《关于禁止发展、生产和储存细菌(生物)及毒素武器和销毁此种武器的公约》缔约国会议

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2012 年会议
2012 年 12 月 10 日至 14 日，日内瓦

专家会议
2012 年 7 月 16 日至 20 日，日内瓦
临时议程项目 6
常设议程项目：审查与《公约》有关的科学和技术领域的发展

可能对《公约》有利的科学和技术发展

执行支助股提交的背景资料文件*

概要

第七次审查会议决定，在 2012-2015 年闭会期间方案中纳入一个关于审查与《公约》相关的科学和技术领域发展的常设议程项目。会议还决定，在这一项目之下，缔约国将审议可能对《公约》有利的科学和技术新发展，包括与监测、诊断和缓解特别相关的发展。在 6 月初的区域集团磋商期间，缔约国要求提供关于这一主题的背景文件。本文件概述了可能相关的进展情况。本文件基于为第七次审查会议编写的背景资料文件《与〈公约〉相关的新的科学和技术发展》(BWC/CONF.VII/INF.3)。附件仅有英文，介绍更为详细，并提到科学文献。

* 本文件因缔约国未按时提出要求迟交。

一. 探测

1. 能够探测到一种疾病正在发生，追究起病病源，并在症状出现前开始进行诊断，会加速作出应对的时间框架。这可减少疾病事件的影响，而且可能减少暗示疾病爆发的可能性。最近科学技术的发展在此领域提供了一系列的能力，包括：不同的方法；对机构内预警和反应体系进行研究；[1] 使用卫星数据；[2] 确定临床前疾病标志；[3] 利用在有生物应激物存在情况下发光的基因制造细菌；[4] 追究病原体和毒素的视频探测器；[5] 以及在环境探测病原体方面的改进。[6]

二. 诊断

2. 最近在生产廉价和便携诊断设备方面取得很大进展。[7] 某些设备有助于在世界上缺乏基本诊断能力的地方创造这种能力。它们还提供了有意义的机会，将诊断工具和技术转送至需要的地点——或至少是在区域而不是在国家范围内。[8] 快速诊断能力方面也有进展，因此能够通过区别细菌和病毒感染的新方法；[9] 病原体基因分类及查明组合时间；[10] 查明单颗粒病原体或病毒；[11] 实时诊断真菌病原体；[12] 更广泛的使用质谱仪；显微镜技术的进展；以及使用测序能力作为公共卫生工具，[13] 做出更迅速、更有效和合适的反应。在制订更快的毒素检查方法方面也取得了进展。[14]

[1] http://www.nti.org/gsn/article/researchers-designing-wmd-shield-for-buildings/
[2] http://www.economist.com/node/13688152
[3] http://www.biomedcentral.com/1471-2105/9/486
[4] http://www.nti.org/gsn/article/researchers-develop-lab-on-a-chip-technology-to-test-water-safety/
[5] http://www.spectroscopyonline.com/spectroscopy/article/articleDetail.jsp?id=376468
[6] http://daccess-dds-ny.un.org/doc/UNDOC/GEN/G10/639/27/PDF/G1063927.pdf?OpenElement
[7] http://www.newscientist.com/article/dn14410-ipodsize-microscope-could-become-lifesaving-gadget.html
[8] http://www.popsci.com/technology/article/2010-02/fingerprint-sized-paper-lab-chip-costs-just-penny
[9] http://pubs.acs.org/doi/abs/10.1021/ac200596f
[10] http://wwwnc.cdc.gov/eid/article/17/4/10-1726_article.htm
[11] http://www.eurekalert.org/pub_releases/2006-11/uog-sbu111506.php
[12] http://www.ncbi.nlm.nih.gov/pubmed/15893831
[13] http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0023400
[14] http://aem.asm.org/content/74/14/4309.full

