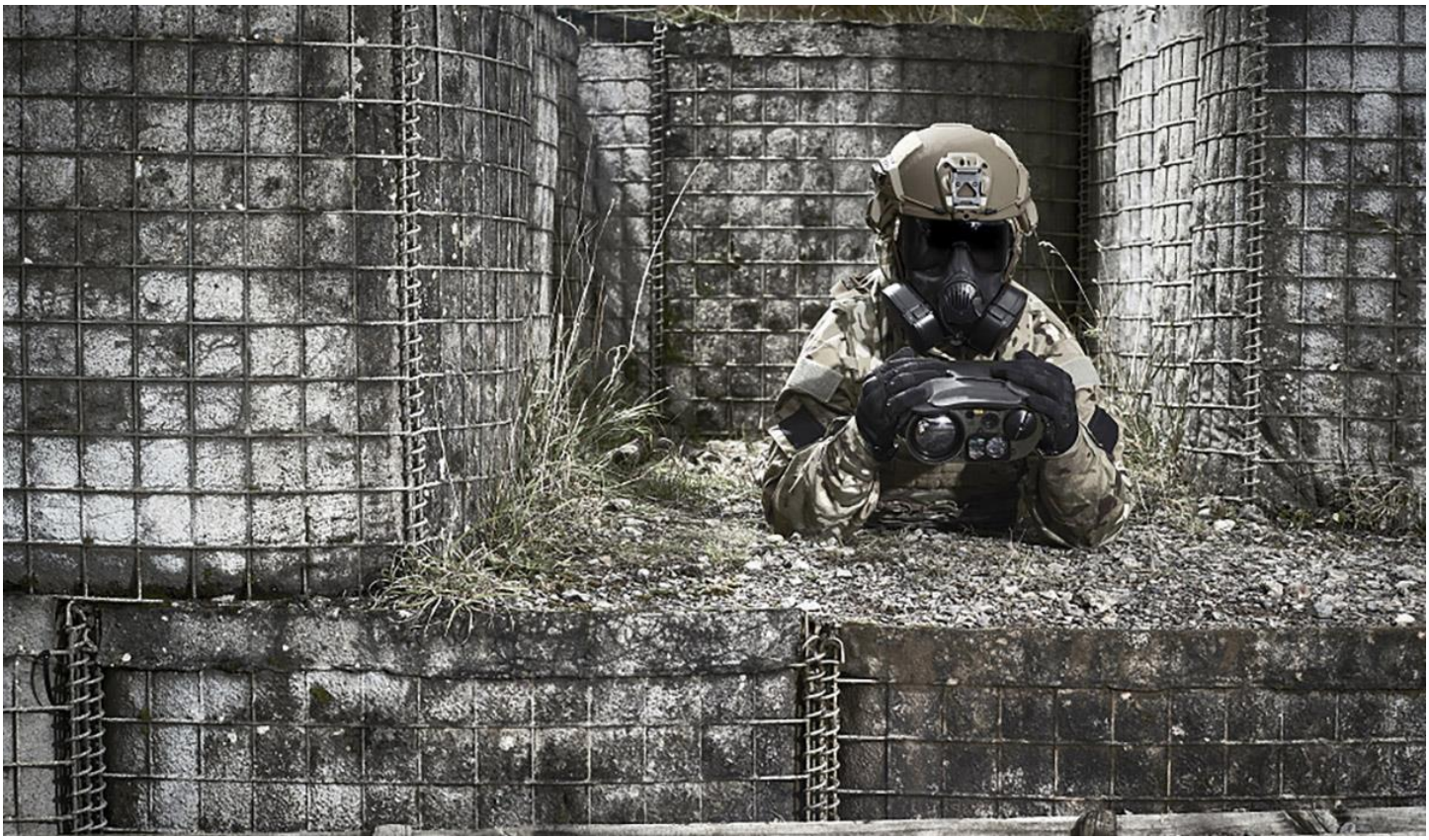

CBRN

Reducing the weight burden of PPE that may need to be worn by soldiers for four hours at a time is one current challenge for the industry. (Photo: Avon Protection)

Combatting COVID-19

The COVID-19 crisis has revealed the danger biological threats pose to military activity and the need for R&D resources to combat future pandemics.

Gerrard Cowan

Freelance defence journalist

The coronavirus outbreak has underscored the danger that biological threats pose to armies, highlighting the need for personnel protection and the demand to support wider populations and government authorities. There are a wide range of programmes under way internationally developing responses to such threats.

Biological warfare

While it is natural to focus on the potential of man-made threats, the impact of the COVID-19 pandemic has exposed the arguably greater danger posed by naturally occurring infectious diseases, said John Parachini, senior international and defence researcher at the RAND Corporation and formerly the director of its Intelligence Policy Center.

