacks in the United States (US) inspired further attacks in the Western World, and highlighted the importance of national and international intelligence sharing for counterterrorism operations. Following the 9/11 attacks, anthrax was disseminated in the US mail system, demonstrating a successful modern use of biological agents. As a result, nations enhanced their Chemical, Biological, Radiological and Nuclear (CBRN) capabilities to prevent, prepare, respond, and recover from CBRN attacks but in the last decade, there has been a decrease in capabilities across military forensic science, counterterrorism, and CBRN. Recent changes in the global and strategic environment such as, the war in the Ukraine, the threat of grey zone conflicts (below the threshold of war) such as the conflict in the Middle East, and strategic competition, indicates international, national, state and local CBRN capabilities need to be reinvigorated in a world under digital transformations. There is a need for a harmonized approach to enhance the integration of military, law enforcement, and CBRN operations to support decision-making. In this paper, we look back to where we have come from and where we are now to make recommendations on where to from here

for military forensic science and counterterrorism, including CBRN which intersects both of these systems.

Introduction

Chemical, Biological, Radiological, and Nuclear (CBRN) attacks make up only a small proportion of the terrorist plots and use in warfare that the world has experienced to date. The prospect of terrorists employing CBRN weapons is of concern to the public and policymakers. Technological advances that make CBRN agents or devices easier and cheaper to prepare and deploy create ongoing challenges to the security agencies tasked to protect us from terrorism. The 9/11 attacks in the United States (US) prompted a decade of government sponsored activities in most countries to prevent, prepare, respond, and recover from CBRN attacks which included significant advances in forensic procedures to assist the investigation of CBRN incidents. The success of these initiatives in reducing the likelihood of a terrorist CBRN attacks has had the counter effect of introducing an element of complacency with a lessening motivation to maintain capabilities. Recent changes in the political, strategic, and operational environment indicates international, national, state and local CBRN capabilities need to be reinvigorated to meet the evolving threat to both domestic and military situations, this is because CBRN intersects both counterterrorism and military operations. The incorporation of forensic procedures into military operations offers a valuable tool for gathering information that is not normally captured in military operations. If performed in a manner required to meet both scientific and legal requisites forensic procedures performed in the battlefield can provide opportunities for both intelligence activities and criminal prosecution.

To understand 'where to from here' for military forensic sciences, counterterrorism, and CBRN, we first need to understand 'where we have come from' and 'where are we now?' The next section of this article will focus on providing a brief history of the use CBRN agents in warfare and terrorism and the rise of domestic and international terrorism, military forensic science and counterterrorism with particular focus on the Australian perspective.

Where have we come from?

1. CBRN

CBRN agents have a long history of criminal, terrorist, state sponsored, and military use, with the first use dating back to B.C. During World War (WW) 1 soldiers were the first to be exposed to scientifically developed (or selected) biological warfare agents (BWA) and chemical warfare agents (CWA). Anthrax and glanders, diseases cause by bacterial BWA, were used to infect livestock of Allied Forces (Kaufer et al., 2020) whilst the use of CWA, namely chlorine, phosgene, mustard gas, and lewisite, were reported to have resulted in the death of approximately 90,000 soldiers and civilians, with over 1.3 million casualties (Fitzgerald, 2008). Following WW1, several international conferences were held to limit the use of chemical weapons in warfare resulting in a general agreement via the Geneva Protocol in 1925 however this did not limit the research of CWA in the lead-up to and during World War 2 (WW2) (Plunkett, 2003). Biological weapons also featured significantly during the Sino-Japanese War from 1937-1945 as a part of WW2 where typhoid, cholera, plague, and anthrax were airdropped onto the civilian population of China (Kaufer et al., 2020). Post WW2, the cold war between the US and the Union of the Soviet Socialist Republics (USSR) resulted in a proliferation of State sponsored research that resulted in the development of new generations of chemical and biological warfare agents (Franca et al., 2019; Roffey et al., 2002). The implementation of the 1972 Biological Weapons Convention (BWC) and the 1993 Chemical Weapons Convention (CWC) aimed to reduce this threat from State sponsors.

