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Plague-d by an Invisible Threat: Reviewing Bioterrorism Readiness in Malaysia

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ABSTRACT

The assassination of Kim Jong-nam – the half-brother of the North Korean leader, Kim Jong-un – in Kuala Lumpur in 2017 shocked the world as it was carried out using the *VX* nerve agent, a lethal chemical weapon, in broad daylight. As this incident marks the first time such unconventional weapons were publicly used on Malaysian soil, it presents an opportunity to review Malaysia's readiness for non-traditional security (NTS) threats. There is an emphasis on a deliberate biological attack, or bioterrorism, given how biological weapons have similar characteristics and institutional pressures as natural pandemics, which have been a part of Malaysia's contemporary public health history. Moreover, the risk of bioterrorism is arguably rising as technological advancements in biotechnology have made tools for pathogen recreation more direct, inexpensive, and accessible. Given the adverse socioeconomic implications of bioterrorism, countries are incentivised to adopt an effective biodefence strategy that can detect, prevent, and respond to such weapons. While Malaysia has had a multi-tiered experience dealing with mass pandemics (e.g. *Nipah* and *SARS* outbreaks), recent events serve as an avenue to strengthen existing strategies and capacities. Thus, to enhance bioterrorism readiness in Malaysia, this article proposes feasible biodefence strategies.

Keywords: bioterrorism, biodefence strategies, non-traditional security threats, health diplomacy, Malaysia

INTRODUCTION

The usage of the *VX* nerve agent, a lethal and extremely toxic chemical weapon, in the assassination of Kim Jong-nam, the half-brother of the current North Korean leader, Kim Jong-un, in Kuala Lumpur in February 2017 sent shockwaves throughout the world. This incident, marking the first time such unconventional weapons were publicly used on Malaysian soil, questioned the extent of domestic readiness in response to NTS threats. That is, given their unorthodox and sophisticated nature – and potential evolution into hybrid threats – Malaysia must conceivably realign its approach towards these threats to preserve its national security. While attempted uses of bioweapons in terror attacks, i.e., bioterrorism, have mostly failed or had limited casualties – demonstrating the constraints faced in developing bioweapons (Zilinskas, Dando and Nixdorff 2011) – Malaysia must remain vigilant to prevent similar instances (re)occurring in the future. In fact, the lack of a dedicated policy framework that outlines biodefence chain of command and strategies arguably places greater importance on efforts to address any security lapses. Nevertheless, given how the intrinsic characteristics and effects of bioweapons may make them initially undiscernible from natural disease outbreaks (Lam 2003, Radosavljevic 2013), how must Malaysia then ensure that its medical and security preparedness is not only adequate to respond to bioterrorism, but also prevent any cases of false negatives?

This article is structured as follows: First, a review on the parameters of biological weapons and its link to bioterrorism. Second, an examination on the effects of bioterrorism on socioeconomic well-being, and current response readiness for bioterrorism from the perspectives of public health and health diplomacy. Third, a proposal on corresponding solutions to enhance biodefence strategies.

BIOLOGICAL WEAPONS AND BIOTERRORISM

Biological warfare, or the use of fatal biological agents, is as old as time – from the pre-historic period in Anatolia to the Mongol Golden Horde in the Middle Ages, there have been well-documented instances of a systematic development and weaponisation of fatal biological pathogens as agents of

warfare among sovereign states (Frischknecht 2003, Riedel 2004, Das and Kataria 2010). Credible external threats to survival during the World Wars and Cold War have incentivised military powers – despite their ratification of the Geneva Protocol of 1925, which banned the use of unconventional weapons in any circumstances – to conduct extensive research on bioweapons, such as *anthrax*, haemorrhagic fever, and *cholera* (Barras and Greub 2014). Besides the alleged deployment of glanders by Soviet Union during the Soviet-Afghan War, the international community has mostly refrained from using bioweapons in active warfare (in contrast to chemical weapons), perhaps due to high risks they pose on the perpetrators and the availability of conventional weapons. Subsequent development of biological agents was further discouraged with the signing of the 1972 Biological Weapons Convention that completely banned the production of such weapons. Since there is minimal evidence of proven stockpiles or active production of bioweapons among most state parties to the treaty – except China, Cuba, Egypt, Iran, Israel, North Korea, Russia, Syria, and Taiwan (Kerr 2008, 14-15) – it implies the effectiveness of international movements in upholding the sanctity of humanity, even during the act of war.

