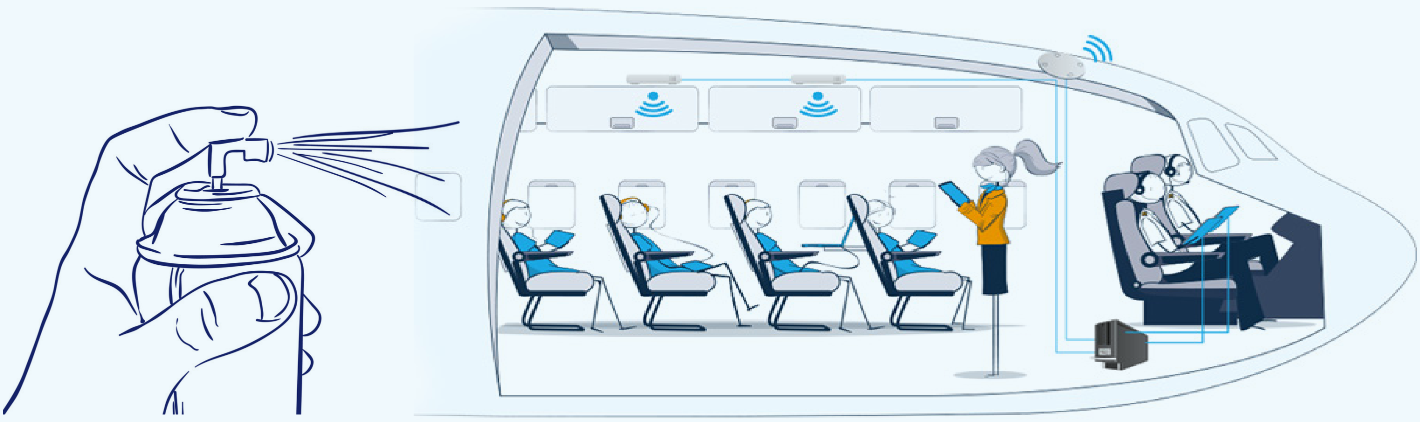
Methods and operating procedures for aircraft disinsection

Report of a WHO consultation
Geneva, 3–4 July 2018



World Health Organization

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1. Introduction

Raman Velayudhan

Dr Velayudhan welcomed participants to the consultation on behalf of the Director of the WHO Department of Control of Neglected Tropical Diseases. WHO had last published guidance on aircraft disinsection in 1995, but this publication was now out of date and parts of it had been superseded by more recent guidelines. Additionally, the rapid spread of mosquito-borne diseases such as Zika virus disease had focused attention on the need for updated guidance, even including on the value of aircraft disinsection as a valid public health measure.

The objectives of the meeting were outlined, namely:

- to review the challenges faced by end-users of aircraft disinsection products;
- to review current and new procedures for aircraft disinsection;
- to review the need for new insecticide formulations; and
- to make recommendations on the selection of disinsection methods to be used.

Participants were reminded of the need:

- to advise on updating the WHO recommendations on the selection and use of aircraft disinsection products and methods;
- to advise on the development of standard operating procedures for all aircraft disinsection methods; and
- to advise on the development of training materials and tools.

The meeting agenda was summarized; it is attached to this report as Annex 1. Participants then introduced themselves around the table. The participants are listed in Annex 2. It was explained for the record that all invited WHO experts had completed a *Declaration of interests for WHO experts* form before the meeting, which had been reviewed by the WHO Secretariat and were found to contain no interests that would preclude any of the persons from taking part in the meeting. Professor Graham Matthews was appointed as the Chair of the meeting, and Mr David Bramley as the Rapporteur.

2. Current aircraft disinsection methods and insecticides

2.1 Overview

Rajpal Yadav

WHO's last formal publication on aircraft disinsection was a 1995 report in the International Programme of Chemical Safety (IPCS) series.[1] Since then, the International Health Regulations (IHR) were adopted by the World Health Assembly in 2005 and came into force in 2007. The IHR defined disinsection as "the procedure whereby health measures are taken to control *or* kill the insect vectors of human disease present in baggage, cargo, containers, conveyances, goods and postal parcels" (IHR, Part I, article 1) and stated that it should "be carried out so as to avoid injury and, as far as possible, discomfort to persons …" (IHR, Part IV, article 22, Section 3). In 2016, WHO convened an expert group in response to the spread of Zika virus, which considered that the effectiveness of disinsection as low for preventing importation of pathogens, as there was a low risk of importation by mosquito vectors compared to infected travellers.[2] Some cases have been identified of dengue viruses being carried by mosquitoes in aircraft and, even if the risk is very low, it nevertheless remains and WHO considered it important to address the issue at the present meeting. More recent documents had provided WHO guidelines on efficacy testing[3] and risk assessment[4] of aircraft disinsection products.

