WHO Global Consultative Meeting on the Safe Shipment of Infectious Substances
WHO headquarters, Geneva, Switzerland, 15–16 March 2018

Report
Abbreviations

ACI   Airport Council International
ADR   European Agreement concerning the International Carriage of Dangerous Goods by Road
BSL-4 biosafety level 4
CAPSCA Collaborative Arrangement for the Prevention and Management of Public Health Events in Civil Aviation
Cat A Category A (infectious substances)
Cat B Category B (infectious substances)
CDC   Centers for Disease Control and Prevention (United States of America)
e-ISST electronic (online) Infectious Substance Shipping Training (WHO)
FAO   Food and Agriculture Organization of the United Nations
FTA   foam-tipped applicator (cards)
IAEA  International Atomic Energy Agency of the United Nations
IATA  International Air Transport Association
ICAO  International Civil Aviation Organization of the United Nations
IHR   International Health Regulations (2005)
MSDS  medical safety data sheets
OIE   World Organisation for Animal Health
PAHO  Pan American Health Organization
PI    packing instruction
polio poliomyelitis
RPMASA Responsible Packaging Management Association of Southern Africa
TB    tuberculosis
UN    United Nations
UNHAS United Nations Humanitarian Aviation Services
VHF   viral haemorrhagic fever
WCO   World Customs Organization
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Executive summary

As part of the International Health Regulations (2005) (IHR), Member States must agree to facilitate, subject to national law and international guidelines, the transport, entry, exit, processing and disposal of biological substances, diagnostic specimens and materials for public health response. This is critical in the early detection, confirmation and development of treatments for pathogens of global health concern in clinical, veterinary and research laboratories.

To create a better understanding of the current challenges and potential solutions to increase countries’ ability to comply with this aspect of the IHR, WHO held a meeting bringing together key players in the various stages of preparing, packaging, transporting and delivering infectious substances and biological materials. This enabled key stakeholders to raise awareness of their roles, share their challenges and seek joint solutions to improve the response to potential disease threats.

The participants began by focusing on two main areas:

- international classification systems and regulations for the transport of infectious substances; and
- needs and opportunities for training.

This enabled many international organizations involved in the transport of dangerous goods to give their perspectives on how the regulations affected their operations. This revealed many challenges in addressing the variable needs of the different modes of transport in a cohesive way. Changes to regulations were clearly needed; current review processes offered several opportunities to make them, but changes needed to have clear bases in scientific evidence and explicit safety records if the global shipping community was to accept them.

The participants expressed shared concerns on training needs and challenges, and cited the differences between multiple modes of transport as a key factor in preventing cohesive recommendations. While several organizations were working on developing new training methodologies and standards, a move toward competency-based training found overall acceptance. Such training would take account of job/function, have a more task-specific focus and would preferably include proficiency testing, which would encourage not only the training of the right people but also a continuing approach to learning. Using different methods of training delivery was agreed to be much better than relying on only one method.

In addition, laboratory leaders from public health agencies, particularly in challenging regions or low-resource settings, shared their perspectives. Most cited similar challenges to the shipping of infectious substances: confusing regulations, limited access to training or packaging materials, lack of access to timely courier services or airlines, and trouble maintaining the cold-chain. Many of these challenges had affected the response to the 2014 outbreak of Ebola virus disease, and much had been learned from the solutions that had emerged.
The participants also examined the lessons that could be learned from the successes of various WHO programmes in developing networks and procedures for shipping samples. Although the solutions could not readily be adapted to all situations, these lessons could be used to improve the shipment of infectious substances. A general discussion revealed that the challenges of shipping infectious substances remained numerous, but so were the potential solutions. The participants shared many ideas that could be useful in planning by both WHO and other organizations.
Introduction to biosafety, regulations and packaging related to infectious substances

Mike Ryan, WHO Assistant Director-General Emergency Preparedness and Response, opened the WHO Global Consultative Meeting on the Safe Shipment of Infectious Substances by describing the importance of the transport of infectious substances, as a part of global health security and the IHR, in achieving WHO’s mandate. The purpose of the Meeting was to balance risk with safety in consideration of the huge public health benefit of shipping infectious substances for all parties involved; communication would be key in facilitating this. Other WHO staff emphasized the importance of the Meeting for biosafety, laboratory strengthening, surveillance and preparedness, and WHO’s work on these issues.

This meeting was held with the following objectives:

1. Regulations and classifications association with shipment of dangerous goods, particularly infectious substances.
2. Training of various contributors to the shipping of infectious substances.
3. Quality management and oversight of the shipment process (audit trails and compliance).
4. Shipping infectious substances in emergency situations.
5. Creation of networks and focal points for shipping infectious substances.

Annexes 1–3 give the results of analysis of the participants’ feedback on the Meeting, present its programme and list the participants, respectively.

Katherine Rooney, of the International Civil Aviation Organization, was appointed Chairperson for the first day of the meeting. She acknowledged the great need for progress on the problems with transporting infectious substance, which were similar across different sectors; this highlighted the potential to find cross-sectoral solutions. The chairpersons for the morning and afternoon of the Meeting’s second day were Brian Crook, of the Health and Safety Executive, United Kingdom, and Brian Harcourt, of the Centers for Disease Control and Prevention (CDC), United States of America, respectively.

United Nations model regulations on and tests of packaging of infectious substances

As well as considering the United Nations (UN) regulations on shipping infectious substances and the safety of packaging, the participants received an update on WHO’s progress in revising its fourteen-year-old Laboratory biosafety manual.1 Earlier versions of the manual were based on biosafety concepts that had been developed before the introduction of polymerase-chain-reaction technology, which had led to great changes in the handling of biological agents in the laboratory. This added urgency to the revision work, which was based primarily on a selection process for risk assessment and control; this deviated from previous interpretations of biosafety, which relied on a simple equation of risk groups and biosafety

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levels that could lead to overengineering and overregulation of laboratories and their processes. The benefits of this new approach would particularly include providing equitable access to safe laboratory services by lower-resource communities.

The UN model regulations on the transport of dangerous goods\(^2\) were reviewed and revised every two years. They covered multiple modes of transport, as did other regulations on the shipment of infectious substances. The current classification system divided infectious substances between Category A (Cat A) and Category B (Cat B). All the Meeting participants were encouraged to take part in the current review of the regulations (see also below), to help facilitate the safe transport of infectious substances.