Despite the discontinuation of state-sponsored bioweapons research programmes, the growing sophistication of non-state actors has shifted the discourse on bioweapons from being instruments of national security to those of mass terror. Bioterrorists are motivated to weaponise and deploy lethal biological substances due to their terror threat and greater accessibility. That is, biological agents have long incubation delay time, quick rate of infectiousness, low detection rate, and similarities with common illnesses that could infect the public at low costs (Nadasi, et al. 2007, Cary 2010, Hummel, Quaranta and Wikswo 2014). For example, the *botulinum neurotoxin*, the most potent toxic substance at the moment, is easy to produce but difficult to detect, in which the gold-standard diagnostic test takes 96 hours and lacks sufficient sensitivity (Berger, et al. 2016, 2). In addition, the recurring *anthrax* outbreaks among humans, livestock, and wildlife in Kenya arguably highlight the susceptibility of certain communities to diseases, whose presence can be prolonged and magnified as they adapt to their local ecosystem (Muturi, et al. 2018). Thus, given how the features of bioweapons are attractive to terror groups, the need for an efficient response system is even more necessary now to prevent an aggravated extent of mass panic and pressures on medical and security infrastructure.

Innovations in dual-use biotechnology have also stimulated terror groups to capitalise on the lethal nature of bioweapons. That is, from advancements in chemogenomic screening research to the incorporation of artificial intelligence in DNA manipulation (Wuster and Babu 2008, Riordon, et al. 2019), tools for synthetic biology are getting more accessible, simpler, and affordable beyond the boundaries of scientific labs to the extent that pathogens can be recreated from scratch (Gronvall 2015, 4). For example, the development of the CRISPR gene editing tool allows highly-virulent organisms to be constructed using guide RNA and enzymes that cost less than €100 (Badounas, Kakkanas and Oikonomopoulou 2018). In fact, this capability to manipulate biological agents with weaker ethical and/or safety standards is possibly intensified after the fall of Soviet Union, as former bioweapons scientists had sold their expertise, technologies, and material to the highest bidder (Cook and Woolf 2002, Domaradskij and Orent 2006). Consequently, the genetic alteration of biological entities could render existing vaccination stockpiles – which were developed by the international community based on a list of 30-60 harmful pathogens – irrelevant (Beck 2003). In other words, the threat of bioterrorism is arguably higher now as the uncontrolled mutation of biological elements could escalate their current features to cause mass terror.

Deploying bioweapons in terror attacks is fundamentally complex relative to conventional terrorism (Beck 2003). For instance, there have been only five recorded bioterrorism attacks between 1980s and 2000s, such as the 1984 non-fatal Salmonella poisoning by the Rajneeshee cult in Oregon and the fatal cases of the 1995 Tokyo subway *Sarin* attack by the Aum Shinrikyo cult and the 2001 *Anthrax* letters in the U.S. (Erenler, Guzel and Baydin 2018, 2). Despite their greater reliance on intricate processes (Hummel 2016, Pilcher 2017), bioweapons can still be used in terror attacks due to potential security lapses, in which an overwhelmed border security could fail to detect covert transportation of deadly germs (King 2003, 436). The recent *Ebola* epidemic, with isolated cases as far as the UK and the US, suggests the complex challenges in managing borders during public health emergencies. That is, the uncoordinated and delayed response from both domestic governments and the international community to quarantine victims and ban immediate travel from affected countries have prolonged and intensified the outbreak effects (Green, et al. 2019). While this incident should prompt countries to enhance their security measures, it could also "inspire" bioterrorists to target countries with lax borders to maximise the extent of mass infection and panic.