Currently, the only three WHO recommended aircraft disinsection products are permethrin (25:75) TC (technical material) and its 2% AE (aerosol) or 2% EC (emulsifiable concentrate) formulations; *d*-phenothrin TC and its 2% AE formulation and 1-*R*-*trans*-phenothrin TC and a combination of permethrin 2% AE and *d*-phenothrin 2% AE in aerosol for cargo areas.

These insecticides and the methods for spraying must comply with WHO specifications and procedures, as well as regulations in the country of flight arrival. The WHO-recommended methods of disinsection were described (see Table 1 for details):[3,4]

- The blocks-away aerosol application is carried out by the cabin crew: the aerosol of 2% *d*-phenothrin insecticide is first sprayed in the flight deck without pilots; then after closure of the cabin door, with passengers on board and before the flight takes off, aerosol is applied in the cabin while keeping the overhead lockers open and the air conditioning turned off. The cargo hold is sprayed by ground staff beforehand. An aerosol containing 2% *d*-phenothrin is currently recommended by WHO and should be applied at a rate of 35 g of formulation per 100 m^3 (i.e. 0.7 g a.i./100 m^3). Cargo holds should also be disinsected.

- A pre-flight aerosol containing an insecticide with rapid action and limited residual action is applied by ground staff to the flight deck, passenger cabin including toilet areas, open overhead and side-wall lockers, coat lockers and crew rest areas. The spray is applied before passengers board the aircraft but not more than 1 h before the doors are closed. A 2%

[1] Report of the Informal consultation on aircraft disinsection, Geneva, 6–10 November 1995. Geneva: World Health Organization International Programme on Chemical Safety (http://apps.who.int/iris/bitstream/handle/10665/59700/WHO_PCS_95.51_Rev.pdf).

[2] WHO Ad-hoc Advisory Group on aircraft disinsection for controlling the international spread of vector-borne diseases, Geneva, Switzerland, 21–22 April 2016 [Meeting report]. Geneva: World Health Organization; 2016 (http://www.who.int/ihr/publications/WHO_HSE_GCR_2016_12/en/).

[3] Guidelines for testing the efficacy of insecticide products used in aircraft. Geneva: World Health Organization; 2012 (http://apps.who.int/iris/bitstream/handle/10665/44836/9789241503235_eng.pdf).

[4] Aircraft disinsection insecticides [Environmental Health Criteria 243]. Geneva: World Health Organization; 2013 (http://www.who.int/ipcs/publications/ehc/ehc243.pdf).

permethrin cis:trans (25:75) formulation is currently recommended for this application, at a target dose of 0.7 g a.i./100 m^3. This requires application at 35 g of formulation per 100 m^3 to various types of aircraft, with a droplet size of 10–15 µm. Preflight spraying is followed by a further in-flight spray, i.e. top-of-descent as the aircraft starts its descent to the arrival airport.

- Top-of-descent spraying is carried out as the aircraft starts its descent to the arrival airport. An aerosol containing 2% *d*-phenothrin, as currently recommended by WHO, is applied with the air recirculation system set from high to normal flow. The amounts applied are based on a standard spray rate of 1 g/s and 35 g of the formulation per 100 m^3 (i.e. 0.7 g a.i./100 m^3).

- Residual insecticide treatment is part of regular pest control measures mainly for cockroach control. The internal surfaces of the passenger cabin including galleys, toilets and cargo hold, excluding food preparation areas, are sprayed by professional pest control operators using a compression sprayer with a control flow valve and flat fan nozzle according to WHO specifications. Permethrin 25:75 (cis:trans) EC is currently recommended by WHO at a target dose of 0.2 g/m^2 applied at intervals not exceeding 2 months. Residual spraying around the galleys and toilets, etc. should be done when the aircraft is undergoing routine maintenance, i.e. when the aircraft is not in service. The emulsion is applied at 10 mL/m^2 to avoid run off. Residual sprays are applied for long-term residual activity on aircraft interior surfaces. Retreatment of areas depends on the frequency of cleaning. In electrically sensitive areas, it may be necessary to use an aerosol instead of a compression sprayer. After treatment is completed, air-conditioning system should be run for at least 1 h before the crew and passengers embark to clear the air of the volatile components of the spray. Areas that undergo substantial cleaning between treatments require supplementary "touch-up" spraying.

The pesticide formulations, including spray cans, should comply with national regulations and international standards as well as with WHO specifications for pesticides. Spray operations should follow international regulations and WHO-recommended procedures and comply with quarantine requirements in the country of arrival.

Disinsection methods and practices can be improved by engaging pest control operators, training cabin crew, treating baggage and cargo areas, keeping overhead lockers open during pre-flight aerosol application, and deploying vector control and sanitation methods in and around aircrafts. Aircraft disinsection faces certain challenges, notably pyrethroid resistance in mosquitoes, and regulatory restrictions in some countries against certain products. New methods are therefore needed including non-chemical methods, especially in collaboration with the International Civil Aviation Organization (ICAO).