The participants received a demonstration of a series of practical investigations, by the Health and Safety Executive in the United Kingdom, of the safety and effectiveness of packaging specifically designed for and commonly used in the transport of infectious substances. A series of tests of packaging, primarily using a fluorescent dye to represent an infectious substance, examined whether it would remain contained in packaging subjected to challenges such as dropping, squashing and spills. These tests were applied to not only traditional packaging but also examples commonly seen in lower-resource areas. All tests showed that liquid samples, even when packaged poorly or in nonregulation ways, remained contained, although unpacking them might pose some risks. These results could be evidence to suggest that further testing may be warranted, to establish simpler but equally safe packaging for infectious substances.

**Discussion**

The discussion of these issues centred mostly on the lack of information on training requirements in the UN model regulations, which was primarily due to the different requirements for different modes of transport. While technical documents from the International Civil Aviation Organization (ICAO) of the United Nations and the International Air Transport Association (IATA) provided more details, the UN regulations still needed improvement in this area. In addition, the participants welcomed the testing of packaging safety by the Health and Safety Executive, and some suggested that this be explored in more detail.

**Impact of transport regulations on countries and international organizations**

Perspectives on the issues related to the shipping of infectious substances varied widely between countries, particularly between those with low and high levels of resources. In France, for example, the French Civil Aviation Authority played a role in the regulation of dangerous goods carried by air. The country had put provisional plans in place to prepare for special transport requests during situations such as the 2014 outbreak of Ebola virus disease. The most important issue was the transportation by air of medical and clinical waste, as the

packaging requirements were impractical. Although ICAO regulations could allow inactivated material to be transported, the French Transport ministry could not allow this, so an alternative solution needed to be found.

Partnerships and education of pilots to manage the risk of disease transmission in air travel
In collaboration with several other UN organizations and clinical partners, ICAO had developed a framework to manage public health events: the Collaborative Arrangement for the Prevention and management of Public health events in Civil Aviation (CAPSCA).³ CAPSCA included voluntary activities, and it was suggested that national and international regulations be adopted across several sectors, mainly aviation. Most activities involved sharing information on annual flight data, passengers and baggage, but also included planning, notification and training for airports in outbreak situations.

Further, the flight crew had a role in the transport of dangerous goods by air. There were many misconceptions about pilots’ knowledge of infectious substances. Most stakeholders in the shipment chain were not experts in biological materials, and thus needed education on the true risks of infectious substances. In addition, there was very likely a disconnect between the current regulations, the perception of risk and the actual data. Pilots’ role – to ensure the safe operation of aeroplanes in a heavily regulated industry – could make them overly averse to risks, even if the risks were low. The release of dangerous substances on an aeroplane, a pressurized container recirculating all air inside, would have serious consequences. This contributed in part to the high rate of refusal to transport infectious substances on aircraft. Education and data collection (blame-free reporting of incidents) were the best ways to address some of these issues with pilots.

Problems and possible solutions to facilitate shipment of animal pathogens and controlling the response to outbreaks
The issues in controlling disease in animal communities are unique, and rapid diagnosis is needed to prevent the further spread of disease. Outbreak prevention differs between animal and human diseases, however. With animals, prevention often begins with culling of livestock even before a diagnosis can be made; human beings, in contrast, are tested for treatment and recovery purposes.

The Food and Agriculture Organization of the United Nations (FAO) used a range of solutions to facilitate the shipping of animal specimens for laboratory testing, such as cotton swabs, filter paper, foam-tipped applicator (FTA) cards or DNA/RNA extract. These carry low risk, so can be shipped more easily as Cat B or exempt for diagnostic purposes. Nevertheless, FAO still experienced many delays in shipping; reducing these requires problems such as poor communication and training to be addressed.

The World Organisation for Animal Health (OIE) had recently updated its *Manual of diagnostic tests and vaccines for terrestrial animals*. It highlighted the need for some kind of internationally agreed, practical guide to transport, especially to clarify uniform training content for transport of infectious substances.

**Discussion**

The participants discussed the international challenges of shipping specimens of foot and mouth disease, noting that the applicable regulations or required documentation were in general quite country specific. Importing samples was particularly difficult.

CAPSCA opened some channels for sharing information, especially for tracing contacts. The participants noted that some challenges still arose in times of undeclared outbreaks, when airlines were reluctant to share traveller information.

While the participants recognized that universal guidance on shipment is highly desirable, devising it would be very difficult, due to the various requirements for different modes of transport.

**Classifying infectious substances: challenge and changes**

The participants explored some of the issues in shipping Cat A infectious substances, and potential solutions.

An amendment had been proposed to the current UN model regulations on the shipment of medical/clinical waste from infected patients. Shipping large volumes of such waste from treatment of Ebola patients had been very difficult, since it had to be shipped as Cat A and appropriate packaging materials had not been available. The current proposal includes a new UN number and packing instruction (PI622) be added to the model regulations, as a more appropriate alternative for large quantities of medical waste. The proposal was being updated and was due to be reviewed by the UN regulations committee in the coming months.

The work of the Universal Postal Union included a responsibility to support public health. Because criminals had maliciously used postal services to send infectious substances, such as variola virus or anthrax transmitted by letter, to unsuspecting recipients, Cat A infectious substances would remain outside the mandate of the postal service. In contrast, Cat B substances could be posted to facilitate public health, although some countries continued to prohibit this. Practices should continue to be reviewed as technology and testing continue to evolve, which might lead to change.

The concerns and challenges faced by CDC in the shipping of Cat A substances into and out of the United States of America primarily involved paperwork, rather than safety risks. This included refusal of shipments for improper wording, confusion in what paperwork was necessary and suddenly retracted special requests for unusual forms, which hampered the achievement of any consistency in procedures. There was also confusion in classification systems, highlighting the case of suspected cases of Cat A infections, when in fact the

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likelihood is extremely low for this, so stringent requirements seem out of proportion. All stakeholders across the board needed training, so everyone knew what to expect and what to ask for. An expedited shipping process in outbreaks would be helpful.

In view of the difficulties in shipping Cat A substances, it was interesting that there appeared to be few major differences between Cat A and Cat B, with the exception of paperwork and minor requirements for testing packaging. Most Cat A pathogens were classified as such when in cultures; clinical patient specimens could, as a rule, be considered as Cat B, which would facilitate shipment. As delays in the arrival of diagnostic specimens due to stringent Cat A requirements could lead to the explosion of outbreaks, any regulations and restrictions applied should be balanced against the public health benefit that may result from a more flexible approach.

Discussion
The participants discussed the potential for reclassifying all patient specimens as Cat B, including the mechanisms required at the level of ICAO. Other potential changes were suggested, such as requesting increased volume limits for shipments.

The participants agreed that any proposal for change needed to be based on strong evidence. Since the last discussion on reclassifying Cat A and B substances had taken place in 2002, there was perhaps a need to review the evidence on and the experience with the classification system that had been gathered since then. In practical terms, this would begin with WHO, with other stakeholders, proposing to ICAO specific, evidenced-based amendments to current regulations.