BIO-TERRORISM AS A NON-TRADITIONAL SECURITY (NTS) THREAT

Caballero-Anthony (2006) defines NTS threats as threats to the survival of national states and their citizens, often from non-military sources, which require comprehensive spatial and policy approaches. This term can also be attributed to the genuine security threats posed by either individual actors using, weaponising, or deploying unconventional instruments or the consequences of natural causes. The expansion of the security discourse is inherently inevitable after the 9/11 attacks given the extent of social, political, and economic damages inflicted by non-state actors. While the alleged implementation of non-military actions by some rogue nations suggests that NTS threat extends beyond unorganised movements, the similar concerns posed by bioterrorism should, at least, fulfil this definition. Nevertheless, the concerns of bioterrorism are further corroborated with a comparison to the common characteristics of NTS threats. That is, 1) they are not caused by inter-state competitions or realignment in balance of power – the underlying motives of bioterrorists could arguably be triggered by individual or societal grievances towards (perceived) injustices; 2) they often have nearly irreversible or near-permanent adverse consequences to both societies and states – the instantaneous and long-term effects of bioterrorism can inflict psychological and physical damages that could alter the dynamics of the socio-economic fabric and national security; and, 3) a multilateral approach is often necessary to offset limitations in domestic policies – addressing the transboundary nature of illegally-sourced or acquired bioweapons and the potentially-infectious manmade pandemics would severely exhaust the capacity and resources of individual governments (Caballero–Anthony 2017). Therefore, given the complex nature and consequences of, and responses to bioterrorism, it should be treated as a legitimate NTS threat to Malaysia.

ASSESSMENT OF BIO-TERRORIST THREATS IN MALAYSIA

Although Malaysia has been largely spared from terrorist attacks post-9/11 – perhaps apart from the Sulu invasion of Sabah in 2013 – the general terror threat has arguably risen in recent years. Two Malaysians linked to the *Islamic State* terror cell launched a grenade attack at the Modiva Bar in 2016 that injured eight people. Similarly, the arrest of over 260 people for terrorism-related offences, the interception of at least 14 planned terrorist attacks, and the increasing number of Malaysians returning from the Syrian Civil War between 2013 and 2016 further accentuate such threats (Jani 2017). Additionally, foreign

separatist groups such as the *National Revolution Front*, *Jemaah Islamiyah*, and *Moro Islamic Liberation Front* have regularly crossed from and to Thailand, Indonesia, and Philippines, respectively, to train, spread their propaganda, and raise funds for terror activities (Chalk, et al. 2009). These incidents can perhaps be justified by the perceived border porosity, a notion that has been echoed by the recent alleged Israeli-sanctioned murder of Fadi al-Batash, a Hamas-linked Palestinian engineer, in 2018 and that of Kim Jong-nam. In sum, while there have been no credible rumours of an impending bioterrorist attack in Malaysia, the state of Malaysian borders may eventually drive foreign-supported terror groups to conduct such attacks.

Moreover, Malaysia's hot and humid tropical climate serves as a conducive condition for recurring outbreaks of infectious viruses and influenza (Sooryanarain and Elankumaran 2015, Pujara, et al. 2016, Deylea, et al. 2016). Bioterrorists are arguably more inclined to exploit Malaysia's environmental setting to maximise the impact and severity of genetically-modified bioweapons, as the prolonged lifespan of common viruses would then contribute to the natural increase in the rate of infection over time. In addition, the hot weather can also lead to higher infection rate as individuals are more likely to remain indoors, in which the longer enclosed interactions can increase the likelihood of infections (Ng and Gordon 2015, 91). However, the climate multiplier effects on bioweapons in Malaysia might be subdued due to its rather high level of socioeconomic development. For instance, the weaponisation of cholera would be more damaging in areas with poor waste management, untreated water supply, and ineffective sanitation services, with recurring incidents tend to be in dirty and overcrowded locations such as urban slums and refugee camps (Zuckerman, Rombo and Fisch 2007). Similarly, the increasing ratio of health professionals to population in Malaysia illustrates some extent of medical capacity to provide basic care in responding to bioterrorism (Department of Statistics Malaysia 2017). The deployment and coverage of a bioterrorism outbreak would be more repressed if there are adequate medical facilities to detect, quarantine, and treat early signs of an outbreak. Even though the tropical climate might encourage the cultivation of natural viruses as bioweapons in Malaysia, its modern domestic medical and water, sanitation, and hygienic facilities will surely negate any efforts to maximise mass terror, infectivity, and casualties.