Discussion

Participants noted the importance of engaging qualified pest control operators in keeping aircrafts and airports free from disease vectors, and of providing appropriate training on disinsection techniques to cabin crew and ground staff. It was reiterated that disinsection of the baggage and cargo areas must not be overlooked and that the overhead lockers must remain open during pre-embarkation disinsection of the cabin to achieve the desired impact of vector control. It was also pointed out that frequent cleaning of certain cabin areas reduces the duration of effectiveness of the residual insecticide treatments and such areas should be subject to residual re-treatments. There is a growing resistance of mosquito vector species to pyrethroid insecticides. Additionally, a growing number of countries in the European Region have recently introduced regulatory restrictions that ban the use of certain pyrethroid formulations in disinsection. Consequently, if disinsection is to continue, new products and appropriate formulations will be needed and non-chemical methods for disinsection may be warranted.

2.2 The application of insecticides in aircraft

Graham Matthews
Cabin crew must be trained in the importance of disinsection and made aware that in order to fully remove mosquitoes, the overhead luggage lockers must remain open. Short-term treatment to control mosquitoes on flights must take place when departing from areas with transmission of malaria and other mosquito-borne diseases such as Zika virus disease. Residual spraying and other pest-control measures should take place during maintenance, usually at 2–3 month intervals depending on the maintenance schedule of the aircraft. Special attention should be paid to the galley and toilet areas to remove insect pests such as cockroaches. Spillage of coffee can encourage insects, especially in carpeted areas. When spraying the cabin, WHO recommends that the sprayers must be fitted with a control flow valve to ensure that the liquid discharge continues to remain constant even as the pressure is declining when the tank is emptying. Residual spraying of walkways connecting the airport building to the aircraft door every 2–3 months should also be considered. Luggage and cargo/freight holds should be treated also with a residual spray.

Reference was made to a report from the 1940s, which noted cases of *Anopheles gambiae* mosquitoes being transported in aircraft during the previous two decades from Africa to Brazil. A publication in 2017 has stated that while disinsection helps to prevent transport of the vector and other invasive species, it was unlikely to impact the spread of vector-borne pathogens, which are more likely to be transported by human beings.[1] Thus, if a person with malaria arrives in an area where malaria is not endemic but the vector is present, the disease can be spread there.

2.3 Disinsection in New Zealand

Steve Gay
New Zealand has none of the vector species that disinsection is intended to prevent and the country does not want them to arrive on planes. All aircraft intending to come to New Zealand must comply with the country's Biosecurity Act of 1993 as well as Health Act 1956, Regulation 5 and 6 of the Health (Quarantine) Regulations. Australia and New Zealand work together on disinsection and have jointly developed a schedule for the procedure. In 1995, New Zealand and Australian entomologists designed a replacement for the blocks-away and the pre-flight and top-of-descent cabin disinsection methods that were being applied in the presence of passengers. The aim of this method was to have a method that is completed immediately before passengers board the aircraft and that will kill any invertebrates present at the time of disinsection as well as to leave a minimal but effective amount of residue to also kill any invertebrates that may enter the cabin between treatment and departure.

Around 1998, New Zealand and Australia jointly developed the Schedule of Aircraft Disinsection Procedures for Flights into Australia and New Zealand, which detailed the disinsection requirements of both countries based on WHO recommendations including requirements for entering into Disinsection Compliance Agreements with either country that was co-managed.[2] Also around this time, New Zealand and Australia implemented the pre-embarkation spraying method which was

[1] Mier-y-Teran-Romero L, Tatem AJ, Johansson MA. Mosquitoes on a plane: disinsection will not stop the spread of vector-borne pathogens, a simulation study. PLoS Negl Trop Dis. 2017;11:e0005683. doi:10.1371/journal.pntd.0005683.
[2] Schedule of aircraft disinsection procedures for flights into Australia and New Zealand. In: Biosecurity; Aircraft Disinsection Procedures [website]. Australian Government Department of Agriculture and Human Welfare Resources (http://www.agriculture.gov.au/biosecurity/avm/aircraft/disinsection/procedures).

completed after the aircraft were serviced and just before passengers boarded, with the air-conditioning switched off and only one passenger cabin door open using 2% permethrin aerosol.

Specific application methods and amounts have been developed for all aircraft types and personnel are trained on the correct application process.

The benefits of the pre-embarkation aerosol spray method over other aerosol methods include that:

- it does not inconvenience passengers;
- it is a simple application process that can be carried out by ground staff or airline crew;
- it uses one treatment rather than the two-stage pre-flight/top-of-descent method and therefore saves money and insecticide; and
- it can also be observed easily both by aircraft staff and the departure authorities. Airlines are offered a choice of either a residual or a pre-embarkation method. The option chosen usually depends on cost or, sometimes, the availability of products. Residual treatment is more expensive than aerosol spraying but residual spraying lasts for 8 weeks whereas aerosol spraying lasts for one flight sector only.