In view of airlines’ and pilots’ aversion to risk, a change in classification might not reduce shipment refusals if the evidence did not suggest a sufficient level of safety in packaging. Safe packaging was therefore suggested as a primary focus. The point was also raised that there are different case types – those ‘known’ to contain infectious substances and those ‘suspected’.

Training shippers of infectious substances
The participants explored the training for shippers of infectious substances offered by IATA and WHO.

IATA took a competency-based, blended-learning approach to training for dangerous goods. Knowledge was no longer sufficient to demonstrate the capacity to perform shipping tasks, and a more holistic approach was needed, including determining the levels of proficiency (knowledge, skills, experience and attitude) of people performing the work. Achieving proficiency first required identifying the basic level of competency in shipping infectious substances, through establishing the job function and the tasks needed for that function. The best learning strategy was thought to be a blended approach (70% on the job, 20% self-learning, and 10% classroom), rather than using one approach (such as online training) in isolation.
Challenges in the shipping of infectious substances in the WHO Eastern Mediterranean Region were related both to health (disease outbreaks) and non-health factors such as political issues. This made logistics challenging, and the WHO Regional Office for the Eastern Mediterranean often lacked the ability to coordinate shipments of infectious substances. Biosafety and biosecurity in the Region were weak overall, as acknowledged by the joint external evaluation under the IHR. Challenges directly related to shipping included restrictive regulations that changed frequently, high costs, lack of cold-chain and lack of packaging materials, but the primary issue appeared to be training. The Regional Office had made significant efforts to train the right people for shipping jobs, by providing training in countries to create appropriate pools of qualified people. In addition, low certification rates showed the need for more training solutions.

Further, WHO provided electronic Infectious Substance Shipping Training (e-ISST) for online recertification of shippers of infectious substances. Although WHO had trained high numbers of shippers (1900 in 54 countries), few (less than 10%) had used e-ISST to sustain their shippers’ certificates. Potential reasons for this included language barriers, poor database management systems, and other information technology issues in the initial set-up of the training, which was hosted across several outdated platforms. To address these issues, WHO was developing an updated version, e-ISST 2.0, with improvements in database management, graphic design and interactivity. Translation had already begun for versions in French and Spanish, as well as English, with Russian planned later. Intensified trainee management was also important, to ensure not only that WHO was training the right shippers but also that the programme was well sustained with new training methods, such as online training.

**Discussion**

The participants widely endorsed the need for competency-based training options, while noting that much progress had already made in improving accessibility and there were plenty of options for continued development. Standardizing the training would be important to ensure that all countries were receptive to newer types of training methods, including online efforts, on which both WHO and IATA were already working.

The participants also stressed the need to identify the target recipients of training (to ensure that the right people were selected) and to consider sustainability (not losing staff to high turnover. Targeting should focus on the people actually handling shipping, rather than higher management staff. The focus on proficiency in training, including continuous learning, supported this approach.

Further, the participants suggested that national focal points play a role in coordinating, overseeing and intensively managing trainees, including through a training-of-trainers approach. Some kind of mentorship programme, in which experts could oversee trainees to check their proficiency (using mobile telephones, for example) was also considered.

The Chairperson for day one suggested that WHO address the needs for training in a broader sense. This could improve awareness and understanding across a broad range of stakeholders, which had been demonstrated in the past in the radiopharmaceutical industry. This work
might also require the engagement of a wider range of stakeholders, including the authorities governing transport modes and administrators of international airports. Finally, the participants were urged to think of practical training solutions to present in their discussions on the following day, with a particular focus on sustainability.

Lessons learned from recent outbreaks
The participants began their work on the second day of the Meeting by exploring the lessons learned from dealing with infectious substances during recent disease outbreaks.

Perspectives from countries, air services and the waste packaging industry
For example, the United Kingdom had developed procedures to classify and facilitate the transport of samples from suspected viral haemorrhagic fever (VHF) patients during the 2014 outbreak of Ebola virus disease. The system was built on a risk assessment algorithm, still used by hospitals throughout the United Kingdom, classifying samples according to their likelihood (low, moderate or high) of containing the disease or another VHF. Only subject matter experts, reached via hotline at the imported fever service, could make this assessment. Within this system, the majority of suspected cases could be classified as having a low likelihood of VHF, and thus transported as Cat B. This facilitated not only the use of easier shipment processes but also quicker diagnostic turnaround time, a major benefit in view of the importance of time in declaring or controlling a potential outbreak.

Although the United Nations Humanitarian Aviation Services (UNHAS) is overseen by the World Food Programme, it provides vital services across all UN agencies, especially where sufficient safety standards cannot be met and/or commercial services are unavailable. During the 2014 Ebola outbreak, UNHAS overcame numerous challenges, such as a lack of standard operating procedures; constructed a purpose-built humanitarian aviation infrastructure; crossed closed air spaces and found personnel willing to operate flights. Important factors in such a success included partnerships, preparedness for another event, standby capacity, onsite coordination, and the sharing of a common objective and clarity of purpose by all stakeholders involved.

Commercial airlines had also made important contributions. Ethiopian Airlines, with one of the largest cargo networks in Africa, had provided assistance during both the 2014 Ebola outbreak and the 2018 plague epidemic in Madagascar. It was now strengthening its processes to provide support during humanitarian crises; new infrastructure was being developed to provide cold-chain facilities. Having strong quality and safety expertise and oversight were key ways to ensure safe shipments. Ethiopian Airlines was also setting up a facilitation committee for cargo shipments, to be convened to make decisions on how to best facilitate shipments in challenging circumstances and emergency situations.

The disposal of infectious waste posed challenges in southern African countries. The Responsible Packaging Management Association of Southern Africa (RPMASA) was a voice from the packaging industry to government, providing input on regulations, training industry stakeholders and auditing for quality and safety. This was an important role; while excellent
legislation covered multiple modes of transport, regulation and oversight were not well integrated across government departments, which worked in silos. In addition, RPMASA found that national regulations were not well known or implemented by stakeholders; training quality was poor; and low penalties encouraged noncompliance, corruption and bribery. Further, clear legislation was lacking for waste disposal, especially in the case of non-burn technologies (autoclaving). A common approach by government, support for policy and protocols and a readiness to reduce the spread of Cat A substances were needed. Achieving these, however, would require training, compliance, the provision of packaging supplies, stronger enforcement and meaningful penalties.