THE EFFECTS OF BIOTERRORISM ON SOCIOECONOMIC WELLBEING IN MALAYSIA

The virulent nature of bioterrorism can disrupt agricultural supply chains and incur health-related financial costs. Natural biological agents were historically used to destroy adversaries' food sources, or "agro-bioterrorism", leading to food shortages, malnutrition, and famines (Runge 2002, Mishra, et al. 2011). Even if the infection was minimised by effective detection and treatment mechanisms, the distrust of food safety standards can have severe repercussions. That is, agro-bioterrorism disrupts economic relations and balances of power since stopping the contagion would impose barriers on international agricultural trade (Runge 2002, 8, Monke 2005). In fact, the contribution of the agriculture sector to employment, GDP growth, and exports in Malaysia entails the devastating effects of bioterrorism on individual livelihoods and national income. This notion is further reinforced by the 1999 *Nipah* outbreak, which saw over 400,000 workers in the pig and other animal-related industries lose revenue or be unemployed (Lam 2003, 117), while the 2006 *avian influenza*, or bird flu, have prompted the culling of over 60,000 poultry birds to prevent further outbreak (Tee, Takebe and Kamarulzaman 2009, 313). Similarly, the prevalence of palm oil in the Malaysian economy should also be a concern as terrorists can infect plantations to induce shortage of biofuel consumption and exports (Roberge 2015, 191). In other words, bioterrorism on important, valuable, and strategic agricultural subsectors would pose a double whammy on the domestic socioeconomic structures because of much lower export incomes and higher food import costs.

The lethal nature of biological pathogens implies that bioterrorism can also have devastating health-related financial effects. For example, Kaufmann, Meltzer, and Schmid (1997) estimated that economic losses from a bioterrorist attack on a major American suburb would range from USD477.7 million per 100,000 persons exposed to *brucellosis* to USD26.2 billion per 100,000 persons exposed to *anthrax*, due to medical procedures (e.g., quarantine and hospitalisation, post-treatment care, and drugs) and lost productivity due to prolonged sickness or early death. Similarly, a Malaysian study found that total direct hospitalisation costs of the 2009 H1N1 influenza outbreak were USD510 per patient, nearly ten per cent of the per capita GNI (USD6,634) (Ong, et al. 2010). Moreover, a study on the projected effects of bird flu on the Malaysian labour force shares a similar outlook: human capital shortages that

are associated with prolonged illnesses and work absenteeism would reduce Malaysia's annual GDP growth by 0.2 per cent (Bloom, de Wit and Carangal-San Jose 2005, 6). Considering the rather labour-intensive nature of the local economy, an infectious bioterrorist incident would surely inflict greater damage to the Malaysian economy as the workforce would either be unable to work or be paying high costs of treatment. With evidence to suggest that bioterrorism can both disrupt major economic activities and cause substantial losses in productivity and finances, local authorities must be vigilant to ensure that such incidents can be prevented.

ASSESSMENT OF RESPONSE READINESS AND CHALLENGES IN MALAYSIA

The lessons learnt from managing pressures of public health emergencies on public health capacity and multilateral response coordination should be an adequate proxy to assess the extent of response readiness in Malaysia (Tee, Takebe and Kamarulzaman 2009). Although the initial response to the *Nipah* outbreak was mainly reactionary (i.e., enhancing surveillance and treatment operations), subsequent policies were arguably more comprehensive with the added emphasis on pre-emptive measures. For instance, Malaysia has then developed a multi-tiered capacity – both domestically and internationally – in managing threats of nuclear, chemical, and biological weapons, with a concerted effort by the Ministry of Health, Ministry of Foreign Affairs, Ministry of Home Affairs, the Royal Malaysian Police, and the Malaysian Armed Forces (Balakrishnan 2016, Malay Mail 2017, Zolkepli 2018). However, Malaysia should not wait for future outbreaks to enhance its response readiness, considering previous improvements were only adapted after major epidemics. Furthermore, while Vikneswaran, et al. (2015, 673) have listed legislations and agencies that are responsible during a large-scale national emergency, an equally-detailed study from the perspective of public health response preparedness must also be conducted.

a) Public health response and challenges

Malaysia's response to the 1999 *Nipah* virus outbreak was commendable: it first established a coordinated and comprehensive Cabinet Task Force Committee that drafted policies and delegated tasks to relevant federal, state, and district entities to facilitate the eradication of the virus (Chua 2010, 71). Moreover, the formation of 24-hour operations rooms did not only help real-time coordination between agencies, but also act as the public communications unit to minimise