In the case of a state conflict involving a major or regional power, it is likely that by the time the warfare reached the level where an adversary would consider using biological weapons, ‘you may have other things to worry about’, he noted, such as nuclear weapons.

The deployment of biological weapons in such a scenario, while possible, is unlikely, he said, because they are very indiscriminate, hard to develop, difficult to use, the impact is uncertain and there are treatment means such as vaccines. ‘Why would you do that when you have other types of weaponry which you can control, and you have a much better sense of the scale and scope of their impact?’

Parachini believes it is also unlikely that a non-state actor could independently ‘create something that would have the cataclysmic consequences that we worry about. Is there interest? Yes. Is there a capability? On balance, no.’

However, the past year has clearly demonstrated the potential impact of naturally occurring viruses on every aspect of daily life, including militaries and their operations, particularly for land forces, Parachini said. The implications of pandemics have been a focus for US intelligence analysts like the National Intelligence Council for many years, he noted.

‘Look at the impact it has had on military operations around the globe, and it wasn’t an intentional use of biological weapons. That is possible, but not very likely,’ he added.

Pioneering protection

Biological threats have long been a major focus for DARPA. While the agency has increased the intensity of some of its work in the area and stepped up its cooperation with wider government authorities in the US, the pandemic has not driven the development of new research priorities, simply because the agency has long been thinking about the space, said Dr Kerri Dugan, director of its Biological Technologies Office (BTO). This meant the agency could boost its focus on existing medical countermeasures for infectious disease programmes, without ‘doing a pivot towards that space’.

BTO has a wide range of programmes that are directly relevant to battling COVID-19. These could play a role in the future battlespace or in combatting any other pandemics, both for armies and other military users but also for broader populations. For example, Dugan pointed to the Pandemic Prevention Platform, which aims to dramatically accelerate the discovery, integration, pre-clinical testing and manufacturing of medical countermeasures against infectious diseases, according to DARPA.

The idea is to rapidly develop antibodies to such diseases from convalescent plasma taken from people who have recovered from the infection, a process that would occur within just 60 days. An antibody-based therapy, identified as part of the programme, has already been approved for emergency use authorisation in the US to help combat COVID-19.

Another relevant programme is Epigenetic Characterization and Observation, which is building a portable device to analyse a person’s epigenetic ‘fingerprint’. This could provide a history of their exposure to different types of weapons of mass destruction, including biological threats and infectious diseases.

For COVID-19, preliminary results using this method suggest that it will be as effective as current tests and provide results earlier after exposure, Dugan said. Additionally, she pointed to the Detect It with Gene Editing Technologies programme, which is using advances in gene editing to support the detection of biological threats, including COVID-19.

‘I think that naturally occurring threats are a very serious concern to the warfighter, as well as the rest of the population,’ Dugan told *Shephard*. ‘With DARPA’s role in preventing and mitigating strategic surprise, we care about getting as far ahead of these threats as possible.’

Dugan noted that today’s nucleic acid-based vaccines were pioneered through the agency’s Autonomous Diagnostics to Enable Prevention and Therapeutics programme of about a decade ago. This work is still a focus for the agency today, through its Nucleic acids On-demand Worldwide programme.

Future solutions

DARPA has also launched programmes specifically focused on COVID-19. This includes SenSARS, which is developing sensors that can quickly detect the presence of the virus in the air. SenSARS was launched in February 2021, stemming from the SIGMA+ programme, which aims to develop capabilities to detect illicit CBRN materials.

‘As part of the SIGMA+ programme, research was already under way in environmental surveillance for pathogens, but the use case was very different and emphasised mobile monitoring,’ said Dr Mark Wrobel, programme manager for SIGMA+. ‘SenSARS put specific focus on possible signatures for SARS-CoV-2 and interior monitoring for the virus to help assess if those spaces were safe,’ he added.

While SenSARS is aimed for use in buildings, SIGMA+ is also evaluating the potential use of wearable technology to detect COVID-19 and other infectious diseases, in an effort led by RTI International and supported by Garmin. It will include a number of studies considering whether wearables can provide indications of infection based on an individual's immune response, said Wrobel. One study will track the health of USN sailors living in close quarters aboard a ship via a specially developed phone app.

DARPA also has a significant focus on manufacturing molecules to help combat COVID-19, notably through the Accelerated Molecular Discovery (AMD) and Make-It programmes. AMD is developing new approaches to increase the pace of discovery and optimisation of molecules that could contribute to medicines, along with a range of other areas; the programme is supporting the rapid development of drugs in the COVID-19 fight. Make-It is automating small molecule production, which could help accelerate the pace of chemical innovation in synthetic chemistry.