**Experiences of carriers in shipping infectious substances**

A representative of the Global Express Association (representing DHL, FedEx and UPS) shared the express delivery sector’s perspective on shipments, noting that each package may go through several couriers in a single journey. Although Cat A shipments comprised a very small part of the commercial market, they presented large technical challenges for storage conditions and logistical coordination. Although most biological specimens posed a low risk to carriers or the public, contingency planning for incidents was necessary and complex, especially for unknown agents, and required access to appropriate prophylaxis. The courier business had multiple stakeholders, and outsourcing (of aircraft or customs-to-door services) was common, meaning that companies may vary in their rules or capacities. To better facilitate shipments, it was important to ensure compliance with regulations (proper classification, detailed descriptions, correct packaging, good communication, complete documentation) before beginning the courier process.

The technical challenges of shipping infectious substances were also viewed from the perspective of a logistics coordinator. Although most customers were aware of and familiar with the regulations on dangerous goods, the complexity of the shipping task hampered understanding of and thus compliance with them. The main goal of the logistics coordinator was to ensure that packages were routed so that they were not delayed. Challenges included keeping strictly to time and maintaining temperature conditions, especially for shipments with dry ice. Good-quality packaging was therefore important, not just for safety but also to maintain temperature through different weather conditions. Clear instructions about what packages need to be stored and transported at what temperatures were essential. Special airline and import restrictions imposed by some countries and/or companies often compounded these challenges, making compliance difficult and refusals still common.

World Courier had been one of the major responders for shipments during the 2014 Ebola outbreak. Shippers had a vast number of responsibilities, ranging from classification to identification, maximum quantities, packaging requirements, marking, labelling, and documentation. To assist with fulfilling these responsibilities, World Courier started a worldwide course for certification in handling dangerous goods. To make services are more widely available, in 2017 World Courier had started to develop collaboration in the African Region. This included working closely with WHO and other partners. World Courier’s experience showed the need to create global awareness and knowledge in order to enable collaboration to improve health care outcomes worldwide.
Discussion
Discussions centred on the reasons why commercial couriers reject or block shipments of infectious substances. These included restrictive costs for couriers to maintain certification or equipment needed for local compliance, restrictions applied by subcontractors such as airlines, clauses in some contracts that prohibit shipments being sent with any biological products (such as cosmetics) and sometimes fears or misinformation about safety. Some couriers, such as UPS, were trying to expand their shipping range by accepting more Cat B specimens, provided PI650 was used. Couriers, however, had the prerogative to set their own variations. While some participants raised insurance issues, given that insurance was based on the scientific value of the sample and not the value of risk control, this should not be an issue for courier companies. Participants noted that some packaging companies appeared to provide packaging materials only in bulk, which may be difficult to store.

The participants also discussed the need for police escorts of Cat A specimens as a biosecurity control. This was said to be impractical if large quantities were being shipped, such as during an outbreak.

Challenges for public health laboratories in shipping infectious substances
The participants examined the challenges for public health laboratories in shipping infectious substances through six examples from countries around the world.

The Kenya Medical Research Institute (an Expanded Programme on Immunization Intercountry Laboratory) was heavily involved in the poliomyelitis (polio) eradication initiative for the whole African Region, requiring frequent shipments from nomadic populations. Cat B shipments were made easy through a door-to-door service provided by a courier in the Region. For some countries, however, no direct routes existed, so transport still required multiple stopping points, leading to drying or damage of the samples. The difficulties for Cat A shipments varied, but primarily involved unusual and difficult paperwork requirements (import/export permits and medical safety data sheets – MSDS), which delayed shipments significantly. The use of inappropriate packaging, particularly primary containers used (such as snap caps and large volumes of tape) was also an issue.

Located in a region comprising many small islands, the Caribbean Public Health Agency depended heavily on commercial and regional carriers to ship samples. Countries varied enormously in laboratory capacities, which increased the importance of enabling shipment to provide adequate capacity to all areas. Although 95% of all shipments in the region concerned Cat B substances, ordinary couriers could not provide consistent services for Cat A; up to eight weeks of diligent discussion with stakeholders were needed to find a way to ship, sometimes with rerouting through many countries to reach a final destination. The Caribbean Public Health Agency worked to strengthen preparedness by investing in training competent personnel across the public health system, including shippers, and gathered information on available resources/couriers in each country. As infectious substance shipment was an essential activity for public health, the Agency also explored alternative advocacy
activities, such as signing memorandums of understanding with commercial couriers. Improved communications, evidence on risks in transport and practical ways for resource-limited settings to implement international requirements were necessary to improve the current situation.

The Pacific Community, also serving a region of small islands, shared many challenges with the Caribbean Public Health Agency, such as having to use exclusively commercial air transport. This led to high costs for shipments, especially to reference laboratories in developed countries such as Australia or New Zealand. Nevertheless, the Pacific Community was fortunate to have developed a three-level network of public health laboratories called Pacific Islands Laboratory Network (LabNet), which facilitated referral mechanisms. The unique challenges facing the region included a vulnerability to natural disasters and climate change, high variability in funding sources and donor governance. The organization focused on disseminating helpful information to all Member States, including on best practices for laboratory activities, which included transportation. This also had challenges, with Internet access still a problem, but communication was improving through increased mobile telephone availability. Lack of training opportunities and access to controlled temperature conditions (cold-chain, dry ice) also continued to be an issue.

Although reasonably well resourced and with a biosecurity level 4 (BSL-4) facility, the National Institute for Communicable Diseases, in South Africa, faced difficulties including challenges in shipment. The portrayal of the Ebola outbreak by the mass media created fear; this meant that only one courier would transport samples to the Institute, and many even rejected other VHF samples. Training was also an issue, with high staff turnover and limited trainers. Poor understanding of underlying topics, such as general biological risks, made it difficult for trainees to understand the rationale for triple packaging. As mentioned by the representative of RPMASA, the numerous government departments involved in transport made obtaining the right permits for shipments extremely challenging. The size of the African Region also posed challenges, especially for implementing external quality assessment (EQA) programmes, requiring different logistics for different parts of the country. These issues were often compounded by civil issues, political instabilities and limitations/regulations imposed by operators (airlines) for carriage.

The Pasteur Institute of Dakar had had similar experience with airlines refusing to ship specimens to the laboratory during the Ebola outbreak. Conakry was a region without testing capacity; the inability to ship specimens from it might have delayed controlling the outbreak. Learning from this experience, the Pasteur Institute of Dakar had developed a network of epidemiological units that shared feedback and resources such as bulletins, diagrams for the flow of shipping samples and explanations of the differences between Cat A and B packaging. Further improvement required actions including the harmonization of laboratory shipment procedures at the national, subregional and international levels, the improvement of the availability to send equipment and the empowerment of the staff of relevant stakeholders.

