

**Совещание государств – участников
Конвенции о запрещении разработки,
производства и накопления запасов
бактериологического (биологического)
и токсинного оружия и об их уничтожении**

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Russian
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Совещание 2012 года
Женева, 10–14 декабря 2012 года

Совещание экспертов
Женева, 16–20 июля 2012 года
Пункт 6 предварительной повестки дня
**Постоянный пункт повестки дня: обзор
достижений в области науки и технологии,
имеющих отношение к Конвенции**

**Научно-технологические достижения, которые
несут в себе потенциальные выгоды для Конвенции**

**Справочно-информационный документ, представленный
Группой имплементационной поддержки***

Резюме

Седьмая обзорная Конференция постановила, что межсессионная программа на 2012–2015 годы будет включать постоянный пункт повестки дня, посвященный обзору достижений в области науки и технологии, имеющих отношение к Конвенции. Конференция также постановила, что по этому пункту государства-участники рассмотрят новые научно-технологические достижения, которые несут в себе потенциальные выгоды для Конвенции, в том числе такие, которые имеют особое значение для наблюдения, диагностики и смягчения заболеваний. В ходе консультаций региональных групп в начале июня государства-участники запросили справочный документ по этой теме. В настоящем документе проводится обзор достижений, которые могут иметь возможное актуальное значение. Он основан на справочно-информационном документе о новых научных и технологических достижениях, имеющих отношение к Конвенции, который был подготовлен для седьмой обзорной Конференции (BWC/CONF.VII/INF.3). В приложении, которое приводится только на английском языке, дается более подробный отчет со ссылками на научную литературу.

* Представлено с опозданием, поскольку документ был запрошен государствами-участниками после надлежащей даты.

I. Обнаружение

1. Способность обнаружить факт заболевания, отследить агенты-возбудители и приступить к диагностике до развития симптомов позволяет ускорить организацию мер реагирования. Это может уменьшить воздействие болезни, а возможно, и прежде всего снизить желательность провоцирования вспышки. Последние научно-технологические достижения открыли целый ряд новых возможностей в этой области, в том числе: наличие различных подходов; исследования по развитию интегрированных систем раннего оповещения и реагирования¹; использование спутниковых данных²; идентификация доклинических признаков болезни³; использование генетически модифицированных бактерий, которые реагируют свечением на присутствие стрессогенных биологических агентов⁴; использование визуальных датчиков для прослеживания патогенных микроорганизмов и токсинов⁵; а также повышение возможностей обнаружения агентов в окружающей среде⁶.

II. Диагностика

2. Имеется ряд новых достижений в производстве недорогого портативного оборудования для диагностики заболеваний⁷. Некоторые приборы могут обеспечить возможность для создания элементарного диагностического потенциала в отдельных районах мира, где такой потенциал сегодня отсутствует. Они также открывают интересные возможности для обеспечения наличия некоторых средств и методов диагностики на уровне лечебных центров – или по крайней мере не в национальном, а в региональном контексте⁸. Достигнуты успехи и в расширении возможностей оперативной диагностики, которые также позволят повысить оперативность, эффективность и целенаправленность мер реагирования, в том числе за счет использования новых подходов к дифференциации бактериальных и вирусных инфекций⁹; определения генотипа патогенов и идентификации явлений, вызванных рекомбинированными организмами¹⁰; идентификации отдельных частиц патогенов или токсинов¹¹; диагностики воздействия грибковых патогенов в режиме реального времени¹²; более широкого использования масс-спектрометрии; внедрения более совершенных микроскопов; а также использования возможностей секвенирования в качестве одного из инструментов в системе общественного здравоохранения¹³. Имеются также достиже-

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>

ния в области развития более быстрых методов анализа на присутствие токсинов¹⁴.

III. Предупреждение и профилактика

3. Достигнут прогресс в создании широкого спектра вакцин, а также в определении новых подходов к разработке вакцин¹⁵. Разрабатывается также ряд новаторских механизмов предупреждения заболеваний. Имеется прогресс и в изыскании путей усиления наших природных иммунных систем¹⁶. Исследователи сообщают также о совершенствовании методов доставки профилактических средств¹⁷.

IV. Терапия

4. Приоритетной задачей для борьбы с болезнями остается разработка новых антибиотических возможностей. За последние несколько лет созданы новые классы антибиотиков; достигнут прогресс в определении их характеристик; достигнуты успехи в повышении их эффективности; идентифицированы новые мишени; достигнуты успехи в понимании того, как бактерии преодолевают действие антибиотиков; а также созданы более эффективные средства обнаружения. К числу достижений в противовирусной терапии относятся: разработка общего противовирусного средства; открытие новых лекарственных средств; улучшение понимания того, как действуют вирусы; открытие противовирусного вируса, вируцидных белков, белков, препятствующих адгезии вирусов к клеткам-хозяевам, белков, препятствующих репликации вирусов, а также высоко-специфичных связывающих реагентов, которые демонстрируют противовирусные свойства. В ходе работ в области биоразведки продолжают выявляться потенциальные терапевтические соединения. Достигнуты также успехи в борьбе с токсинами, в том числе посредством генетического манипулирования с механизмами хозяина, использования наночастиц для улавливания токсинов, а также применения подходов, основанных на использовании антител, для их вымывания из организма.

V. Потенциал реагирования

5. Имеют место достижения в определении того, что заболевание обусловлено не природными, а культивированными патогенами¹⁸, а также в разработке статистических подходов для разделения смешанных наборов данных¹⁹, равно как и в развитии потенциала судебно-микробиологической экспертизы, причем все это будет оказывать содействие в выявлении факта нападения и возможной ответственной стороны²⁰. Исследования также показывают важность эффективных карантинных мер для ограничения воздействия²¹. Достижения в развитии

¹⁴ <http://aem.asm.org/content/74/14/4309.full>

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

технологий деkontаминации, такие как создание антибактериальных пеносорбентов и использование наночастиц, могли бы облегчить задачу очистки после нападения²².

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. They 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

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.popsoci.com/technology/article/2010-02/fingerprint-sized-paper-lab-chip-costs-just-penny>

the development of paper-based diagnostic ‘chips’ through advances in microfluidics and the use of silica nanoparticles.³²

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 Raman 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

³² <http://www.popsci.com/technology/article/2010-02/fingerprint-sized-paper-lab-chip-costs-just-penny>

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/>

opportunities for improving upon the natural process;⁴⁵ as well as through the modulation of 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. Laboratory 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

⁴⁵ <http://www.ncbi.nlm.nih.gov/pubmed/21045130>

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](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](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](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>

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 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 adjuvants 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

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>

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

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

⁷¹ <http://www.pnas.org/content/early/2011/03/01/1016657108.abstract>

⁷² http://wwwnc.cdc.gov/eid/article/16/8/09-1787_article.htm

⁷³ <http://www.koat.com/print/29135497/detail.html>