widespread panic (Chua 2010, 76-77). However, an official response policy was only framed in 2003 after the *Severe Acute Respiratory Syndrome* (SARS) regional outbreak, in which the *Rapid Response Model* (RRM) listed detailed procedures for a prompt and effective response that would minimise the lethality of infectious diseases (Ministry of Health 2003). In fact, the extensive nature of RRM covers pre-outbreak readiness, disease surveillance, risk communication, health and safety guidelines for healthcare workers, and training. For instance, eight public hospitals were predesignated as providers for specialised infectious diseases treatment (Ministry of Health 2003, 22), which would ensure greater patient-care compatibility. Subsequently, the threat of bird flu prompted the Government to launch the *National Influenza Pandemic Preparedness Plan* in 2006 to facilitate medical, industrial, and public communications responses. While there were no main amendments to the RRM, this plan allocated annual funding of RM60.4 million to stockpile vaccines and protective equipment, train medical staff, upgrade medical and research facilities, and conduct drills (The Star 2006). Realising the necessity of an overarching emergency response protocol, the Disease Control Division of the Ministry of Health has subsequently published two further editions of the 'Case Definitions for Infectious Diseases in Malaysia' in 2006 and 2017. These documents serve as guidelines for medical professionals to address infectious diseases instantaneously and systematically. Hence, regular updates to the public health framework, albeit reactionary than pre-emptively, assure that Malaysia can respond to biological outbreaks effectively.

However, the controversy surrounding the dumping of toxic waste in Pasir Gudang, which affected over 500 individuals and hospitalised over 166 victims in total (Moses and AR 2019), has questioned the actual extent of emergency readiness. That is, although this incident might be outside the jurisdiction and scope of the RRM, the fact that the dumping transpired over an extended period underlines major flaws in public health procedures, namely in risk detection, surveillance, and intra-government communication. For example, while most affected students in Pasir Gudang only reported symptoms of common illnesses, the rather clustered pattern of such illnesses and an unusual number of victims should have prompted the first responders to explore potential causes (Cariappa, Vaz and Sehgal 2002, 327). In fact, existing constraints within the public health system are arguably not caused by technical factors, but rather due to an ineffective implementation of medical surveillance

to identify and communicate any uncommon health patterns (Hakim 2015). In cases of outbreaks, such malpractices could increase the dissemination and lifespan of the disease, and subsequently, aggravate their devastating effects. Thus, while it might be premature to conclude that Malaysia has inadequate response capacity toward bioterrorism based on this incident, the failure to detect irregular fluctuations in public health indicators poses a major security vulnerability – indicating the need to revise and enhance the current emergency response practices.

b) Health diplomacy

From SARS to the *Middle Eastern Respiratory Syndrome coronavirus* (MERS), the worldwide transmission of contagion diseases reinforces the need to address bioterrorism beyond public health and domestic security (Abdullah and Abdul Rahim 2016). That is, the importance of international health diplomacy (IHD) in mitigating the consequences of bioterrorism highlights the role of foreign policy as the other foundation in the two-pronged biodefence approach. IHD refers to diplomatic activities – from formal health negotiations to partnerships with non-governmental organisations – that support public health capacity-building (Katz, et al. 2011). While the underrepresentation of healthcare professionals in Wisma Putra alludes to potential limitations in coordinating global health partnerships, Malaysia's active involvement in the World Health Organisation (WHO) and other regional and bilateral health initiatives would demonstrate otherwise (Barraclough and Phua 2007). In fact, it has regularly complied to international regulations in reporting previous cases of infectious outbreaks, although through the Ministry of Health, in which its International Health Sector conducts annual planning exercises at the WHO regional office (Ministry of Health 2012). However, the relative recency of such foreign policy initiatives and framework, in which they were mostly introduced long after the infectious outbreaks in the early 2000s, provides a weak basis for an accurate and thorough assessment of its readiness for bioterrorism attacks.

Consequently, the structural approach of Malaysia's IHD would arguably pose a challenge in navigating the politics of global health emergencies and participating in long-term cooperation with multilateral agencies. That is, Malaysia must delicately navigate the global power imbalances to ensure that the right narratives on domestic health emergencies are accurately projected and represented due to their real-life policy implications. The discrepancies in the narratives – and subsequently, the corresponding response – surrounding

Ebola (as an outbreak in a low-income setting) and SARS (as an outbreak that affected the high-income) illustrate how the absence of marginalised voices would affect the socioeconomic dynamics in informing decision-making process (Kapiriri and Ross 2018). The sluggish global responses to the early stages of *Ebola*, despite the clear warning signs, further highlights the importance of setting the accurate narratives. Furthermore, the other element of IHD involves health cooperation organised by other countries and international organisations. For example, WHO conducts recurring and regular assessments of domestic readiness for infectious disease outbreaks as a form of a long-term partnership, in which its benefits would only be maximised with a realistic and accurate knowledge on domestic capacity among global health diplomats who are involved in planning and implementing these assessments (Chattu 2017). In other words, while Malaysian diplomats have adequate political acumen to handle global diplomacy, their inexperience in the medical field could potentially result in less accurate narratives and descriptions of the domestic public health readiness for bioterrorism incidents.