Public Health England is a responsible custodian for the United Kingdom’s culture collections, providing biological controls and virus supplies worldwide. In contrast to many other organizations, Public Health England’s shipments always comprised known pathogens,
meaning that classification was rarely an issue. Nevertheless, the variability in the national or international regulations to be applied, depending on the destination, remained challenging. These challenges included long wait times for export and import licenses, incorrect paperwork completed by the end user, and unusual registration requirements. Another major challenge was maintaining the chain of custody in countries where door-to-door tracked shipments were not available or feasible and may be a biosecurity concern. Although most challenges were manageable for normative work, they had frightening implications in emergencies.

**Discussion**

The participants’ discussion focused on the example of shipment of the United Kingdom, including the requirements for the chain of custody and export licenses, and the difficulty of compliance for unknown specimens and/or in an outbreak, when expeditious shipments were needed. When time was an issue, however, licenses were generally processed quickly in the United Kingdom, and general import/export licenses could be obtained and then held to use in emergencies.

A participant asked why, if molecular techniques could be used on inactivated samples for diagnostics, timely shipments for further testing were necessary. The participants agreed that speedy shipment was still important, depending on the nature of the sample (for example, multiple cases of eradicated diseases), and for typing and tracking of virus evolution for prevention and treatment. Nevertheless, such samples represented a small proportion of the whole, and all samples were not time sensitive.

**Roles of WHO programmes in shipping infectious substances**

The roles and experience of WHO programmes and regional offices in shipping infectious substances were explored.

**Global programmes on hazard management and three communicable diseases**

The programme on infectious hazard management supported the response to laboratory teams and took part in the global laboratory alliance for diagnosis of high-threat pathogens, a network for sharing information, biological materials and experience. Much of the programme’s work was related to outbreak response, involving many unknowns on pathogens and epidemiology, which led to a large variety of different samples and transport needs. Factors compounding these challenges included unstable political context, social and media pressures, complicated customs procedures, the shortage or lack of certified shippers and the lack of adequate transport material (such as dry ice and packaging), trust from airline representatives at the local level and direct transport routes. The way forward could be to develop an outbreak protocol to help lift transport barriers during emergencies, when lives are at stake. As the lack of trust contributed to delays, partnerships between local shippers and airlines designated as trusted shippers may be a valuable solution.
The WHO polio programme had made immense progress. As the disease was eradicated in most parts of the world, current activities focused on surveillance, to prevent resurgence and small outbreaks. This required the sharing of almost 240,000 stool samples per year, transported under cold-chain conditions. The programme thus faced challenges including poor logistics and supply, the absence of or variations in national regulations to be applied, local shippers’ lack of awareness of packaging and the risk of infection and lack of compliance. Owing to limited resources, countries often prioritized testing for other diseases (such as Ebola virus disease) over polio testing during outbreaks. Proposed solutions included the provision of more packaging and logistics services, training for field laboratory staff, sourcing of ice packs, sharing of valid import permits, mapping of available couriers and ensuring of good communication between sender and recipient. Movement in sequencing and molecular diagnostic capacities presented new opportunities for sending inactivated samples (such as FTA cards), even though these needed to be validated.

WHO’s global influenza programme had created a strong relationship through the competitive WHO bidding process with World Courier, to develop a standard protocol for influenza shipments. This protocol enabled national influenza centres to ship samples up to four times per year to support the vaccine development team. Shipments were sent on dry ice and ideally transported within 72 hours. The programme developed a chart to define, depending on the sample, how to classify and ship influenza samples, which was recorded in the WHO biocontainment guidance on the transport of influenza samples. Nevertheless, the programme still encountered some issues, usually from poor documentation and incomplete information in shipping declarations. Miscommunication between stakeholders, particularly based on fear generated by misunderstanding or media stories, remained a big problem. More training and awareness were therefore needed.

The work of WHO’s tuberculosis (TB) programme involved a wide range of testing, which required a range of different laboratories with appropriate capacities. Shipment was therefore essential to get coverage of testing, but also for quality control to send proficiency-testing samples and maintain laboratory quality. Having a good specimen referral system meant better access to laboratory services, increased access to diagnostics and overall improvement in equity in access to health care. This was why facilitating shipment is so important. Finding locally sustainable shipment methods, such as motorcycles or even carriage by hand, was important. Like the influenza programme, the TB programme used agreements with World Courier to assist with door-to-door shipment. This arrangement was expensive for WHO, however, and sometimes still involved difficulties such as requirements for customs declarations, evidence of a current shipper’s certification, current import permits and contact details of a shipment’s recipient.

**Shipping infectious substances in two WHO regions**

Member States in the Western Pacific Region included very large countries and small island nations. Although well served by courier companies, the interconnected Asian countries still encountered problems with high prices and government approvals for the shipping of infectious substances. For small island countries, the reference laboratory set-up helped to facilitate shipping, but infrequent or nonexistent aviation services and cold-chain storage
were major barriers. Possible solutions included improving coordination and communication, especially to refamiliarize Pacific communities with the use of laboratory network Labnet resources. Other products were being explored, including the use of checklists, posters and videos on sample referral systems and a direct-connection flight tool. More training, ensuring continuity by using the training of trainers, and recertification methods would also be useful.

In the Americas, the Pan American Health Organization (PAHO) was developing strong training and certification processes for staff working in influenza, veterinary, TB and other microbiology laboratories. The aim was to ensure that each country in the Region had at least two trained personnel, and to sustain this by encouraging online recertification. The challenges in the Region included working mostly in emergencies, lack of political support, lack of policies and regulations, high cost (especially for training), high staff turnover, limited numbers of couriers and packaging suppliers, language barriers for training materials, complicated customs procedures and lack of direct flights to remote areas. Important needs for the future included implementing sustainability and quality management procedures, and continuing training for all stakeholders. As to regulations, WHO could provide more leadership and enhance coordination and networking among stakeholders. Innovative packaging options, an improved training curriculum and guidance for emergency situations would also be valuable.

**Discussion**

Discussing the request for MSDS, the participants reached consensus that these were neither required nor appropriate for biological substances, which differ from chemical substances. Changing the term infectious substances to the term infectious materials in the regulations could perhaps reduce the confusion about their nature.

The participants highlighted the difference between the challenges of having too many regulations and having none at all. In the latter case, the absence of national regulations in many places meant that local requirements were unknown in the field. The biggest need was not to have more regulations, but to define minimum safety standards for cases where no regulations exist. A country’s capacity or the local situation may hinder the ability to comply with the most stringent international regulations.

**Recommendations and conclusions**

1. Review categorization of samples including diagnostics. This should include reviewing the possibilities of sample inactivation prior to transport. This would require proof of inactivation, however; many samples thought to be inactivated have proved to contain live biological agents.

