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اجتماع الدول الأطراف في اتفاقية حظر استحداث وإنتاج وتكديس الأسلحة البكتريولوجية (البيولوجية) والتكسينية وتدمير تلك الأسلحة

اجتماع عام ٢٠١٢
جنيف، ١٠-١٤ كانون الأول/ديسمبر ٢٠١٢

اجتماع الخبراء
جنيف، ١٦-٢٠ تموز/يوليه ٢٠١٢
البند ٦ من جدول الأعمال المؤقت
البند الدائم في جدول الأعمال: استعراض التطورات الحاصلة في ميدان العلم والتكنولوجيا فيما يخص الاتفاقية

التطورات الجديدة في ميدان العلم والتكنولوجيا التي قد تكون لها مزايا للاتفاقية

وثيقة معلومات أساسية مقدمة من وحدة دعم التنفيذ*

موجز

قرر المؤتمر الاستعراضي السابع أن يشمل برنامج ما بين الدورات في الفترة الممتدة من عام ٢٠١٢ إلى عام ٢٠١٥ بنداً دائماً في جدول الأعمال بشأن استعراض التطورات الحاصلة في ميدان العلم والتكنولوجيا فيما يخص الاتفاقية. وقرّر المؤتمر أيضاً أن تنظر الدول الأطراف في إطار هذا البند في التطورات الجديدة في ميدان العلم والتكنولوجيا التي قد تكون لها مزايا للاتفاقية، بما فيها التطورات التي تكتسي أهمية خاصة في مجال مراقبة الأمراض وتشخيصها والتخفيف من وطأتها. وخلال مشاورات المجموعات الإقليمية التي جرت في بداية حزيران/يونيه، طلبت الدول الأطراف ورقة معلومات أساسية بشأن هذا الموضوع. وتتضمن هذه الوثيقة نبذة عن أوجه التقدم التي يمكن أن تكتسي أهمية في هذا الصدد. وهي تستند إلى وثيقة المعلومات الأساسية التي أعدّت للمؤتمر الاستعراضي السابع (BWC/CONF.VII/INF.3) والتي تتناول التطورات العلمية والتكنولوجية الحديثة المتصلة بالاتفاقية. ويتضمن المرفق، الصادر بالإنكليزية فقط، سرداً أكثر تفصيلاً مع إحالات مرجعية إلى كتابات علمية.

* تأخر تقديم هذه الوثيقة لأن الدول الأطراف طلبتها بعد الموعد المحدّد.

أولاً- الكشف

١- تتيح القدرة على كشف حدوث الإصابة بمرض، وتعقب العوامل المسببة، وبدء عمليات التشخيص قبل ظهور الأعراض، تقصيرَ الحيز الزمني الذي يمكن فيه تنظيم إجراءات الاستجابة. ويمكن أن يفضي ذلك إلى التقليل من تأثير الإصابة بالمرض، وربما حدّ أصلاً من جدوى التسبب إرادياً في انتشاره. وقد أتاحت التطورات الحديثة في العلم والتكنولوجيا مجموعة من القدرات الجديدة في هذا المجال تشمل ما يلي: ظهور نُهج مختلفة؛ والبحوث المتعلقة ببناء نظم داخلية للإنذار المبكر والاستجابة[١]؛ واستخدام البيانات الساتلية[٢]؛ وتحديد مؤشرات الإصابة بالمرض قبل المرحلة الإكلينيكية[٣]؛ واستخدام البكتيريا المحورة التي تتوهج تحت تأثير عامل بيولوجي مجهد[٤]؛ وأجهزة الكشف البصري لتعقب المُمْرضات والتكسينات[٥]؛ فضلاً عن تحسينات في الكشف البيئي عن العوامل[٦].

ثانياً- علم التشخيص

٢- طرأ عدد من التطورات حديثاً في إنتاج مُعدّات رخيصة ومحمولة لتشخيص الأمراض[٧]. وثمة بعض الأجهزة التي قد تمكّن من بناء قدرات تشخيصية في أنحاء مختلفة من العالم تفتقر حالياً إلى تلك القدرات. وتتيح تلك الأجهزة أيضاً فرصاً هامة لنقل بعض أدوات وتقنيات التشخيص إلى مكان الرعاية - أو على الأقل إلى سياق إقليمي بدلاً من سياق وطني[٨]. وحدثت تطورات في القدرة على التشخيص السريع، الأمر الذي سيمكن أيضاً من تقديم استجابة أسرع وأكثر فعالية وتكيفاً مع الحالة، بوسائل تشمل ما يلي: اتباع نُهج جديدة للتمييز بين العدوى البكتيرية والعدوى الفيروسية[٩]؛ وتحديد النمط الجيني للمُمْرضات وتبيّن حالات التمازج[١٠]؛ وتحديد الجسيمات المنفردة من المُمْرضات أو التكسينات[١١]؛ والتشخيص

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(١) http://www.nti.org/gsn/article/researchers-designing-wmd-shield-for-buildings/.

(٢) http://www.economist.com/node/13688152.

(٣) http://www.biomedcentral.com/1471-2105/9/486.

(٤) http://www.nti.org/gsn/article/researchers-develop-lab-on-a-chip-technology-to-test-water-safety/.