The New Zealand Ministry of Primary Industries regularly carries out bioassays using laboratory-bred houseflies on aircraft arriving from overseas to ensure that residual and pre-embarkation treatments are compliant. This bioassay process was developed by the same entomologists who designed the pre-embarkation method.

Discussion

It was proposed that WHO, which has not changed its guidelines on disinsection since 1995, should consider recommending the Australia/New Zealand pre-embarkation method when passengers are not on board. However, the Chair urged participants not to recommend the use of a specific technique above other methods since different techniques may suit different areas and situations.

Concern was expressed that the amount of pesticide recommended by WHO might be too low. The spraying of cargo holds consists of either residual treatment of the floor, walls and ceiling surface or aerosol spraying of the hold to knock down flying insects. Both spraying methods leave a minimal but effective amount of residue to also kill any invertebrates that settle on the aircraft or cargo surfaces but neither has any impact on insects inside luggage or containers of cargo.

Another concern was that an aerosol spray applied in a cabin up to 1 h before passengers embarked may not be active and kill mosquitoes that enter the cabin at the same time as passengers. Small droplets may remain airborne for some time, but once the ventilation system is switched on the droplets can be removed from the cabin. There is a lack of any published data to confirm the persistence of the actual spray. However, permethrin droplets that drift onto seats, for example, could still be effective and would be more persistent than other products used in aircraft.

Treatment of aerobridges targets only mosquitoes in the cabin, whereas treatment of the baggage tunnels and cargo handling areas of the airport would target mosquitoes emerging from the aircraft hold and Unit Load Devices (aircans) and is arguably more important.

In Australia, airlines on compliance agreements with the government are offered a choice: while most airlines landing in Australia do have compliance agreements in place, those who do not must employ either the pre-flight/top-of-descent method or the on-arrival method of disinsection. Both entail spraying with passengers onboard.

3. Challenges faced by airlines, associated industries and product manufacturers

3.1 Airline industries

Andrew Grimes
The speaker pointed out that the European Union (EU) biocidal regulations reference the WHO efficacy guidelines, which require testing on board aircraft with mosquito species that are not available in some parts of the world. As such, the testing of permethrin has become too expensive and his company will not supply it after September 2018.

Another challenge is the lack of clear guidance from WHO. A 23-year-old document with separate updates and recommendations makes compliance difficult; all WHO guidance should be accessible together and made available online. It was claimed that some documents contradict each other. Additionally, insecticide quantities are difficult for airlines to follow and to calculate. Treatment of cargo holds was not properly addressed in the WHO documentation. WHO should therefore consider adopting the layout of the Australia/New Zealand website.

A third challenge concerns the recommended active ingredients, not least because some can be detrimental to human health when applied in cabins. At the same time, airlines must consider the pre-flight discomfort of passengers, some of whom complain of being sprayed. Compliance is a common problem: some personnel spray excessively in the toilets or even in open air outside the cabin as air crew must show that the cans have been used or emptied. The crew prefer the pre-embarkation method. For testing the efficacy of new products, test species cannot be imported; therefore, susceptible native species could be used.

Discussion

WHO was urged to update its guidelines urgently and to seek an effective product to succeed permethrin. The pre-embarkation method itself had elicited no complaints from cabin crew, although crew had complained about residual spraying when ground crew had sprayed crew rest areas, which they should not do, and crew members had spent time lying on treated beds. Another drawback is that aerosols are not allowed to be used in aircraft cabins in the USA; however, the ICAO reported that there had been some testing of nonchemical disinsection methods for the US military.

WHO's advice on the use of currently recommended products is that they pose no risks to human health when used according to label recommendations, which clearly implies that if not used according to user recommendations, problems may occur. Industry is developing new molecules for public health purposes although their current target product profiles do not include aircraft disinsection products as the aircraft disinsection market is small and not commercially profitable. One of the problems with permethrin is that it tends to be overused in agriculture, leading to development of resistance in mosquitoes. Also, in recent years pyrethroids and pyrethroid-treated bed nets have been extensively distributed for malaria control.

UUDS Aero Group

Julian Ehrhard
UUDS, a French company that specializes in pest control for the airline industry, has carried out research and development on a range of vector control products, including residual treatments, disinsection and preventive treatments to eliminate mosquitoes. Many elements need to be considered in aircraft disinsection. For instance, treatment of catering trollies is often not included in

disinsection, but UUDS tests for two airlines found that the catering trolley attracts both cockroaches and mosquitoes. The plane must be treated and so must the trolley be.

The company has developed an insecticide formulation that combines permethrin and piperonyl butoxide (PBO) which, although not recommended by WHO, is produced in France for disinsection purposes. The maximum concentration of permethrin in a given formulation must not exceed 0.8% for use in the European Region, but airlines have their own standards and the concentration may therefore be lower.