PROPOSED SOLUTIONS TO ENHANCE BIODEFENCE STRATEGIES

There is a primary dedicated policy framework that outlines the multi-tiered and -faceted biodefence strategies and cross-organisational chain of command in an event of bioterrorism in Malaysia. However, Mair and Mair (2003) argue that (bio)terrorists are rational actors who conduct cost-benefit analysis to consider the perceived effort and risk, anticipated rewards, and excuses of a (bio)terror attack. Since an effective counter-proliferation approach should comprise policies that increase perceived efforts and risks, decrease potential rewards, and remove excuses (Mair and Mair 2003, 2), this two-sided biodefence strategy of domestic and international solutions can then serve as an ideal response to bioterrorism.

a) Domestic solutions

An effective public health response to bioterrorism requires an equal emphasis on promotive, preventive, and curative interventions, such as outbreak information dissemination, pre-emptive vaccinations, and immediate medicinal access, respectively (D. K. Mishra 2016). Thus, enhancing mitigation and adaptation, improving equity in healthcare distribution, and leveraging on the advancements in biotechnology are potential solutions that can address the complex challenges in responding to bioterrorism.

i. *Enhanced mitigation and adaptation*

In general, the recommended biodefence strategy involves multivariate mitigation and adaptation procedures, such as improving patient management and allocation in emergency departments, public health surveillance, funding for a robust public health system, coordination among government agencies, identification training, decentralised response plans, biosafety (i.e., management of lethal biological substances), biosecurity (i.e., strict prevention of illegal or malicious weaponisation of toxins), and protection of vulnerable infrastructure (Henderson 1999, DaSilva 1999, Redhead and Tiemann 2002, Das and Kataria 2010, Erenler, Guzel and Baydin 2018). That is, these measures do not only ensure a rapid response in treating affected victims, but also distinguishing bioterrorist attacks from manageable outbreaks of emerging diseases. While enhancing mitigation and adaptation may be unfeasible or a low-priority due to the minimal odds of bioterrorism relative to the costs of establishing and maintaining this extent of preparedness, strengthening public health infrastructure and capacity can also enhance the detection and prevention of other disease outbreaks and viral illnesses (Henretig 2001, Frist 2002). Thus, to alleviate resource constraints, Malaysia could leverage on its experience managing the *Nipah*, bird flu, and SARS outbreaks to improve existing public health capacity that would be adequate in response to bioterrorism attacks. Similarly, in the light of the recent Pasir Gudang incident, more attention should also be given to reporting and detection of mass public health trends. More specifically, Malaysia can conduct more frequent training and treatment drills, as per the RRM, to ensure that front-line responders and district offices are always ready to respond to similar incidents. From a policy planning perspective, the Ministry of Health could perhaps produce more frequent updates of its 'Case Definitions for Infectious Diseases in Malaysia' document – relative to its current 10-year intervals of 2006 and 2017. This approach is particularly important to ensure that all the hard work is not made obsolete by more sophisticated and rapidly-transforming advancements in biological weapons.

ii. *Equitable distribution of healthcare facilities*

However, resource constraints pose another challenge in developing adaptation and mitigation capacity for bioterrorism, especially in the developing world. In addition to the limitations in resources and human expertise, an unequal distribution of healthcare access could imply disproportionate vulnerability to bioterrorism along geographical and income demographics. In Malaysia, these

disparities suggest institutional pressures on public health facilities as the burden of patients are not equally distributed according to the capacity of such facilities and the shortage of experts due to the migration of senior medical professionals to the more lucrative private sector (Merican, Rohaizat and Haniza 2003, 85-87). While conventional wisdom believes greater public health funding will be the main solution, the suboptimal preparedness levels for hazardous material incidents in American and Canadian emergency departments – despite a more lucrative financial allocation and detailed counterterrorism approach – suggest a more intertwined solution (Henretig 2001, Kollek, Welsford and Wanger 2009). Thus, this rather long-term action would require greater investments in constructing and upgrading public health facilities in low-income and rural areas to ensure minimum reporting and detecting standards.