三. 预防和防疫

3. 在研制广谱疫苗和疫苗研发的新方法方面也取得进展。[15] 正在制订一系列新的预防疾病机制。在改进人体免疫系统方面也发现了新方法。[16] 研究人员还报告说，在预防疾病释放技术方面取得了进展。[17]

四. 治疗

4. 研发新抗生素仍然是与疾病进行斗争的首要考虑。近几年的进展包括：研制了新种类的抗生素；特性研究方面取得了进展；提高了其效力；确定了新目标；更好地理解细菌如何产生抗药性；以及更好的药物发现工具。抗病毒治疗方面的进展包括；泛病毒药物的研制；新药的发现；更好地理解了病毒如何工作；发现了一种抗病毒病毒；杀死病毒的蛋白质；破坏病毒与宿主细胞粘连的蛋白质；破坏病毒复制的蛋白质；以及具有抗病毒活力的高亲和力试剂。生物勘探不断确认具有治疗潜力的化合物。应付毒素方面也取得了进展，包括对宿主机制的基因操控，利用纳米粒子控制毒素，以及使用抗体方法将毒素冲出体外。

五. 反应能力

5. 在确定疾病是否由培养的而不是天然的病原体引起方面取得了进展，[18] 在用统计方法分离混合数据组[19]和发展微生物法医能力方面也取得了进展——所有这些都有助于确定是否发生疾病侵袭以及原因何在。[20] 研究还显示有效的隔离措施在限制影响方面的重要性。[21] 发展去污技术，例如抗菌泡沫和纳米粒子的使用均有利于疾病侵袭后的清除。[22]

[15] http://www.plospathogens.org/article/info%3Adoi%2F10.1371%2Fjournal.ppat.1000921
[16] http://www.nature.com/nature/journal/v476/n7361/full/nature10356.html
[17] http://www.technologyreview.com/news/419880/a-flu-vaccine-without-the-needle/
[18] http://news.rice.edu/2010/08/16/telltale-signs-of-bioterror/
[19] http://www.sciencemag.org/content/322/5898/44.1.full.pdf
[20] http://www.pnas.org/content/early/2011/03/01/1016657108.abstract
[21] http://wwwnc.cdc.gov/eid/article/16/8/09-1787_article.htm
[22] http://www.koat.com/print/29135497/detail.html

Annex

[ENGLISH ONLY]

Developments with possible beneficial consequences: a more detailed review

I. Detection

1. Being able to detect that a disease event is happening, to track causative agents, and start diagnostic practices prior to symptoms speeds up the timeframe in which a response can be organized. This can reduce the impact of a disease event and possibly reduce the desirability of instigating an outbreak in the first place. Recent advances in science and technology have provided a range of new capabilities in this arena, including: different approaches, such as through native air sampling techniques;[23] research into in-building early warning and response systems;[24] partial prediction systems for normal disease events based on satellite data;[25] the identification of pre-clinical disease indicators, such as the expression of switch-like genes;[26] the use of engineered bacteria that glow when in the presence of a biological stressor, such as a pathogen; [27] the use of membrane immunofiltration analysis with visual sensors for tracking of pathogens and toxins;[28] as well as improvements in environmental detection of agents by nanowire sensors or by immunographic methods.[29]

II. Diagnostics

2. There have been a number of recent advances in the production of cheap and portable equipment for diagnosing diseases.[30] Some of these devices may enable the creation of rudimentary diagnostic capabilities in parts of the world currently lacking such capabilities. The also offer interesting opportunities to move some of the diagnostic tools and techniques currently in use to the point of care - or at least into a regional, rather than national, context.[31] Relevant developments include: the creation of image sensing chips that could lead to the development of highly portable microscopes, similar technology has since been integrated into lens-less microscope prototypes that works with mobile phone technology; a cheap (US$10), pocket size polymerase chain reaction (PCR) machine that runs off two AA batteries which can be used to identify a number of pathogens; as well as the development of paper-based diagnostic ‘chips’ through advances in microfluidics and the use of silica nanoparticles.[32]