(٥) http://www.spectroscopyonline.com/spectroscopy/article/articleDetail.jsp?id=376468.

(٦) http://daccess-dds-ny.un.org/doc/UNDOC/GEN/G10/639/27/PDF/G1063927.pdf?OpenElement.

(٧) http://www.newscientist.com/article/dn14410-ipodsize-microscope-could-become-lifesaving-gadget.html.

(٨) http://www.popsci.com/technology/article/2010-02/fingerprint-sized-paper-lab-chip-costs-just-penny.

(٩) http://pubs.acs.org/doi/abs/10.1021/ac200596f.

(١٠) http://wwwnc.cdc.gov/eid/article/17/4/10-1726_article.htm.

(١١) http://www.eurekalert.org/pub_releases/2006-11/uog-sbu111506.php.

الآني للمُمْرضات الفطرية[١٢]؛ وتوسيع نطاق استخدام القياس الطيفي الكتلي؛ والتطورات في التكنولوجيا المجهرية؛ فضلاً عن استخدام القدرة على تحديد متواليات حمض الدنا كأداة من أدوات الصحة العامة[١٣]. وقد أُحرز تقدم أيضاً في إعداد اختبارات أسرع للتكسينات[١٤].

ثالثاً- الوقاية والتوقية

٣- أُحرز تقدم في إيجاد لقاحات تُستخدم على نطاق واسع، فضلاً عن اتباع نُهج جديدة لتطوير اللقاحات[١٥]. ويجري أيضاً استحداث مجموعة من الآليات الجديدة لاتقاء الأمراض. وتَحقَّق تقدم أيضاً في إيجاد طرق لتحسين نظمنا المناعية الطبيعية[١٦]. وتفيد تقارير الباحثين أيضاً بإدخال تحسينات على تقنيات توصيل مواد التوقية[١٧].

رابعاً- المداواة

٤- ما زال تطوير قدرات جديدة للمضادات الحيوية أولوية في مجال مكافحة الأمراض. وقد شهدت السنوات القليلة الماضية وضع فئات جديدة من المضادات الحيوية؛ وإحراز تقدم في توصيفها؛ والنجاح في تحسين فعاليتها؛ وتحديد أهداف جديدة؛ والتقدم في فهم كيفية تغلب البكتيريا على المضادات الحيوية؛ وتحسين أدوات الكشف. ويشمل التقدم المحرز في مجال العلاج المضاد للفيروسات ما يلي: تطوير عقار مضاد لجميع الفيروسات؛ واكتشاف عقاقير جديدة؛ وتحسن فهم طريقة عمل الفيروسات؛ واكتشاف فيروس مضاد للفيروسات؛ والبروتينات المدمرة للفيروسات؛ والبروتينات المعطلة لالتصاق الفيروسات بالخلايا الحاضنة؛ والبروتينات المعطلة لتنسخ الفيروسات؛ فضلاً عن كواشف التطابق الترابطي الشديد التي تدل على نشاط مضاد للفيروسات. وما زال التنقيب البيولوجي ماضياً في تحديد المركّبات العلاجية الممكنة. وأُحرز تقدم أيضاً في طريقة التعامل مع التكسينات، بما في ذلك من خلال التحوير الجيني للآليات الحاضنة، والجُسيمات النانوية لحبس التكسينات، فضلاً عن استخدام الأجسام المضادة لتطهير الجسد من التكسينات.

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(١٢) http://www.ncbi.nlm.nih.gov/pubmed/15893831.

(١٣) http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0023400.

(١٤) http://aem.asm.org/content/74/14/4309.full.

(١٥) http://www.plospathogens.org/article/info%3Adoi%2F10.1371%2Fjournal.ppat.1000921.

(١٦) http://www.nature.com/nature/journal/v476/n7361/full/nature10356.html.

(١٧) http://www.technologyreview.com/news/419880/a-flu-vaccine-without-the-needle/.

خامساً- القدرة على الاستجابة

٥- أُحرز تقدم في تحديد ما إذا كان تفشي مرض ينطوي على وجود مُمْرضات مزروعة أو مُمْرضات طبيعية[١٨]، وفي النهج الإحصائية المتبعة لفصل مجموعات البيانات المختلطة[١٩]، وكذلك في تطوير قدرات علم الأدلة العدلي في مجال الميكروبيولوجيا - وهذه كلها أمور من شأنها أن تساعد في تحديد وقوع هجوم أو عدم وقوعه، وتحديد الجهة المسؤولة عنه[٢٠]. وقد بيّنت البحوث أيضاً أهمية تدابير الحجر الصحي الفعالة في الحد من الأثر[٢١]. ويمكن أن يؤدي تطور تكنولوجيا التطهير، من قبيل الرغوات المضادة للبكتيريا واستخدام الجسيمات النانوية، إلى تيسير عملية التنظيف عقب حدوث هجوم[٢٢].

(١٨) http://news.rice.edu/2010/08/16/telltale-signs-of-bioterror/.

(١٩) http://www.sciencemag.org/content/322/5898/44.1.full.pdf.

(٢٠) http://www.pnas.org/content/early/2011/03/01/1016657108.abstract.

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

(٢٢) 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]

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[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 but to hold its replication in check until the hosts immune system could begin to respond

[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.

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.[6667] 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]

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

[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.

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.