2. Build a network for shipping samples.

3. Devise one triple-packaging system appropriate for all categories of samples.

4. Better clarify training mechanisms. All stakeholders in the chain should receive awareness training, and training for different stakeholders should be harmonized. It is essential to ensure that the right people attend training. Established organizations could
be used as hubs for training. E-learning could offer a standardized approach; although face-to-face contact is valuable, it may be unsustainable, especially financially. Consideration must be given to quality control and the monitoring of trainees’ identities to prevent fraud; in addition, standardized training should take account of local regulations, variations and cultural aspects.

5. WHO should make its new e-ISST available as soon as possible, and translate it into additional languages. The course could perhaps be used in training workshops. WHO should also set up a monitoring system or improve existing systems to encourage recertification.

6. WHO should connect with other organizational stakeholders, such as the World Customs Organization (WCO) and the International Atomic Energy Agency (IAEA), to explore new proposals for regulation changes. Continue to work with ICAO and IATA on this.

7. Relevant competent authorities should consider developing an emergency plan for transportation during outbreaks. This work should summarize the minimum requirements for preparedness that countries need to meet, and could involve the stockpiling of packaging materials and issuing of emergency transport licences. WHO should take the lead in these efforts.

8. Continue to build the evidence base for safety of packaging requirements. Cost-effective packaging solutions need to be developed that also meet safety standards.

9. There is a need to build a stronger communication network for shipping, identifying, for example, sources of assistance (at IATA and/or WHO) to contact when a sample is blocked in a country. A formal global shipment network (similar to the Global Outbreak Alert and Response Network), giving the members a platform for discussion, could be beneficial. Such networks should also be constructed at the national level, although strengthening current networks would be a more easily achieved goal.

The participants recognized WHO as the key leader in the health and medical implications of shipping infectious substances, and urged it:

- to act in a number of areas that involve its health expertise, such as the classification of infectious substances and evidence-based safety protocols for packaging materials and substance volumes; and
- to coordinate the efforts of relevant intergovernmental agencies, particularly IAEA, OIE, FAO and possibly WCO.

As the participants also highlighted the roles of ICAO and IATA in setting standards and clarifying numerous aspects of the shipment process, WHO must try to work with these agencies to bring better harmonization between the health, safety, and regulation aspects of the shipment process.

While the Meeting seemed to focus on the issues of shipment and the barriers to addressing them across the shipment chain, several important dialogues were opened that may help to facilitate further collaboration, particularly in training and evidence-based health and safety practices. Furthermore, although consensus could not be reached on many of the issues, each
issues seemed to have at least several possible solutions that could be explored, with various short-, mid- and long-term options to be considered. Overall, it might be suggested that the Meeting did not highlight any one clear direction for future action, many options that could be pursued. This provides not only some difficulty in creating priorities for action but also some optimism that many different steps could be taken to work collectively towards the safer, more timely and efficient shipment of infectious substances.
Annex 1. Qualitative analysis of participant feedback

A survey conducted after the WHO Consultative Meeting on the Safe Shipment of Infectious Substances provided an opportunity for participants to share subjects that they would have liked to discuss further, and issues that need to be addressed by future actions. Their comments were reviewed and collated by subject heading to establish the most commonly mentioned areas that WHO staff should prioritize to plan its next steps.

The participants’ comments were summarized under the seven general subject headings shown in Fig. 1 and discussed below. An eighth subject area, not included in the analysis below, was general comments on the organization of the Meeting. Around half of these comments were congratulatory, while the rest indicated that future meetings should allot more time for questions and discussion, by either having fewer presentations or extending the length of the event. In addition, two comments indicated that manual exercises, presumably with packaging or documentation for shipping infectious substances, might add some value.

Fig. 1. Issues for further discussion and future priorities highlighted by participants

Training
Both the discussions at the Meeting and the comments received in the survey clearly showed that training was an area of great interest. More than a quarter of comments received
pertained to training and related aspects. One of the primary issues was the harmonization of training, as international guidelines do not explicitly address the needs and/or content of the training required to orient and/or certify shippers of infectious substances. National regulations tend to determine what is needed for training shippers in each country. The International Air Transport Association (IATA) is widely recognized as a reputable training provider, with some national regulators even requesting IATA certification to ship Category A (Cat A) substances. As IATA is a private entity, however, lower-resource countries may deem its training unaffordable. Furthermore, IATA’s role as an international benchmark was questioned, with some comments suggesting the avoidance of specifying IATA training as the only standard to follow.

Other comments discussed the need to find options to make training more accessible and widely available. Two primary options were mentioned: the first was training of trainers, where national/local training events, perhaps by IATA, would create a pool of locally standardized trainers who could then disseminate information to shippers in the country. This requires some additional consideration, as it may be difficult to validate the quality assurance of shippers subsequently trained, to ensure that they have received an acceptable level of training that is sufficient for certification. During the Meeting, such national face-to-face training was also recommended, not just for the training of trainers but also to reduce costs (national travel being cheaper than regional travel) and improve impact for the country in terms of trainee numbers.

The second option proposed involved online training, which allows extremely wide access to training and is much cheaper than face-to-face courses. Online content is more interactive and content more easily adapted to include new information or activities that enhance learning. Furthermore, mobile applications are now widely recognized as having a strong saturation rate among even in low-resource countries, and could be used not only for training but also for ensuring ongoing access to regulations, instruction materials and guidance at the point of packaging and shipping. The participants recognized that online training (similarly to the training of trainers) presents some difficulties in the validation of quality, but more in validating the trainees performance and therefore in being used for certification purposes. IATA was one of the world leaders for training shippers on dangerous goods, but had not yet found a way to adequately control the quality of online training or benchmark its sole use to certify shippers, although such work was underway. In addition, some countries’ regulations prohibited the use of online training alone for certification.

Nevertheless, several comments supported online training portals, especially for recertification after original face-to-face training, and encouraged making this accessible as soon as possible. During the Meeting, other participants highlighted a need to consider making such online recertification available to those who has completed a course certified by IATA, but WHO; this would help to improve access to recertification that was not currently offered by other bodies. This proposal required additional consideration as WHO felt it might be held accountable for such certificates, although it could not verify the content delivered in the training.
In summary, training remains a major issue. Future action should include the harmonization of the training content needed by various stakeholders in the shipment chain, which should likely be a consolidated effort by WHO, the International Civil Aviation Organization (ICAO) and IATA. A revamped online recertification scheme should be made available as soon as possible to help shippers to renew expired certificates, and some serious consideration should be given to when and how the platform could be expanded to include other participants, whether from other training courses for purposes of orientation/education without certification, or as an alternative to face-to-face training. Establishing an industry benchmark (perhaps also an effort of the three organizations mentioned above) for online training may still be necessary, as may lobbying at the national level so that the applicable regulations facilitate this.