Discussion
During the discussion it became clear of the need to establish exactly what percentage of permethrin is permitted by the EU and then to assess its efficacy. UUDS was recommended to ask the WHO collaborating centre in Montpellier, France to test its product. It was commented that the EU's restrictions on use of permethrin in disinsection stem primarily from concern about its widespread use in crop-spraying and the risk of negative environmental impact, such as damage to bee populations. However, disinsection of aircraft is a totally different use. It was also mentioned that cleaning frequency may affect the concentration of remaining insecticide residues.

Lufthansa Technik AG

Barbara Schindler
Lufthansa uses residual treatment with the lance method[1] with 0.2 g of permethrin/m^2. However, this generates concerns, such as droplets forming at the base of surfaces; if these are upper surfaces in the aircraft cabin, the liquid may drip onto seats and other materials. It was suggested that residual spraying should apply only in cargo holds and cargo cabins, and not in cabins in which passengers travel and cabin crew work. Even dry fog creates some moisture and, generally, there is concern about how to calculate the correct amounts for specific areas of the aircraft. The pre-embarkation aerosol method leaves no residues, is quick and easy to perform, and requires no precise numbers per square metre. It was noted that Italy has introduced a regulation that all aircraft coming to Italy should have undergone residual treatment. As Lufthansa does not have an Italian fleet, this means it would have to do residual spraying of 700 aircraft every few months. In addition, the company expressed concern at the possible damage to the health of cabin crew members resulting from repeated exposure to permethrin. Consequently, the company prefers a recommendation for pre-embarkation spraying.

PSA-Paris

Amira Khaled
PSA-Paris has a product using *trans*-phenothrin. In a comment on EU regulations, the speaker stressed that permethrin has not been banned outright; rather, producers of products using permethrin must issue a dossier of justification for its continued use. Nevertheless, the situation is complicated by the fact that different countries ban, or limit the use of, different chemical substances. Europe has a European Chemicals Agency that must approve the use of chemicals, so a company preparing a submission for a new disinsection product must submit it to this agency as well as to aircraft manufacturers and national health authorities. The European biocidal regulations were outlined for participants, as was the procedure for testing products.

A European regulation on fluorinated gas prohibits the use of aerosols with hydrofluorocarbons above a certain level except for medical purposes (e.g. inhalers) or when required by national

[1] It is a technique in which a lance attached to a hand compression sprayer is used for indoor residual spraying that produces significantly larger spray droplets than when a cold fog is applied.

regulations. In 2017, PSA's aerosol received from the European Commission a non-time-limited exemption from the regulation. The company uses WHO-recommended doses, although use of *d*-phenothrin has now been replaced by 1-*R*-*trans*-phenothrin, which has slightly better efficacy, in disinsection formulations.

3.2 Other contributors

Aero-Sense of Belgium has encountered the same problems as its competitors. However, it noted that Europe is a good market for producers since, once a product has completed a registration process, which may be strict, a company is authorized to sell that product in all the countries of the EU. A question was raised about the possible need for pesticide application at the entrance to airports, and it was stressed that other modes of transport such as trucks and container ships also contribute to the international spread of vectors.

British Airways is responsible for compliance with disinsection in its aircrafts (as opposed to the situation in some countries where the local health authorities are responsible). One of the reasons for noncompliance may be that there are too many detailed requirements. A simpler set of regulations that are easy to understand would help improve compliance.

It was noted that, in addition to passenger walkways to the aircraft, the buses that carry passengers to the aircraft can also carry vectors, as can the vehicles that deliver the luggage to the aircraft.

E-mist Innovations Inc has developed an electrostatic method of insecticide application (including for disinsection) that enables a surface to be disinsected quickly. The company is working on a hand-held battery-powered device for disinfecting aircraft cabins and, following examination of cargo holds of a variety of aircraft, currently has a battery-powered backpack for electrostatically disinsecting holds. It has worked with the US Department of Defense and claims success in creating barriers to insects in large spaces. The products have been used to reduce disinfections in large schools and in hospitals. However, the cost for aircraft disinsection equipment would be likely to be higher than the cost of current equipment, but the cost of the disinsection application would be significantly cheaper than chemical methods.

Discussion
The electrostatic method was used primarily as a more rapid means of treating luggage and cargo holds with a residual spray, but not in cabins, although a small version of the device might be applicable for pre-embarkation treatment.

4. The perspective of the International Civil Aviation Organization

Ansa Jordaan

The International Civil Aviation Organization (ICAO) Assembly asked the ICAO Secretariat to work with WHO to review ICAO recommendations on disinsection and also to assess possibilities for nonchemical disinsection. The ICAO website includes an Airport Vector Control Register, which involves taking control measures against vectors with the aim of keeping an area of 400 m perimeter of airports free of vectors.[1] Many airport authorities know very little about vectors and consequently do minimal vector control. The ICAO, which is working towards the harmonization of standards in aircraft and at airports, stressed the need for guidelines on vector surveillance and control in airports.