The simplicity of the manufacture of chemical and biological agents, albeit in crude form, has attracted the attention of terrorist groups, as well as cults. In 1984 the US Rajneeshee cult attempted to influence the outcome of a local election by poisoning salad bars with Salmonella at multiple locations in Oregon, with 751 cases of salmonellosis documented (Kaufer et al., 2020). In 1994, the Japanese cult Aum Shinrikyo, disseminated the CWA sarin in Matsumoto city killing seven people, and again in 1995 in the Tokyo subway killing 13 and injuring thousands (Nakajima et al., 1997, Ganesan et al., 2010). Aum Shinrikyo also attempted a number of dispersions of botulinum toxin and anthrax but these attacks did not result in any harm to exposed individuals (Kaufer et al., 2020). In 2001, the Amerithrax attacks in the US used envelopes in the postal system to disperse highly refined anthrax spores to politicians and media outlets resulting in the death of five people and the infection of 12 others (Kaufer et al., 2020). Historically, chemical and biological attacks were conducted by terrorists with domestically motivated origins. Interest in CBRN by domestic terrorists is increasingly motivated through international origins. This also includes the potential for CBRN agents to be used on the battlefield and the need to consider attribution of CBRN during a military forensics operation.

2. The rise of international terrorism

In the 19th and early 20th centuries, terrorism was primarily a domestic issue (Esmailzadeh, 2023). However, in the late 20th century, international terrorism emerged with events such as the attacks on members of the Israeli athletic team at the 1972 Munich Olympics and the Lockerbie airplane bombing in 1988 (Esmailzadeh, 2023). Globally, terrorism has evolved from a primarily domestic issue to an international one largely due to changes in the political and religious perspectives, technological advances, and the emergence of international terrorist organizations and transnational attacks. A key sequence of events that changed the threat landscape, started in 1979, when the (then) USSR invaded Afghanistan. The US, through the Central Intelligence Agency (CIA), supported the Afghan insurgents and individuals to revolt against the USSR. In 1988-89, the USSR withdrew its forces from Afghanistan which subsequently precipitated the Afghan Civil War, resulting in the emergence of religious extremist groups and the formation of al-Qa'ida. This landscape further changed when Abu Mus'ab al-Zarqawi (a Jordanian jihadist) pledged his allegiance to Osama bin Laden, establishing an al-Qa'ida presence in Iraq (now known as Islamic State of Iraq and the Levant (ISIL)) (Esmailzadeh, 2023). Funding from State sponsors has allowed terrorist groups to evolve into well trained, well-coordinated and well-armed organizations. The internet provides the primary platform through which terrorist groups can extend their reach internationally (Bureau of Counterterrorism, 2022).

3. The Australian CBRN perspective

The attack at the 1972 Olympic Games and the Sydney Hilton Hotel bombing in 1978 were the catalysts for Australia to strengthen the protection and response to a terrorist event. In 1978 the Federal Parliament established the Australian Bomb Data Centre (ABDC). The following year, three federal law enforcement agencies, namely the Commonwealth Police, Australian Capital Territory Police, and the Australian Bureau of Narcotics, were combined into a single law enforcement agency, the Australian Federal Police (AFP) which also housed the ABDC (Brown, 2003). In 1979, the Federal government also created the Standing Advisory Committee for the Commonwealth State Co-operation on Protection Against Violence (SAC-PAV) which included Australian Government and state and territory agencies with the primary aim to establish a set of national arrangements and agreements to respond to threats or acts of politically motivated violence (Foster, 1986). Now known as the Australian and New Zealand Counter Terrorism Committee (ANZCTC), the committee continues to enable capability building through shared training and equipment acquisition wth a view to build a national terrorist response capability with jurisdictions supporting specialist functions (Australian-New Zealand Counter-Terrorism Committee, 2022).

‘Operation Pendennis’ is an historic example of an Australian joint counterterrorism operation between the AFP, Victoria Police, New South Wales Police, and Australian Security Intelligence Organisation (ASIO) in 2005 which successfully disrupted the activity of two terrorist cells, one in Sydney and one in Melbourne. The ‘home-grown’ terrorists were inspired by al-Qa’ida and its narrative. Simultaneous raids on the Sydney and Melbourne cells resulting in the arrest of thirteen men in Melbourne (with the conviction of nine) and the arrest and conviction of nine others in Sydney. It was unclear what the specific target of the attack was, but it was alleged at criminal trial that they planned to attack major sports events, and government buildings, including evidence the terrorists had undertaken surveillance of the Lucas Heights nuclear reactor (Bart Schuurman, 2014).