The training of trainers may also be a valid option, although similar benchmarking and validation considerations also apply. This may be a valid midterm or transition option until training issues (harmonization and online benchmarking) are further clarified.

**Revision of classification system**

Over one fifth of comments from the survey related to clarifying the classification system used to separate infectious substances into three categories: Cat A, Cat B and exempt. Some participants suggested reviewing the need for the third category, as a revision (and ultimately simplification) of the Cat A and B classifications would perhaps be sufficient.

Participants felt that some review of the Cat A list, which had probably not been addressed since 2002, was necessary, as technology and knowledge had advanced to a point where the true risks of various diseases were better understood; in addition, the varied types of samples now being transported posed different risks than just an isolated pathogen, for which the classification had largely been devised. Many considered that reclassifying certain specimen types at least could see many tests being sent as Cat B, at a cheaper and faster pace. Some clarification would still be needed, however, as Cat B packages are still subject to national variations, including import/export permits and other controls. This means they may be less easy to transport than Cat A packages, which, although requiring higher cost and a larger documentation trail, tend to pass quickly once the shipments have been initiated. Others felt this kind of reclassification might further encourage carriers to require that Cat B substances be shipped in Cat A packages, despite the lower classification. Overall, the participants thought that classifying substances as Cat B in as many situations as possible would help to facilitate shipments worldwide. This is particularly true of patient specimens (versus cultured pathogens) and specimens for which there was a suspected but low likelihood of a Cat A pathogen. Participants recalled Public Health England’s protocol for classifying suspected, but low-likelihood, viral haemorrhagic fever cases as Cat B with this rationale, which proved to be quite successful.

Other variations in the class regulations were suggested to further facilitate shipment. One involved requesting to increase the volume of Cat A substances that may be shipped on passenger aircraft from 50 mL, so that at least isolated countries (such as the Pacific islands) could send more substances in one shipment, which would be easier than sending several single shipments. Another suggestion involved clarifying the need for medical safety data
sheets (MSDS) for Cat A pathogens, which seemed to be unanimously unsupported during the meeting, stated as being inappropriate for ‘substances’ of a biological nature vs ‘materials’ (e.g. chemicals) for which MSDS were originally intended. There could be a need to request a clause in international regulations that suggests that MSDS are not needed for shipments of Cat A or B substances.

Overall there remains a strong case for WHO to take the lead in proposing certain changes to the current classification system. Participants seemed to support such changes as reviewing Cat A lists, making patient specimens classifiable at Cat B, introducing likelihood assessments into classification decisions (a form of risk assessment) and increasing volume allowances for various classes. As mentioned in the body of this report, any proposed changes would be likely:

- to require collaboration between international leaders: WHO, the World Organisation for Animal Health (OIE), the Food and Agriculture Organization of the United Nations (FAO) and ICAO;
- to need to be backed by medical evidence of safety and relevance;
- to be promoted by supplying material on the medical evidence to other stakeholders of the shipment chain; and
- to be supplemented by reviews of the packaging safety, simplification of packaging and clarification of training needed to ship.

**Networking with other stakeholders**

Many comments stressed the need for networking among stakeholders. The specific activities suggested ranged from opening a dialogue with some other stakeholders that have experienced similar issues (IAEA in relation to transporting radioactive material) to engaging with stakeholders absent from the meeting, including representatives of the World Customs Organization (WCO) and border controls, medical advisors, more dangerous goods inspectors, airport representatives (ACI), or several nongovernmental organizations. One participant suggested such meetings could be streamed online to allow more participation.

Several participants mentioned better networking in the context of reference networks and open communication between links of the shipment chain. The examples given included memorandums of understanding between public health laboratories and airlines or couriers to better facilitate shipments. In addition, reference networks could be used to clarify where specimens should be sent in the event of an outbreak; WHO gave examples of laboratories not knowing which reference centre to contact, making organization of the shipment impossible, as different destinations would warrant different logistics. This could be considered as part of another subject area, creating emergency action plans, but may also be considered as part of a WHO strategy to clarify laboratory reference networks within and among priority countries.

The need for health organizations (WHO, FAO and OIE) to network with regulatory and operational organizations (ICAO and IATA), to establish ways to take action at a higher level to better facilitate shipments, was given particular importance. This should include, for example, revision of the medical basis for classifying infectious substances, proposed
changes to the volume of infectious substances to be carried on passenger aircraft, the development of global standards for training on shipping infectious substances, and changes in packaging requirements

**WHO leadership and action**

Several participants expressed a reliance on WHO leadership and action, to pave the way for facilitation of the shipping of infectious substances, in both the survey responses and the Meeting. As the international representative of health, WHO is responsible for presenting the relevant health and safety information to those in other industries who may not be involved in health-related activities on a regular basis. For many stakeholders, infectious substances made up such a small part of their regular work that making any changes in this work would be impossible without the leadership of or perhaps pressure from the international level.

Some participants suggested communicating with non-health stakeholders in easily understood terms about the health aspects of shipping infectious substances. This may include the delivery of information about the transmission of infectious substances to improve understanding, especially amongst non-health staff, on the spread of infectious substances and on the actual risks associated with shipping them. This might include informative videos, guidance, posters and bulletins. Promotion and communication could also be relevant to create a better understanding of the consequences of denying or delaying shipments, so that stakeholders including customs/border controls, carriers and even national regulatory authorities gave greater importance to facilitating shipments.

The need for WHO leadership was often mentioned in conjunction with activities in the other subject areas, such as engaging with other stakeholders, providing evidence-based health and safety information on the relative effectiveness of packaging methods or providing evidence on safety based on incident statistics. Further, several comments urged that WHO use the conclusions and momentum from the Meeting as soon as possible to drive action. As described above, these actions could include:

- informal coordination with other stakeholders (such as WCO and IAEA) to share experience;
- formal coordination on training with ICAO and IATA;
- formal coordination with OIE and FAO on proposals to ICAO for changes in regulations;
- production of educational materials on the risks of infectious substance and the role of shipping infectious substances in improving global health, and preventing and controlling outbreaks; and
- commissioning or collection of scientific evidence on safety, including incident statistics and the effectiveness of packaging materials in reducing risk of release.