With regard to nonchemical disinsection, the USA and other ICAO Member countries have welcomed the idea. One nonchemical possibility being investigated is the use of an air curtain at doors that would exclude mosquitoes from entering the aircraft. As for the aircraft service doors, investigations are ongoing regarding the types of self-closing curtain. However, it was reported that at present no one is ready to invest in standard operating procedures and further requirements until they know what WHO will recommend on nonchemical disinsection. Consequently, WHO was asked to consider establishing standards and performance criteria for nonchemical disinsection, which was proposed to be 90% control of vectors.

A variety of other possible nonchemical disinsection methods have been proposed and will be considered, if only to exclude them. These include ultraviolet scanning, sonic devices and the use of some form of insect repellent that excludes insects from the aircraft rather than killing them when they are inside.

ICAO is also considering a model for risk assessment of an aircraft flying from airport A to airport B, considering what vectors – if any – must be the focus of disinsection and how the situation differs according to the season. However, a problem may arise when an aircraft is obliged to stopover somewhere other than its final destination. This discussion has raised non-health concerns, including political ones, but so far there has been considerable interest in the model. As weather patterns and temperatures change, these will affect the risk of disease vectors in future.

Discussion

The group expressed appreciation of the proposed risk model but considered that keeping it updated would be difficult. Nevertheless, although perhaps challenging in the longer term, there is currently not even a baseline of information to work with. The idea of putting mosquito traps in aircraft cabin was discussed as a means of establishing the size of the problem of disease vectors being transported internationally by passenger aircraft as it may not capture mosquitoes in cargo holds.

While there was general agreement that an effective nonchemical form of disinsection would be a preferred solution, it was unclear how this could be achieved and how effective it would be. It was suggested that a nonchemical method might in fact be more complex than the methods used currently. ICAO responded that the initial intention would be that the nonchemical means would be used for the cabin only and that chemical methods would still be applied to the cargo hold, i.e. nonchemical disinsection would be an adjunct to chemical disinsection.

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[1] Airport vector control register. In: Crises and Rapid Response Programme [website]. ICAO/Uniting Aviation (https://www.icao.int/crr/Pages/Airport-Vector-Control-Register.aspx).

In further discussion, participants noted that some countries have made substantial progress in disinsecting ports of entry in accordance with the International Health Regulations (IHR), although other countries have done very little. With regard to pests on aircrafts, WHO has focused primarily on the prevention of mosquitoes while also considering prevention of international transport of other pests such as mites, ticks, bed bugs and rodents including rodent control at seaports.

The International Air Transport Association (IATA) expressed its support for the pre-embarkation method of disinsection, encouraged the development of clearer guidelines, and welcomed the review of nonchemical options.

Given that the WHO guidelines on aircraft disinsection are outdated, the Organization was urged to prepare updated guidelines as soon as possible.

5. New preventive/disinsection techniques in development

Ashwani Kumar

The IHR recommend that airport buildings and conveyances should be "free of sources of infection or contamination, including vectors and reservoirs". However, there is a need for vector control within a 400 m perimeter of international airports considering the active flight range of mosquitoes. The ICAO Assembly in 2010 and 2016 emphasized the need for more effective vector control in and around airports, and in aircrafts leaving airports. The presentation listed current types of disinsection and the concerns for the health of passengers and crew.

One of the nonchemical disinsection methods is air curtains (provided by elongated high-power fans), which are already in use in some public stores, storage areas and laboratories. In 2009, a US Department of Agriculture study demonstrated[1] some positive results but observed a number of problems, including that it was not possible to ensure a 100% effective air curtain at the entrance to the aircraft because of differences in the shapes of aircraft bodies. One solution might be to have air curtains fitted during aircraft manufacture to cabin doors and cargo/baggage holds. More investigation is needed to assess the viability of this option.

Discussion

As there is often a gap between the passenger bridge (walkway) and aircraft, the air curtain fitted at the end of the passenger bridge may be as effective as the air movement in stopping mosquitoes from entering an open gap.

Aircraft bodies differ and the passenger jetties never fit completely with the side of every (or even any) aircraft, and ICAO clarified that changes to aircraft bodies are not possible. However, it could be that certain types of aircraft and equipment are more appropriate to certain places.

The issue of responsibility for disinsection was raised. In some cases, airports take responsibility for disinsection of aircraft; in other cases, airlines own terminals at an airport and would be responsible for disinsecting both the aircraft and the jetties; and in other cases the local health authorities may be responsible.

[1] Meeting to preliminarily review non-chemical methods and requirements for aircraft disinsection, Gainesville, Florida and Orlando, Florida, 15 -16 December 2008. Unpublished report.

6. Assessment of current methods of disinsection

This was a general discussion on the value of the different methods of chemical disinsection.

6.1 Blocks away
(Method using aerosols containing 2% *d*-phenothrin or 2% 1-*R-trans*-phenothrin for the cabin)

Method

- This aerosol method is used when passengers are on board the aircraft and the baggage is secure in overhead lockers. At that stage there is usually a rush to get the plane off the stand for take-off. The method ideally should be done with the luggage lockers open (since spraying of luggage bins is important) but this is not specified in the recommendations. Closing the lockers is required by a safety regulation once the aircraft door is closed.
- The cargo holds will require either 2% residual treatment or aerosol treatment with a combination of 2% permethrin 2% *d*-phenothrin.