iii. *Utilisation of biotechnology advancements*

Advancements in modern biotechnology can also negate the emergence of genetically-modified bioweapons and enhance effectiveness in biodefence strategies. For instance, detailed research on genomic identities can create corresponding vaccines and treatment drugs, develop a more accurate bioweapons detection and identification tool, and strengthen the immune system to withstand multiple microbial attacks (Ainscough 2002). Similarly, scientists can also extract developments in other fields of biotechnology, such as *immunoassays*, directed evolution, and *nuclei acid amplification*, to produce more instruments to boost medical readiness for bioterrorist attacks (Moorchung, Sharma and Mehta 2009, Raj, Saxena and Saxena 2017). In addition, technology could also be used to confront the threats and outbreaks of bioterrorism. That is, complex robotics could reduce the risks of infection and exposure among front-line workers and first responders as the former can conduct disease surveillance and monitoring, enforce quarantines, provide medical supplies to patients of highly-infectious diseases (e.g., smallpox), and conduct minor remote-sensor operations (Rosen, Koop and Grigg 2008). In other words, successful implementation of robotic technology – for instance, drones for simple yet important tasks of supplying medicines to quarantined areas – can reallocate valuable human resources to more critical and complex health emergencies of a bioterrorist attack. Considering Malaysia's relative technical and financial constraints, an outright adoption of advanced technologies might be limited but the rapid innovations in technology and the possibility of technology transfers could provide an opportunity for pioneer testing.

b) International multilateral solutions

The role of foreign policy is also essential to overcome the resource constraints in reinforcing public health systems. Many countries are motivated to provide humanitarian or capacity-building assistance to those hit by disease outbreaks, albeit not for altruism. That is, there are national security (e.g., defending against permeable contagion), economic (e.g., securing source of imported goods), and political (e.g., maintaining global balance of power) motivations in the international efforts to mitigate the consequences of a large-scale bioterrorist attack (Nohrstedt and Baekkeskov 2018, 48-49). Nevertheless, Malaysia can complement its domestic preparedness for bioterrorism by promoting greater international cooperation in prevention and treatment measures and championing stricter multilateral regulations on developing bioweapons.

i. *Greater international cooperation on outbreak mitigation*

To prevent bioterrorism from overwhelming an overburdened public health facility, there is a need for established regional partnerships in which unaffected neighbouring countries would deploy relevant medical assets (e.g., vaccine stockpiles and temporary hospitals) to alleviate the incident. The importance of an international health cooperation can be seen from both the consequences of its failures and the benefits of its successes. On one hand, the failure of the U.S. Congress to fund the global *Zika* virus response readiness in 2016 has arguably contributed to negative public health consequences in poorer countries (Hodge and Weidenaar 2017, 93). In contrast, Malaysia benefitted from this international cooperation as it was only able to identify the features and transmission types of the *Nipah* virus in 1999 after sending the victims' tissue samples to the Centres for Disease Control and Prevention (CDC) in Atlanta, USA, for further tests (Kamaron 2002). Yet, as an upper-income developing country, Malaysia faces resources constraints to enhance its domestic readiness for bioterrorism but its slow ascent to a developed nation raises expectations for an expanded altruistic role in global and regional health (Barraclough and Phua 2007). Thus, Malaysia can then pursue advanced technological transfers and research collaboration while providing primary physical and logistical assistance as to promote greater international collaboration. However, despite foreseeable benefits of a productive international public health coordination, collective action and interdependency problems might pose a moral hazard on domestic public health capacity (Nohrstedt and Baekkeskov 2018). This issue involves both non-affected and affected countries, in which the former

might shirk its responsibilities in assisting the latter by freeriding other donor countries while opportunistic leaders in the latter might prolong outbreaks to ensure continuous flow of aid. Hence, Malaysia – both as the recipient and the donor – must then promote an empowering and effective international partnership with a focus on domestic growth of public health and human resources, rather than a one-off medical assistance.