Following the US anthrax attacks most nations experienced a deluge of white powder incidents which spurred an international response to enhance each nation’s ability to respond to CBRN events; Australia was no exception. In 2007 the Australian Chemical, Biological, Radiological and Nuclear Data Centre (ACBRNDC) was established by the Australian government to monitor and record CBRN threats, and to provide expert advice to Government, health, and emergency agencies (Wilson et al., 2008). Housed in the AFP, the ACBRNDC worked side-by-side with the ABDC to provide CBRNE coverage to whole of government. However, in 2012 the ACBRNDC merged with the ABDC to form a technical forensic intelligence team known as Weapons Technical Intelligence (WTI). WTI maintains expertise across the CBRN, explosives, and Improvised Explosive Device (IED) disciplines for the AFP and the whole of government, albeit in a reduced capacity when compared with the data centres. This decline in resourcing has mirrored the CBRN risk level which has steadily declined since 2001 due to the absence of threats (except hoaxes), and in Australia a shift from terrorist threat to criminal threat. The current global strategic environment, has indicated there is a need to enhance preparation for a potential CBRN attack and capabilities for forensic attribution of the agents by law enforcement and military organizations (Wilson, 2023).

4. Military Forensics or forensic science in support of military operations

The emergence of international terrorist organizations in Afghanistan and Iraq and the subsequent wars in these countries also influenced the emergence of a new field of forensic sciences, namely military forensic science commonly referred to in military doctrine as 'exploitation'. Military forensic science emerged in Iraq in 2001 as it was recognized that forensic science could be employed beyond its traditional law enforcement and criminal justice purposes to help counter the IED threat faced by coalition forces in Iraq and later in the Afghanistan conflict (Muhl Jr, 2011).

Military forensic science on the battlefield differs from traditional forensic science in that military exploitation seeks information that can contribute to contemporary intelligence rather than for prosecution purposes. Rapid exploitation is imperative, requiring laboratories be immediately adjacent to the military theatre. Deployable laboratories were designed for this purpose (Figure 1). The initial deployable laboratories in Iraq were Combined Explosives Exploitation Cell (CEXC) facilities, which concentrated on the documentation of IEDs, collecting trace evidence, and analysing device construction and operation (technical exploitation) (Herion, 2012, McIntyre, 2016, Phillips, 2008). The military laboratory capability has since evolved to be equipped with a comprehensive set of forensic capabilities and trained personnel including latent print development, chemical testing, DNA analysis, and digital evidence extraction and analysis (Wilson et al., 2019a, Tonkrongjun et al., 2019, Wilks et al., 2017).

The subsequent drawdown from Iraq and Afghanistan necessitated fewer forensic science capabilities within these theatres of operation. In turn, the reduced demand for forensic capabilities to support military operations has resulted in a decrease in the number of deployable laboratories, equipment, capabilities and trained personnel globally post Iraq and Afghanistan (Wilson et al., 2020b, Wilson et al., 2019a).

Figure 1: Example of deployable laboratory configuration, a) shipping configuration showing how the laboratory is deployed, b) the interior setup, and c) the exterior view of the deployed laboratory. Images courtesy of Global Forensic & Justice Center at Florida International University, Miami, FL, United States of America.

Where are we now and where to from here?

Over the past decade, the global strategic and operational environment has evolved, which has affected the global response to terrorism and military conflict. There has been a shift towards strategic competition (often referred to as peer or near-peer competitors), grey zone conflicts (below the threshold of conventional warfare), and increased use of proxy organisations, such as militias, private military companies, and insurgent groups (Mazarr, 2015, Rid and Buchanan, 2015, Paul and Matthews, 2016). The use of proxy organisations further complicates the strategic and operational environment (Staniland, 2012). This complex geopolitical environment has shifted military engagements away from overt warfare to more nuanced forms of conflict that does not involve large-scale military operations (Mazarr, 2015). This has resulted in the blurring of the lines between military operations and law enforcement capabilities (Wilson et al., 2020c). There is little doubt the extension of forensic exploitation into the battlefield is a natural progression for military forensics. The alliance of military and law enforcement forensics can provide the conduit through which this can be achieved. The next section of this article will consider a number of aspects of the law enforcement and military relationship which can support the proposal.

1. Integration and Harmonization

Globally, terrorism is a significant asymmetric threat, which does not respect international borders and requires integration and harmonization nationally and internationally, as well as across organizations. Counterterrorism aims to equip law enforcement, forensic scientists, the intelligence community, and other agencies to counter the threat of terrorism. The threat of global terrorism means that offshore operations, such as in the theatre of operation can transition into onshore domestic terrorism investigations. For example, under Australian counterterrorism legislation and policy, foreign terrorist fighters that return to Australia can be held accountable for any terrorist acts and criminal activity that they have committed overseas. If it is not possible to prosecute returned foreign terrorist fighters in Australia then there are mechanisms in place to help to deradicalize them, reintegrate them into Australian society and for security and intelligence agencies to monitor and manage these individuals (Counter-Terrorism Coordination Centre, 2022).