**Creation of evidence base**

The comments made on a presentation given during the Meeting (on the positive results of the Health and Safety Executive’s experiments, testing United Nations model packaging against a series of challenges) welcomed both the results and the visual component of the presentation as useful tools for communication and education. Several participants commented that further testing, using scientific methodologies and reported results, could be
useful in building evidence of safety. The information could also be shared with shipping-chain stakeholders to build their understanding of the true risks/safety aspects of shipments in transit. Participants also suggested that other evidence, such as incident statistics, could be useful, although there is no centralized system for incident collection and/or it seems limited incidents have happened to make data available. Others suggested that investigating noncompliance records could help to determine whether fines or sanctions had ever been given for shipments of infectious substances, and that the suggested costs of shipping be examined. While overall cost may be not a primary determinant of shipping, evidence of the cost–benefit ratio for better facilitating shipments could be useful.

Some comments suggested that further testing on packaging may not just provide evidence for safety promotion but also form the basis for designing new, simplified packaging materials. The participants thought that, if simpler packaging were available (providing that its safety had been tested and proved) then training on packaging could be given in a way that more easily builds trust among stakeholders and shipments would be better facilitated overall.

**Creating emergency action plans**
Several comments highlighted the need for emergency action plans to facilitate shipment in outbreaks. Although several comments to this effect were made, limited elaboration was present in the survey comments. However, during the Meeting this topic highlighted several important factors:

- An emergency action plan should be developed by whom? imminently before the next outbreak occurs.
- There may be some need to look at both pandemic and epidemic situations, each of which have slightly different needs and considerations (the example of influenza was given for pandemic response).
- An emergency action plan could include a network of focal points within international organizations to create pressure when/if needed to facilitate shipments and relaxations or special provisions in international regulations.

**Harmonization of regulations**
Although the quantitative analysis of survey results indicated that the participants seemed to have gained a good understanding of current international regulations, several comments indicated that further clarity was needed. Many noted the differences between international regulations: the ICAO technical instructions and the ADR.

Others called for the highlighting of the differences between regulations for different transport modes, such as road and maritime regulations, as aviation regulations had received much emphasis at the Meeting. Although IATA published its regulations, these are not formal regulations and are based solely on the technical instructions provided by ICAO. The participants agreed that, while IATA’s position should not be considered in the context of international regulations, it is a benchmark for much of the aviation industry; this means that IATA’s influence on applicable regulations still needs to be considered.
Other comments highlighted the need for more consistency across national regulations. They recognized that national and operator regulations almost always favour more stringent rules than those internationally applicable, which further complicates the shipment process. It may be necessary to encourage countries to refrain from adding such variations, as, even with international regulations applied, safety seems to be sufficient and additional regulations only impede the shipment process. There is no clear way to do this, however, although this task is likely to require significant advocacy from multiple internationally recognized organizations, promoting such practice in a united way, which may be difficult.

Many countries, especially those with limited resources, had no regulations on shipping infectious substances; even if regulations were adopted, without regulatory bodies and national oversight, they might still mean very little to facilitating national shipments. South Africa, for example, had significant legislation, but no oversight or enforcement. More advocacy or even more guidance could help countries pass applicable legislation. Furthermore, responsibility for national regulations was sometimes spread across numerous government departments, with no coordination between them, which hampered understanding and compliance.

An OIE representative suggested that a document be developed to present harmonized practical guidance, endorsed by international organizations, on numerous occasions throughout the Meeting. The document could provide guidance on the minimum general requirements for the shipment of infectious substances. It could serve as a reference in situations where national regulation was unclear. Developing such a document may be difficult, due to the number of stakeholders and variations in current regulations, but the idea perhaps warrants further investigation.

**Conclusions**

The WHO Consultative Meeting on the Safe Shipment of Infectious Substances was extremely well received by the participants. Most felt that its objectives had been met and sufficient breadth of coverage was achieved in the two days allotted. They also thought, however, that the Meeting further highlighted the many challenges in shipping infectious substances. Due to the huge number of stakeholders involved and a lack of harmonization in regulations, training and networks, for example, finding solutions acceptable to all stakeholders remained a difficult task.
# Annex 2. Programme

## Day 1: Thursday, 15 March

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*Note: *WHO Laboratory biosafety manual* refers to the World Health Organization's guidelines for laboratory biosafety.

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*Note: The table provides an overview of the topics and speakers for the first day of the programme. The topics include opening remarks, infectious substances and risk assessment, practical demonstration, and classification and movement of Cat A and Cat B infectious substances.*
- Concerns and challenges of shipping Cat A substances in and out of the United States of America
  Brian Harcourt

**Discussion on evidenced-based reclassification of patient specimens as Cat A as Cat B infectious substances**
  Kazunobu Kojima

**Training shippers of infectious substances: platforms, methodologies and best practices**
  Natasha Griffith
  Alexandra Jimenez
  Karen Nahapetyan
  Lisa Stevens

- The online training experience: Centers for Disease Control and Prevention
- Competency-based training and blended training approaches
- Training successes and challenges in the WHO Eastern Mediterranean Region
- An update on the WHO online infectious substances shipping training

**Open discussion on training needs and platforms**
  Day 1 Chairperson

**Recap of day 1 and adjournment**

### Day 2: Friday, 16 March

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| • for vulnerable/resource-limited countries  
• under emergency situations | Day 2 Chairperson |
| Discussion on a taskforce/network on infectious substance shipping: terms of reference, membership  
Summary, conclusions and recommendations, and plan of action Adjournment | Day 2 Chairperson |
Annex 3. Participants

Dr Emma Aarons, Public Health England, United Kingdom
Dr Virginia Asin-Oostburg, Caribbean Public Health Agency, Trinidad and Tobago
Ms Haaba Baldeh, International Civil Aviation Organization, Canada
Ms France Bernier, Transport Canada/Government of Canada, Canada
Mr Julio Bollain, Dangerous Goods Management, Spain
Dr Brian Crook, Health and Safety Laboratory, Health and Safety Executive, United Kingdom
Dr François Diaz, World Organisation for Animal Health, France
Ms Salanieta Elbourne, Pacific Community, New Caledonia, France
Mr Javier Garcia, Universal Postal Union, Switzerland
Mr Babacar Gning, Pasteur Institute Dakar, Senegal
Ms Nathalie Hagmann, Federal Office of Civil Aviation, Switzerland
Dr Brian Harcourt, Centers for Disease Control and Prevention, United States of America
Ms Joanne Hassan, Kenya Medical Research Institute, Kenya
Dr Emma Hobbs, Public Health England, United Kingdom
Mr Julian Humphreys, Global Express Association, United Kingdom
Ms Alexandra Jimenez, International Air Transport Association, Switzerland
Ms Akiko Kamata, Food and Agriculture Organization of the United Nations, Italy
Ms Sabrina Mansion, United Nations Economic Commission for Europe, Switzerland
Dr Jean-Claude Manuguerra, Pasteur Institute, France
Ms Veerle Melis, BioLogistic Services, Netherlands
Ms Yanet Mulugeta, Ethiopian Airlines, Ethiopia
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