ii. *Supporting international public health initiatives*

Greater coordination on global public health surveillance and the standardisation of disease reporting are essential in preventing a delayed response to current outbreaks and streamlining the dissemination of information to at-risk population. Thus, Malaysia has a major role in supporting current international legal instruments, such as the International Health Regulations (IHR) under WHO, to ensure that severe public health risks will not pose a global threat across national boundaries. That is, the IHR enforces binding requirements on all its 196 state parties to report public health emergencies to WHO and outlines necessary procedures in ensuring an effective international disease detection, identification, and response (World Health Organization 2017). Similarly, judging from the importance of agricultural trade, global efforts to reduce the risk of agro-bioterrorism should also be supported. For instance, bilateral and multilateral initiatives (particularly with the Food and Agriculture Organization, or FAO) can coordinate on conducting more regular and frequent surveillance on animal and crop health, preventing the deliberate entry of pests and plant pathogens, and encouraging greater sanitation measures near sources of agriculture (Meyerson and Reaser 2002, 598). In other words, Malaysia's strict adherence to these principles and commitment to transparency in public and agricultural health information flows can set an example in encouraging immediate and accurate reporting of similar details by other countries, which could then reduce the risks of regional outbreaks. However, the emergence of new infectious diseases from increased cross-border interactions and the exposed weaknesses of IHR's self-assessment of core public health capacity during the recent *Ebola* outbreak highlight the need for a comprehensive review of current practices (Feldbaum 2009, Gronvall 2015).

iii. *Multilateral regulations on bioweapons*

Malaysia can also capitalise on existing multilateral policies to prevent bioweapons from entering in the first place. Its commitment towards biological non-proliferation can be illustrated through its active and persistent

involvement in the Biological Weapons Convention (BWC), in which it immediately signed upon its introduction on 10 April 1972 and later ratified in 1991. Since the BWC has been reviewed seven times between 1980 and 2011 to further strengthen and expand its jurisdiction (Krishan, Kaur and Sharma 2017, 1679), this momentum could lead to an even more stringent restrictions on biological agents, such as: 1) production allocations of key components in bioweapons are based on state's existing response capacity, 2) limitation on cross-border transportation of hazardous biological material and equipment, and 3) severe punishment on illegal or discreet transfers of such substances. While this approach will be perceived as an interference on sovereignty, the devastating effects of bioterrorism would arguably justify these policies. In addition, multilateral public health and national security entities could also pursue an active deterrence in preventing bioterrorism. For instance, Kosal (2014) proposed approaches that would be relevant in foreign diplomacy, such as indirect deterrence – i.e., targeting state sponsors or individual supporters and financiers of bioterrorism through economic sanctions and travel bans – and collective actor deterrence – i.e., empowering international organisations such as the United Nations or WHO as the legitimate leader in advancing a bioterror-free world. Although the global political economy – in which certain states hold sizeable economic, political, and military influence – might translate into a selective implementation and enforcement of such deterrence measures, the establishment of an intended framework would already be a major step for humanity. Thus, to ensure that Malaysia is protected from foreign-based bioterror attacks, it should play a more active role in global diplomacy to influence and guide the discourse on bioweapons proliferation and deterrence.

CONCLUSION

The rise of sophisticated terror groups and greater accessibility to biotechnology advancements pose a substantial NTS threat. Although Malaysia has been largely spared from major terrorist attacks, their unconventional nature can catch everyone off-guard. Considering the devastating socioeconomic impacts of bioterrorism and the role of tropical climates in promoting a more infectious epidemic, Malaysia is arguably even more vulnerable than ever. Thus, with this growing threat of the cultivation, weaponisation, and deployment of modified biological pathogens for bioterrorism attacks, an effective biodefence strategy would require a two-pronged approach. That is, the recent *Ebola* outbreak in West Africa illustrates that a robust foreign policy is as important as a reliable public

health capacity in minimising the effects of a deliberate use of bioweapons. With regards to Malaysia, there is a primary dedicated policy framework that outlines the multi-tiered and -faceted biodefence strategies and cross-organisational chain of command in an event of bioterrorism. Additionally, basic public health capacity and foreign policy structure do exist in the aftermath of Malaysia's experience with highly-infectious, natural outbreaks such as the *Nipah* virus and *avian influenza*. Nevertheless, more attention should be given to enhance current prevention capacities and develop a mechanism that would facilitate coordination between both domestic and international actors. This article can be further expanded by widening the scope of bioterrorism readiness to better reflect the scale and evolutive nature of NTS threats and the corresponding defence approaches by Malaysia, and hence, minimising the overdependence and overreliance on foreign entities. More specifically, exploring how applicable they would be in hybrid threats could be an interesting angle of future research.

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