In Australia, the ANZCTC is responsible for counterterrorism and facilitating interoperability across jurisdictions. The ANZCTC manages the counterterrorism coordination strategies, plans, and capability (Australian-New Zealand Counter-Terrorism Committee, 2022, Counter-Terrorism Coordination Centre, 2022). This approach provides close cooperation across Commonwealth, State, Territory, and New Zealand (NZ) governments, including the Joint Counter Terrorism Teams (JCTT) in each Australian State and territory. This strategy has been effective for early detection and disruption of acts of terrorism.

In Australia, one of the key law enforcement and national security issues facing counterterrorism operations is when to declare an investigation or operation as terrorism, because counterterrorism investigations enact specific legislation, which may result in standing up of multiagency joint counterterrorism teams. Another consideration is the Australian Defence Force (ADF) can be called on to support the law enforcement response and the community during or following a terrorist incident. The ADF may assist law enforcement, and security and intelligence agencies under the Defence Force Aid to Civilian Authorities (DFACA) (Part IIIAAA of the Defence Act 1903) (Australian-New Zealand Counter-Terrorism Committee, 2022).

It has been proposed that a 'systems approach' can be used to describe forensic science as a system of systems that supports the larger systems that includes the criminal justice, law enforcement, and military systems. (Wilson et al., 2019b, Wilson et al., 2020b, Wilson et al., 2020c). The units of the forensic science system can include counterterrorism operations and CBRN. A systems approach to forensic science provides integration and harmonization by recognizing that all components are integrated and provide an end-to-end approach (Figure 2). For example, traces collected on the theatre of operation or during counterterrorism operations could potentially be used to support prosecution in the civilian legal system. Therefore, there is a need to preserve the prosecution option, because the analysis of today's traces to inform intelligence, could be tomorrow's evidence in a court of law. Preservation of the prosecution option can be achieved under a forensic intelligence model, referred to as Forensic Enabled Intelligence in the military domain.

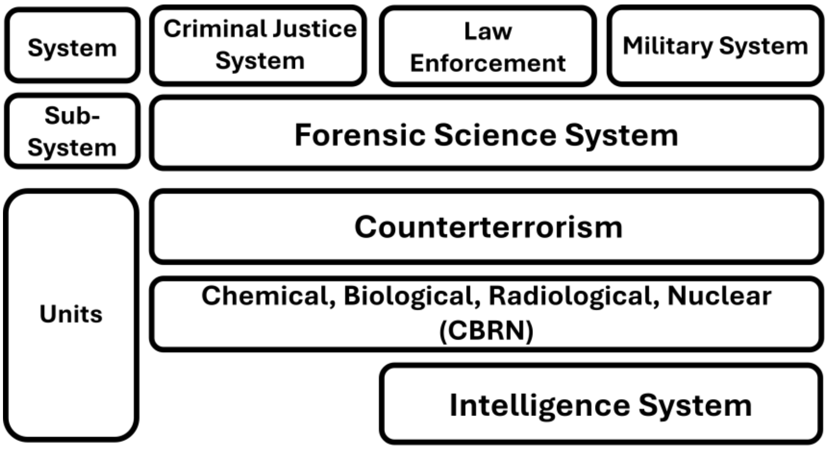

Figure 2: The forensic science system of systems informs the larger criminal justice system, law enforcement, and military systems. The units can include counterterrorism operations that are mainly law enforcement operations but may be informed by military operations and intelligence. Chemical, Biological, Radiological, and Nuclear (CBRN) events intersects the law enforcement and military system and response to CBRN events may require joint operations. Therefore, it is important to note that these systems do not operate in siloes. The intelligence system informs all the larger systems (Figure modified from (Wilson et al., 2019b).

In 2004, Forensic enabled intelligence emerged in the military domain to link people to places, places to things, and things to people. Forensic enabled intelligence has evolved significantly since its inception and now is integral to operational support, necessitating timely, accurate, and actionable intelligence (Wilson et al., 2020a). Due to the time-sensitive nature of military operations, there may be the need for rapid forensic analysis at the point of collection and results are maybe needed within a 15-minute timeframe on-site, with further priority analysis within 24 hours. This approach requires properly trained and equipped soldiers that can perform forensic collection and analysis in theatre and soldiers and/or scientists performing intermediate or advanced level forensic analysis as a priority within deployable forensic facilities as close to the point of collection as possible. Where practical, this should occur without affecting the ability of a forensic laboratory with advanced capabilities to perform additional analyzes on the same trace preserving the prosecution option, if required. The need to preserve the prosecution option has been highlighted by the rise in global terrorism and foreign fighters over the past decade, which are contributing factors to the blurring of the lines between military objectives and law enforcement activities (Wilson et al., 2020b).