Problems

- Currently, the method is not followed correctly, as lockers are generally closed when the aerosol is sprayed. It is then followed by, or often replaced with, top-of descent spraying, which does not provide adequate disinsection on its own.
- Why spray passengers unnecessarily, if other methods are as effective?
- The efficacy of this method relies heavily on compliance with the proper procedure.
- This method may interfere with or delay the timing of the flight, since if done properly, the aircraft cannot be moving because the lockers must be kept open.
- This method involves visible exposure of pesticides to passengers, which causes passengers to complain and raises concerns over potential exposure risks.
- This method is only useful in treating the cabin and requires the use of additional methods in the cargo hold.
- Some aircraft make intermediate stops on their way to their final destination. A question was raised regarding an aircraft that undergoes blocks-away treatment at initial take-off and touches down at a second airport for some passengers to disembark and more passengers to get on board before continuing its journey. There is currently no regulation as to whether a second blocks-away treatment should be applied. At such a stop, continuing passengers usually remain on board and, if another blocks-away spraying is applied, they will be subjected to a second spraying with an additional spray exposure after being subjected to the blocks-away spraying at the airport of origin.
- In locations where persons board the plane in open areas, as happens in many countries with mosquitoes, even if pre-embarkation spraying is done, the fact that the door is open while passengers embark allows mosquitoes to enter at that time.

Advantages

- If a top of descent spray is not applied later, this method employs a one-time exposure to passengers.
- This method provides a viable option under different country regulations regarding chemical spraying.

Actions suggested

- The name should be changed from “blocks away” to “pre-departure” in order to avoid confusion over timing of method.
- This method should remain an option for airlines’ discretion but be kept as a low priority.
- This method should be recommended for in-transit stops, in which passengers do not disembark the aircraft, in countries which require disinsection.
- In accordance with regulations considering transit stops as new flights, this method must be recommended as a standalone method.

6.2 Pre-embarkation (Method using aerosols containing 2% permethrin for the cabin)

Method

- The pre-embarkation method is aerosol disinsection completed after the catering has been loaded, service doors closed and just before passengers embark. All areas of the aircraft cabin including overhead and side lockers, toilets, flight deck, crew rest areas, lift access and galleys are sprayed. The air conditioning is switched off for the duration of the disinsection and for the 5 min saturation time after spraying is finished. This method is only effective for one flight sector.
- The ground staff or crew applies aerosol in the aircraft cabin before passengers board. The original studies conducted 22 years ago before this method was introduced indicated that the extent of insecticide residue being left in the cabin would be sufficient to kill any insects that might enter the aircraft after spraying and before departure, i.e. as passengers board.
- The cargo holds will require either 2% residual treatment or aerosol treatment with a combination of 2% permethrin and 2% *d*-phenothrin (or 1-R-trans-phenothrin).

Questions

- How effective is the residual activity of the aerosol sprays?
- For how many hours would the effects of the active ingredients last?
- Is there any need for additional risk assessments on the potential hazards of the residual coating that may remain after cleaning?
- Does the number of seats need to be taken into account in calculating the quantity to be distributed?

Problems

- In areas with large mosquito populations, there is no way to ensure mosquitoes do not enter the aircraft after spraying has been done with this method, although residual activity from permethrin, especially on horizontal surfaces, is likely to persist and manage mosquitoes that enter the craft after disinsection.
- There is no approved product for this method in certain regions, e.g. in Europe, but there are not so many flights from Europe for which disinsection would apply – unless an aircraft from Europe touches down in a tropical country on its way to a non-affected area. However, PSA has already carried out pre-embarkation testing with one of its products.
- This method may only be performed before passengers embark, so it is only a feasible option for certain scenarios.
- There is a need for more clarity on the efficacy and safety of droplet sizes. It was stated that the EU has no specific regulation on droplet size but WHO’s 1995 guideline says droplets

should be between 20 and 60 µm. The recommended speed of discharge could be in a range 0.8–1.2 g per second. As to the nozzle of the aerosol spray, points were made in favour of both single-shot and multi-shot nozzles. It was noted that any changes in droplet size or nozzle specifications specified in WHO's recommendations would need to be approved by WHO. Droplet size will depend on the type of nozzle/sprayer and selection of size will vary between a spatial and residual treatment. Thus, a space spray < 30 µm VMD droplet size while a residual treatment requires > 70 µm size droplets.

- This method is only useful in treating the cabin and requires the use of additional methods in the cargo hold.
- To be able to recommend the pre-embarkation method as used in Australia and New Zealand for over 20 years, WHO needs evidence that it is at least as good as an existing method. There was general agreement that the pre-embarkation method is better than the blocks-away or the pre-flight and top-of-descent method.