[23] http://online.liebertpub.com/bsp
[24] http://www.nti.org/gsn/article/researchers-designing-wmd-shield-for-buildings/
[25] http://www.economist.com/node/13688152
[26] http://www.biomedcentral.com/1471-2105/9/486
[27] http://www.nti.org/gsn/article/researchers-develop-lab-on-a-chip-technology-to-test-water-safety/
[28] http://www.spectroscopyonline.com/spectroscopy/article/articleDetail.jsp?id=376468
[29] http://daccess-dds-ny.un.org/doc/UNDOC/GEN/G10/639/27/PDF/G1063927.pdf?OpenElement
[30] http://www.newscientist.com/article/dn14410-ipodsize-microscope-could-become-lifesaving-
[31] http://www.popsci.com/technology/article/2010-02/fingerprint-sized-paper-lab-chip-costs-just-penny
[32] http://www.popsci.com/technology/article/2010-02/fingerprint-sized-paper-lab-chip-costs-just-penny

3. There have also been advances in rapid diagnostic capabilities, which would also enable a faster, more efficient and tailored response, including through: new approaches to differentiate between bacterial and viral infections; [33] the use of real-time reverse transcription PCR to genotype pathogens and identify reassortment events;[34] the use of Surface Enhanced Ramen Spectroscopy (SERS) to measure the change in frequency of a near-infrared laser as it scatters off viral DNA or RNA allowing the identification of single particles of pathogens or toxins;[35] the real-time diagnosis of fungal pathogens through Selected Ion Flow Tube-Mass Spectrometry (SIFT-MS);[36] as well as the use of sequencing capacity as a public health tool to identify causative agents as well as viral subtypes and reassortment events.[37] There have also been advances in developing faster assays for toxins, such as for the Clostridium botulinum Neurotoxin Type A.[38]

III. Prevention and prophylaxis

4. Certain recent advances have led to the identification of new vaccines. Progress has been made in the creation of broad-spectrum vaccines, such as a pan-influenza vaccine.[39] Genome wide analysis has also shown promising signs for the development of broad spectrum vaccines for bacteria, such as a single vaccine for common E. coli infections. [40] New approaches for vaccination have also been developed. One group reported having identified a standardised approach for genetically manipulating pathogens to make them harmless, whilst still inducing immunity in a mouse model. Another group discovered that they could prevent the replication of a variety of bacterial pathogens, such as those which cause tularaemia, plague, melioidosis, and brucellosis, by exposing a host to cationic liposomes non-coding DNA complexes (CLDC) mixed with pathogen membrane factors.[41]

5. A range of novel approaches to pre-empt disease are also being developed, including making use of advances in the understanding of infections to enable non-pathogenic bacteria to protect against pathogenic viruses, as well as efforts to improve how our immune systems function.[42]

6. Efforts to improve the immune system have included: building self-replicating killer cells from a disabled form of HIV-1 and human T-cells capable of killing target cells, multiplying inside the host and patrolling against relapses and subsequent infections (which has shown dramatic results in three patients to date); [43] building genetically-modified antibodies against specific pathogens by reprogramming human B-cells and assisted by engineered T-cells; [44] advances in our understanding of how the immune system uses antibodies to respond to viral infections after they enter host cells, opening up new opportunities for improving upon the natural process;[45] as well as through the modulation of

[33] http://pubs.acs.org/doi/abs/10.1021/ac200596f
[34] http://wwwnc.cdc.gov/eid/article/17/4/10-1726_article.htm
[35] http://www.eurekalert.org/pub_releases/2006-11/uog-sbu111506.php
[36] http://www.ncbi.nlm.nih.gov/pubmed/15893831
[37] http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0023400
[38] http://aem.asm.org/content/74/14/4309.full
[39] http://www.technologyreview.com/news/421253/a-long-lasting-universal-flu-vaccine/
[40] http://www.ncbi.nlm.nih.gov/pubmed/20439758
[41] http://www.plospathogens.org/article/info%3Adoi%2F10.1371%2Fjournal.ppat.1000921
[42] http://www.nature.com/nature/journal/v476/n7361/full/nature10356.html
[43] http://stm.sciencemag.org/content/3/95/95ra73.abstract
[44] http://hplusmagazine.com/2010/02/02/re-engineering-human-immune-system/
[45] http://www.ncbi.nlm.nih.gov/pubmed/21045130

the gut microbiome to both reduce the chances of infection and reducing the adverse side-effects of antibiotics.[46]