There is also a need to consider the pivot to state-sponsored proxy warfare that is used to achieve state strategic objectives. For example, the Islamic Resistance in Iraq (IRI) is reported to be an Iranian backed armed group that oppose the US support of the Israel-

Hamas conflict. The emergence of proxies, such as IRI, raises the question 'how do we leverage military forensic science and the prosecution option under rule of law at the strategic level or to achieve a strategic outcome'? The pivot from full out warfare to grey zone operations and state-sponsored proxy warfare has meant that there has also been a shift in the types of devices recovered by the military. Uncrewed Aerial Vehicles (UAVs), as well as IEDs are collected and analysed for biological traces; fingermarks; toolmarks; and/or digital traces (Atkinson et al., 2021).

The ADF is seeking to exploit the gap between military and traditional forensics through the implementation of a deployable forensic capability. The deployable laboratory facility, known as the L2 MATEX facility, comprises several forensic capabilities contained in one connected space. The L2 MATEX facility functions as a fully functional, albeit in a reduced capacity, forensic laboratory at the forward operating base. The facility will be staffed by ADF and AFP Forensics staff. The facility, when fully operational, will provide capability for the following forensic/military disciplines: triage, biology/DNA, fingerprints, chemical analysis, documentation and media, weapon system and device, digital, intelligence, and geospatial analysis.

The approach of the ADF and AFP Forensics working together in the L2 MATEX capability is that under a forensic enabled intelligence model where military personnel are tasked with collecting traces in theatre, and provide the traces to the L2 MATEX at the forward operating base. Timely intelligence is produced to inform decision-making and allow follow-up action in the theatre of operation. The ADF working with AFP Forensics personnel will be able to maximize forensic exploitation whilst providing exhibit continuity consistent with fit-for-purpose quality management systems to preserve the prosecution option (Wilson et al., 2019a, Wilson et al., 2018).

2. Research and Development

Good science supports good results and informs-decision making. Internationally there is no 'center of excellence' to support traditional law enforcement and forensic science research. The National Academy of Science (NAS) Report on *Strengthening Forensic Science in the United States: A Path Forward* notes that there is no unified strategy for forensic science research, and the research is not well supported in the US. One of the key recommendations from the NAS report was the implementation of a National Institute of Forensic Science (NIFS) to address this shortfall. Due to various political reasons, NIFS was never formed in the US and 15 years after the publication of the NAS report there is still no federal agency to support a unified forensic science strategy (National Research Council, 2009). In Australia, this role is coordinated by the Australia New Zealand Policing Advisory Agency (ANZPAA) National Institute of Forensic Science (NIFS). In 2018, the Research and Innovation Advisory Committee (RIAC) was established to review and provide advice on research priorities to ANZPAA NIFS. ANZPAA NIFS in consultation with RIAC and the forensic science community produced a Research and Innovation Roadmap to help provide a strategy for investment of funding and resources in forensic science research in Australia and New Zealand. Although there is only a small amount of funding associated with the roadmap it aims to minimise duplication of effort (National Institute of Forensic Science, 2020). The research priorities in the roadmap also can apply to military forensics, counterterrorism, and CBRN.

Even though there are international programs that support collaboration for non-conventional forensic sciences, the key question is ‘how do we engage nationally and internationally to make the biggest impact?’ The ‘simple’ answer is, to share research needs, requirements, and current projects across nations so that we minimise duplicate effort. Furthermore, sharing of lessons learned will also help to enhance international cooperation and collaboration to build trust, leveraging and establishing relevant agreements, and research funding. An example, of international cooperation is the CBRN Counter-Terrorism Capability Exercise (CAPEX) held every two years.

The Chemical, Biological, and Radiological (CBR) Counter-Terrorism Quadrilateral Group (Australia, Canada, United Kingdom (UK), and the US) leads the CAPEX series. During CAPEX, law enforcement and military organizations cooperate on specific vignettes that are designed to test their response to CBR events and evaluate their capabilities. The outcomes and lessons learned inform needs and requirements as well as future research collaborations (Australian Government Department of Home Affairs, 2022). An example of a research program that has resulted from CAPEX is the Emergency Response Decision Support System (ERDSS) (Chemical Companion, 2024) which provides first responders with decision support for hazardous environments contaminated with chemical agents. The software tool is provided free-of-charge to the military, law enforcement, and fire departments and operates on Windows, Android, and iOS systems.