 The automated, small-footprint, continuous manufacturing platform for the production of Ciprofloxacin developed by On Demand Pharmaceuticals as part of DARPA's Make-It programme. (Photo: On Demand Pharmaceuticals)

Such research could have significant implications for soldiers, said Dr Anne Fischer, a Defense Sciences Office programme manager. For example, Make-It is maturing technologies originally developed under a previous DARPA programme – Battlefield Medicine – which would create a relatively small machine that could take raw materials and produce medicines for soldiers in the field. The programme is now focusing on extending this technology to a broader number of medicines, including injectable medication, based on requirements highlighted by COVID-19, both for the military and more broadly.

'If you had a forward operating base and they need a sort of cabinet of all the medicines they might require to treat a soldier in the field, it may just be impossible to have all that on hand. The idea is that you would ultimately be able to produce medicines in the field,' Fischer explained.

This would have important implications for logistics, she noted, at a time when the dangers of medicinal shortages have been demonstrated around the world. The ability to take a range of feedstocks or ingredients and tailor medicines as required would bring important benefits both to the general population and specifically for soldiers.

It is a complicated process, she noted, and may not in every instance be the right solution to a shortage. But the capabilities DARPA is building are flexible to meet many needs and could well feed into other advanced manufacturing goals for the military in areas like pharmaceuticals or biologic drugs.

Perfecting PPE

FLIR Systems recently won a contract with DARPA under the agency's Personalized Protective Biosystem (PPB) programme, which will incorporate a material and a biological solution to protect individuals from biological threats. FLIR is participating under the material solution and will develop new lightweight fabrics to ease the burden of personal protective equipment (PPE) for those who deal with chemical and biological threats. These fabrics would be used in protective suits and equipment like boots, gloves and eye protection, fighting and reducing chemical and biological threats to the eyes, lungs and skin.

Other participants are developing a biologically based protection system that does not rely upon fabrics or materials but on the use of advanced molecular components or even living organisms to be delivered as inhaled, topically applied or eye drop formulations. Such protective measures would work continuously without the need for any bulky suits or masks, while protecting individuals from a variety of threats simultaneously.

The concept of developing a radical new approach to producing lightweight PPE for the military is not new, said Dr David Cullin, VP for FLIR Detection Systems. There have been ongoing approaches to improve the protection provided by such equipment and to make them less burdensome to operators; indeed, the company had started working on PPB concepts long before the pandemic struck, while DARPA conceived of the programme a year before the first cases occurred.

However, 'the pandemic is probably serving to focus people's attention on a whole bunch of different directions to go in', he said, with implications on a broader scale: for example, in the production of face masks.

Cullin has worked in the broader biodefence sector for about 25 years and noted that throughout most of these years, 'you were in the business of convincing people to be ready', building technologies and systems, thinking through problems and building CONOPS. When those in the sector thought about bioterrorism and threats to military forces, much of the focus was on large-scale attacks with something like anthrax, he said, or the use of infectious materials. However, there is now a greater focus on naturally occurring threats, such as zoonotic viruses, which are transmitted from animals to humans.

Whether a biological threat stems from nature or a man-made attack, 'the technologies used to detect it, the technologies used to counter it and the way you think of force management are all the same', Cullin said. 'The pandemic has made people realise that the things we've been talking about for a long time are not only potential threats, but they do happen.'

 Avon Protection’s FM51 in-vehicle respiratory system. (Photo: Avon Protection)

The outbreak is shedding more light on the area for armies and other forces, with a heightened level of energy now being directed towards such threats from an R&D perspective.

Hamish de Bretton-Gordon is a former British Army CBRN specialist, who until recently was managing director of CBRN at Avon Protection, a manufacturer of respiratory and ballistic protection systems like the FM50 face mask and the FM51 in-vehicle respiratory system. He said in a recent webinar for the company – where he is still a consultant – that he expects the pandemic to impact militaries in many ways looking forward, perhaps including the provision of additional support to civil authorities in distributing vaccines and in other areas.

Military PPE has not changed significantly in the past ten to 20 years, De Bretton-Gordon highlighted. While such equipment successfully protects personnel from breathing in biological and other threats, the weight burden is an increasing concern, with the potential for soldiers to wear respirators and PPE for three or four hours at a time. This could lead to dehydration, a particular challenge in warmer environments.

However, while it is important to reduce weight, it is also vital that such PPE remains robust, De Bretton-Gordon noted. It needs to be well fitted to a person's face, particularly if they are expected to wear it for up to four hours at a time. 'We must get better at how we do that, and there are technological solutions,' he said.

According to De Bretton-Gordon, there is likely to be an increased emphasis on countermeasures, many of which are also key to the safety and health of the general population, notably vaccinations. PPE will be a particular focus for armies in the coming years, with COVID-19 serving as a potent reminder of the need for further evolution.