7. There have also been advances in delivering vaccines and prophylaxes, including through trans-dermal patches.[47]

IV. Therapeutics

8. Developing novel antibiotic capabilities remains a priority for the fight against disease. The last few years have seen the creation of novel classes of antibiotics, e.g. Ceftobiprole.[48] It has also seen the initiation of programmes to develop targeted antibiotics that sense and attack specific pathogens.[49] Researchers have also identified a range of new targets for antibiotics, including: manipulating the cell walls of multi-drug resistance bacteria;[50] disrupting flagella and motility;[51] structural elements in RNA polymerases;[52] as well as disrupting quorum sensing systems.[53] Papers published in the last few years have shown how previously uncharacterized antibiotic systems, such as the aminoglycosides, actually work. [54] This might enable the development of improved systems and conformationally similar drugs developed. Research has also identified additional mechanisms by which bacteria overcome antibiotics - both at the genetic level and functionally, such as through the use of nitric oxide-producing enzymes.[55] There have also been advances in new antibiotic discovery technology, for example, through nanotechnology cantilevers to enable high-throughput screening.[56]

9. Perhaps the most promising recent development in anti-viral therapy has been the possibility of developing a broad-spectrum antiviral drug that could kill any cell infected by a virus.[57] Researchers redesigned the enzyme that detects long strands of RNA (which is only produced during viral transcription and replication), which binds to the RNA blocking further production of viral proteins and initiates an extreme self-destruction response. Laboratories trials have shown these drugs to be effective against 15 human pathogens ranging from those that cause the common cold to haemorrhagic fevers. A range of more traditional anti-viral drugs have also been discovered, including: squalamine, a compound that protects sharks from viral infections; RNA interference (RNAi) therapies for Ebola in non-human primates;[58] as well as the identification of novel monoclonal antibody therapies for influenza infections.[59] Research over the last five years has also helped further our understanding of how viruses work, which in turn opens now opportunities for therapies. One group has published, for example, how Ebola infects cells. A second team used a more sophisticated understanding of Ebola to create a siRNA protocol designed not to cure Ebola

[46] http://www.ncbi.nlm.nih.gov/pubmed/18197175
[47] http://www.technologyreview.com/news/419880/a-flu-vaccine-without-the-needle/
[48] http://newswire.rockefeller.edu/2008/07/02/new-antibiotic-beats-superbugs-at-their-own-game/
[49] http://www.nature.com/news/2010/100414/full/464970a.html
[50] http://www.cbc.ca/news/health/story/2010/10/08/bacteria-cell-wall-trick.html
[51] http://www.ncbi.nlm.nih.gov/pubmed/20676082
[52] http://www.cell.com/abstract/S0092-8674(08)01190-2
[53] http://www.newscientist.com/article/dn16563-new-antibiotics-would-silence-bugs-not-kill-them.html
[54] http://www.cell.com/abstract/S0092-8674(08)01195-1
[55] http://www.sciencemag.org/content/321/5887/365.abstract
[56] http://www.newscientist.com/article/dn14912-nanolevers-could-speed-up-hunt-for-superbug-drugs.html
[57] http://www.plosone.org/article/info:doi%2F10.1371%2Fjournal.pone.0022572
[58] http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(10)60357-1/fulltext
[59] http://www.cidrap.umn.edu/cidrap/content/influenza/panflu/news/feb2309monoclonal-br.html

but to hold its replication in check until the hosts immune system could begin to respond effectively, which in turn allowed a monkey to recover from the disease. In 2008, researchers discovered virophages - viruses which spread at the expense of other viruses. Such a discovery offers possibilities for the design of anti-viral virus therapies.[60]