3. Education and Training

There is also no international ‘center of excellence’ to address military, counterterrorism, and CBRN education and training. Within Australian, the main objective of the ANZCTC is to contribute to the security of Australia and NZ. The ANZCTC has evolved, with contemporary police practices, from the 1980’s where the focus was simply on managing the incident through to the resolution phase. The current committee now includes capability groups that advise on prevention, protection, investigation, rehabilitation, and exercise management following the ICENRIRE (Isolate; Contain; Evacuate; Negotiate; Resolve; Investigate; Rehabilitate; Evaluate) elements of incident command (Bob Atkinson, 2011).

The objective of any training within the ANZCTC environment is to create courses that are accessible to all jurisdictions, so that all members within the specialist units receive the same training to enable interoperability when required to support another jurisdiction. This enables the police members from different jurisdictions to work as a single team when required or to capacity build during a protracted response. This philosophy also includes the ANZCTC equipment acquisition program. Where possible all states and territories receive the same specialist equipment and consumables as this enables specialist resources to be shared by jurisdictions during demand surges. Much of the equipment and consumables used in the counterterrorism space is of a highly specialist nature with long supply timeframes, thus the common platform approach is important when equipment is out of service within one jurisdiction or during deployments and can be rapidly replaced via loan arrangements between jurisdictions. Similar loan arrangements for consumables allows jurisdictions to maintain sufficient stockpiles for emergency situations whilst minimising waste due to expiry dates.

Forensic science related capabilities under ANZCTC traditionally fall under the investigation streams and now include bomb scene examination, forensic support, and CBR capability groups. These capabilities provide advice and direct training and exercises to enhance and develop specialist skill sets to accommodate the emerging threats to Australia and NZ. Members of the ADF are involved in the development of training, and often form part of the Directing Staff in the training environment. This leveraged approach also includes the use of ADF ranges and specialist training facilities that are beyond the scope and budget of many smaller police jurisdictions. This cross-pollination of skill development and shared experience enables a healthy environment of continual development across the capability groups.

The integration of ADF members into the ANZCTC builds trust and networks to allow members to reach into each other's expertise and organizations. The CAPEX series of exercises demonstrates the need for law enforcement and military organizations to train together. A key issue with joint training between law enforcement agencies and the military is the rotation of military personnel through the posting cycle. There is a need for law enforcement and military agencies to establish enduring relationships for training and exercises that are organizational based and not personality-based so that the relationships do not deteriorate when military personnel rotate. This would be strengthened by recognizing that military forensic exploitation is a skill within the military that needs to be maintained throughout a soldiers career. Another key issue is the loss of CBRN education and training in nations that have decreased their CBRN capability.

Final Comments

The domestic terrorist events that occurred in the US in the early 2000s stimulated a decade of focussed efforts by nations to enhance their capabilities and laws to prevent, prepare for, respond to, and recovery from future terrorist events, including CBRN events. In parallel, most law enforcement agencies in developed countries shifted the focus of their counterterrorism investigations from response to disruption. These efforts have been exceptionally effective in preventing similar terrorist events from occurring. However, in the absence of domestic terrorist events the stimulus to maintain and enhance counterterrorism capability has waned. Furthermore, with the drawdown from Iraq and

Afghanistan the military forensic science deployable laboratory capability has decreased globally.

However, the current political, strategic, and operational environments including the war in Ukraine, the threat of grey zone conflict (such as the current situation in the Middle East), and strategic competition indicate at the present time, more than any time in the past, CBRN capability needs to be reinvigorated. The expansion and strengthening of forensic capabilities into military operations has numerous benefits that range from extending the range of information that is available to inform military operations to providing a safeguard for the legal defence of military activities. The current activities in the Occupied Palestinian Territory of Gaza demonstrate the global scrutiny that is now expected from military operations. Further, the performance of military forensic activities performed in collaboration with domestic forensic laboratories is critical to successfully prosecuting and security convictions of foreign terrorist fighters.

The leverage of interagency cooperation is essential for the benefit of national and global security with emphasis on the following considerations;

- Enhanced integration of the military, law enforcement, and CBRN operations to support decision-making;
- National and international sharing of research needs, requirements, and ongoing work to help reduce duplication of effort;
- Recognition of military forensic exploitation as a key profession that needs to be maintained during the warfighters career; and
- Conduct of joint exercises with military and law enforcement organizations to enhance trust and build networks.

References

Atkinson, S., Carr, G., Shaw, C. & Zargari, S. 2021. Drone forensics: The impact and challenges. *Digital Forensic Investigation of Internet of Things (IoT) Devices***,** 65-124.

Australian-New Zealand Counter-Terrorism Committee 2022. *National counter-terrorism plan,* Canberra, Australia, Commonwealth of Australia

Australian Government Department of Home Affairs 2022. *2021–22 annual report* Canberra, Australia, Commonwealth of Australia.

Baker, D. 2004. The reinvention of Australian Federal Policing in the pursuit of national security. *International Journal of Comparative and Applied Criminal Justice*, 28, 145-167.

Bart Schuurman, S. H.-H., Andrew Zammit and Pete Lentini 2014. Operation pendennis: A case study of an australian terrorist plot. *JSTOR,* 8**,** 91-99.

Bob Atkinson 2011. *Queensland police service (qps)* Queensland, Australia Minister for Police, Corrective Services and Emergency Services

Brown, T. 2003. The coming of age: Australian bomb data centre. *Platypus Magazine,* 78**,** 16-20.

Chemical Companion. 2024. *Emergency response decision support system* [Online]. Florida, United States: MEPSS LLC. Available: https://www.chemicalcompanion.org/ [Accessed 31st February 2024 2024].

Counter-Terrorism Coordination Centre 2022. *Safeguarding our community together australia's counter-terrorism strategy 2022,* Canberra, Australia, Commonwealth of Australia.
Crispino, F. 2024. Towards a forensic semiotics. *Forensic Science International***,** 111968.
Dror, I. E. 2020. Cognitive and human factors in expert decision making: Six fallacies and the eight sources of bias. *Analytical Chemistry,* 92**,** 7998-8004.
Esmailzadeh, Y. 2023. Defining terrorism: Debates, challenges, and opportunities. *Challenges, and Opportunities (May 27, 2023)*.
Fitzgerald, G. J. 2008. Chemical warfare and medical response during world war i. *American journal of public health,* 98**,** 611-625.
Foster, S. 1986. Maintaining a co-ordinated approach to counter terrorism. *Australian Quarterly,* 58**,** 321-325.
Franca, T.C.C., D.A.S. Kitagawa, S.F. deA. Cavalcante. J.A.V. da Silva, E. Nepovimova and K. Kuca. 2019. Novichoks: the dangerous fourth generation of chemical weapons. *International Journal of Molecular Sciences* 20(5): 1222.
Ganesan, K., Raza, S. & Vijayaraghavan, R. 2010. Chemical warfare agents. *Journal of pharmacy and bioallied sciences,* 2**,** 166.
Herion, O. R. 2012. Expeditionary forensic support to joint force commanders: What changes or considerations are warranted? *Quantico, VA: US Marine Corps Command and Staff College*.
Intelligence, P. J. C. O. & Security 2006. Review of security and counter terrorism legislation. Canberra Australia: Parliament of Australia Canberra.
Karolyi, G. A. & Martell, R. 2010. Terrorism and the stock market. *International Review of Applied Financial Issues & Economics,* 2.
Kaufer, A. M., Theis, T., Lau, K. A., Gray, J. L. & Rawlinson, W. D. 2020. Biological warfare: The history of microbial pathogens, biotoxins and emerging threats. *Microbiology Australia,* 41**,** 116-122.
Kirk, P. 1963. The ontogeny of criminalistics. *The Journal of Criminal Law, Criminology and Police Science,* 54**,** 235-238.
Lead Inspector General Report to the United States Congress. 2024. *Operation inherent resolve and other u.S. Government activities related to iraq & syria. January 1, 2024 – march 31, 2024*