10. There have also been relevant advances in developing therapies to deal with toxins, including: the identification of genetic sequences in hosts required for intoxication by ricin and Pseudomonas exotoxin (offering treatment opportunities by blocking the functionality of these genes);[61] nanocarriers designed to allow toxins to be flushed from the system;[62] nanoparticles designed to trap toxins and carry them to the liver for destruction; [63] compounds designed to prevent the uptake of toxins into certain cell types, such as botulinum toxin into nerve cells;[64] as well as small binding agents designed to latch on to toxins enabling them to be identified by antibodies, also allowing it to be flushed from the system.[65]

11. Several research groups have also been developing more unusual therapeutic approaches. Developments in the understanding of human metabolic network topology in disease have led to the development of multi-target drugs designed to disrupt disease-related molecular networks.[66] [67] Equally, advances in sequencing capabilities have enabled the use of comparative genome wide analysis to identify novel targets for drugs. One research group has developed non-biological nanofactories designed to prevent bacterial replication offering an entirely new approach for therapeutics via nanomaterials. Another group built a nanoparticle that disrupts bacterial cells walls and shows promise in treating bacteria that have become multi-drug resistant. There is also an ongoing research project to develop adjutants that help break up bacterial infections into single cells, making them more sensitive to existing antibiotics.[68]

V. Response capacity

12. Over the past five years there have been advances that improve capabilities to investigate if an attack has taken place and who might be responsible. Researchers are currently working on a way to identify cultured pathogens (as opposed to those that have evolved in nature).[69] This would help determine that a disease event has a deliberate or accidental origin, rather than being caused naturally. New statistical methods have also been developed to identify individual genotypes from samples comprised of mixed genetic data or from aggregate SNP data enabling better tracing of specific agents during investigations.[70] Perhaps most importantly, recent years have also seen the release of some of the microbial forensic procedures and practices used to investigate the use of B. anthracis filled envelopes as a weapon in the United States.[71]

[60] http://www.nature.com/nature/journal/vaop/ncurrent/full/nature10380.html
[61] http://www.asiaone.com/News/AsiaOne+News/Singapore/Story/A1Story20110724-290762.html
[62] http://www.ncbi.nlm.nih.gov/pubmed/18654405
[63] http://pubs.acs.org/doi/abs/10.1021/ja102148f
[64] http://www.ncbi.nlm.nih.gov/pubmed/21832053
[65] http://news.tufts.edu/releases/release.php?id=156
[66] http://www.pnas.org/content/105/29/9880
[67] http://www.ncbi.nlm.nih.gov/pubmed/18985027
[68] http://www.ncbi.nlm.nih.gov/pubmed/18985027
[69] http://news.rice.edu/2010/08/16/telltale-signs-of-bioterror/
[70] http://www.sciencemag.org/content/322/5898/44.1.full.pdf
[71] http://www.pnas.org/content/early/2011/03/01/1016657108.abstract

13. Data published since 2006 also has implications for restricting the spread of a disease event. A paper published in August 2010, for example, demonstrated that quarantine methods are effective in preventing secondary outbreaks. Although enforced quarantine is a traditional disease control measure, relevant legislation in many countries has not been updated recently and may be inconsistent with subsequent developments in rights and freedoms.[72]

14. There are also advances which will help clean up after a disease event. One group, for example, reported in 2011 having developed a decontamination foam capable of killing pathogens such as that which causes anthrax, using nothing more than chemicals found in common household materials.[73]

[72] http://wwwnc.cdc.gov/eid/article/16/8/09-1787_article.htm
[73] http://www.koat.com/print/29135497/detail.html