[Online]. Available: https://media.defense.gov/2024/May/02/2003455786/-1/-1/1/OIR_Q2_MAR2024_FINAL_508.PDF [Accessed].
Mazarr, M. J. 2015. Mastering the gray zone: Understanding a changing era of conflict.
Mcintyre, R. 2016. Counter-ied collection and exploitation: A capability in need of a system of systems approach. *Counter-IED Report,* 2016**,** 1-6.
Muhl Jr, G. M. 2011. *Defeating improvised explosive devices (ied): Asymmetric threats and capability gaps,* Carlisle Barracks, PA, USA, Army War College.
Nakajima, T., Sato, S., Morita, H. & Yanagisawa, N. 1997. Sarin poisoning of a rescue team in the matsumoto sarin incident in japan. *Occupational and environmental medicine,* 54**,** 697.
National Institute of Forensic Science 2020. *Research and innovation roadmap 2020-2025,* Melbourne, Victoria ANZPAA, NIFS.
National Research Council 2009. *Strengthening forensic science in the united states: A path forward*, National Academies Press.
Paul, C. & Matthews, M. 2016. The russian "firehose of falsehood" propaganda model. *Rand Corporation,* 2**,** 1-10.
Phillips, S. 2008. The birth of the combined explosives exploitation cell. *Small Wars Journal*.
Plunkett, G. 2003. *Chemical warfare agent sea dumping off australia*, Department of Defence.
Ribaux, O. 2023. De la police scientifique à la traçologie - le renseignement par la trace. . *Lausanne, CH,* Presses polytechniques universitaires romandes.
Rid, T. & Buchanan, B. 2015. Attributing cyber attacks. *Journal of Strategic Studies,* 38**,** 4-37.
Roffey, R., A. Tegnall and F. Elgh. 2002. Biological warfare in a historical perspective. *Clinical Microbiology and Infectious Diseases* 8: 450-454.

Rossy, Q., Décary-Hétu, D., Delémont, O. & Mulone, M. 2017. *The routledge international handbook of forensic intelligence and criminology*, Routledge.
Roux, C., Bucht, R., Crispino, F., De Forest, P., Lennard, C., Margot, P., Miranda, M. D., Nicdaeid, N., Ribaux, O. & Ross, A. 2022. The sydney declaration–revisiting the essence of forensic science through its fundamental principles. *Forensic Science International,* 332**,** 111182.
Roux, C., Crispino, F. & Ribaux, O. 2012. From forensics to forensic science. *Current Issues in Criminal Justice,* 24**,** 7-24.
The Commonwealth of Australia 2003. Terrorism and cyclone insurance act 2003. *In:* Issued by Authority of the Assistant Treasurer, M. F. H. a. M. F. H., Social and Community Housing, (ed.). Canberra, Australia: Assistant Treasurer, Minister for Housing and Minister for Homelessness, Social and Community Housing.
Tonkrongjun, P., Phetpeng, S., Asawutmangkul, W., Sotthibandhu, S., Kitpipit, T. & Thanakiatkrai, P. 2019. Improved str profiles from improvised explosive device (ied): Fluorescence latent DNA detection and direct pcr. *Forensic science international: genetics,* 41**,** 168-176.
United Nations Security Council 2004. *Security council resolution 1566 on threats to international peace and security caused by terrorist acts,* New York, New York, United States, United Nations.
Bureau of Counterterrorism. 2022. Country Reports on Terrorism 2022. U.S. Department of State.
Wilks, B., Morgan, R. M. & Rose, N. L. 2017. An experimental study addressing the use of geoforensic analysis for the exploitation of improvised explosive devices (ieds). *Forensic science international,* 278**,** 52-67.
Wilson, L. 2023. Biological agents: Overview. *In:* (Ed.), I. M. M. H. (ed.) *Encyclopedia of forensic sciences.* Oxford: Elsevier.
Wilson, L., Roffey, P. & Norman, K. The integration of the australian chemical, biological, radiological and nuclear data centre into australian federal police forensic operations. ANZFSS symposium; Counter terrorism Forensics. , 2008 Sydney, Australia.
Wilson, L. E., Gahan, M. E., Lennard, C. & Robertson, J. 2019a. The black sheep of forensic science: Military forensic and technical exploitation. *Australian Journal of Forensic Sciences,* 51**,** 636-648.
Wilson, L. E., Gahan, M. E., Lennard, C. & Robertson, J. 2019b. A systems approach to forensic science applied in the military domain. *Australian Journal of Forensic Sciences,* 51**,** 12-21.
Wilson, L. E., Gahan, M. E., Lennard, C. & Robertson, J. 2020a. The forensic intelligence continuum in the military context. *Australian Journal of Forensic Sciences,* 52**,** 3-15.
Wilson, L. E., Gahan, M. E., Lennard, C. & Robertson, J. 2020b. Why do we need a systems thinking approach to military forensic science in the contemporary world? *Australian Journal of Forensic Sciences,* 52**,** 323-336.
Wilson, L. E., Gahan, M. E., Robertson, J. & Lennard, C. 2018. Fit for purpose quality management system for military forensic exploitation. *Forensic science international,* 284**,** 136-140.
Wilson, L. E., Kessler, M. P., Ellis-Smith, J. & Robertson, J. 2020c. A systems approach to integration of military operations and law enforcement investigations: Toward a unified forensic intelligence model. *Wiley Interdisciplinary Reviews: Forensic Science,* 2**,** e1358.