Advantages

- This method offers a more user-friendly option for airlines.
- Sprays with residual effects used in this method maintain a light residual coating on the walls and ceiling that lasts for one flight sector and differs from residual spraying.

Actions

- The protocol developed by New Zealand and Australia for this method should be adapted for widespread use and recommendation by WHO, updating the current pre-embarkation recommendations.
- This method should be recommended to be carried out using a nozzle with the ability to act as a multi-shot nozzle.
- This method must stipulate that the air conditioning is turned off and the recirculation system should be set to the lowest flow rate for a minimum of 5 min after spraying to allow the droplets to reach the walls/floors/hidden surfaces and have a residual effect.
- The current recommended concentration of permethrin is 2% AE (target dose of 0.7 g AI/100 m^3) which could potentially be lowered. However, what is important is not the concentration in the formulated product but the quantity per cubic metre applied. Thus, it is the dose per cubic metre that needs to be lowered in the EU.
- Permethrin persists longer after residual treatment than with aerosol treatment, and this should be considered from the perspective of the occupational health of the aircraft crew.
- Cargo hold spraying should be noted as being required, using either 2% residual treatment or aerosol treatment with a combination of 2% permethrin 2% *d*-phenothrin.
- There was some discussion of spraying aircraft seats, which would amount to some 1250 m^2 of surfaces in an Airbus A380. Participants were requested, if new exposure calculations are to be considered, to supply data on the amounts of substance to be used. WHO intends to update the 1995 IPCS disinsection guidelines; therefore, if methods are to be revised, data are needed to support decisions.

6.3 Pre-flight and top-of-descent (Method using aerosols containing pre-flight 2% permethrin and top of descent containing 2% *d*-phenothrin or 2% 1-*R*-*trans*-phenothrin for the cabin)

Method

This method has two-parts as follows:

- Part 1 pre-flight disinsection – completed after the catering has been loaded, service doors closed and just before passengers embark. Areas sprayed are flight deck, toilets, crew rest areas, lift access and overhead and side wall lockers

- Part 2 top-of-descent – area sprayed is the cabin aisles only. Spraying takes place as the aircraft begins its descent to the arrival airport and the air circulation system is set to normal. The latter is neither effective nor recommended when it is done alone. However, it is sometimes done alone because it is listed as a separate method. It should not be listed as a separate method since it must always be preceded by pre-flight disinsection, which is basically the same as pre-embarkation. There is value of top-of-descent method when the crew forgot to do a pre-flight treatment, or when there are several stops en route before the aircraft travels to a “non-vector” area.
- The cargo holds will require either 2% residual treatment or aerosol treatment with a combination of 2% permethrin 2% *d*-phenothrin (or 1-R-trans-phenothrin).

Questions

- How common are transit stops in high risk areas today?
- Can this method be replaced by proper pre-departure or pre-embarkation method application?

Problems

- This method is often not completed properly with only the top of descent part completed. This is not satisfactorily effective on its own, but currently, it is often used as more time-efficient substitute for other methods.
- This method involves visible exposure of pesticides to passengers, which causes passengers to complain and raises concerns over potential exposure risks.
- This method is only useful in treating the cabin and requires the use of additional methods in the cargo hold.

Advantages

- This method provides an additional option for airlines.

Actions

- This method needs to be renamed in order to stress that it must be applied as the second part of a two-step process.
- This method should be recommended as an option for use for transit stops in high-risk areas with large vector populations but be given low priority.
- The ICAO suggested having recommendations for single flight travel, and other recommendations for flights that involve an intermediate stop.

- For flights stopping for a short period in a second airport before continuing to the next destination, the initial pre-embarkation spraying could be followed by a top-of-descent spraying after stopping at the second and subsequent airports.

6.4 Residual spraying

Method

- In this method, cabin and cargo surfaces are treated with permethrin 2% EC (dose 0.2 g AI/m^2) with the floor areas treated twice to achieve 0.5 g AI/m^2 but the food preparation areas and electrically sensitive areas are excluded. The flight deck and crew rest areas have a 2% permethrin aerosol treatment.
- It is considered effective for 8 weeks.
- This was considered a solution for cargo holds but not for the passenger cabin (for which there would be pre-embarkation aerosol spraying).
- British Airways does very little residual spraying because it uses designated aircraft on certain routes that receive treatment.
- Lufthansa uses pre-embarkation aerosol spraying plus residual treatment for its long-haul fleet. Because Italy now requires all arriving aircrafts to have been disinsected, Lufthansa has to spray its short-haul fleet too.

Problems

- This method is only operational and cost effective when planes are constantly running on specific routes requiring disinsection. It leads to an added layer of operational complexity for airlines operating large numbers of aircrafts on an array of routes.
- In practice, this method has caused excessive wetting and stickiness of surfaces, ultimately leading to passenger complaints and surface degradation from some airlines/applicators. With regard to the excessive wetting caused in Lufthansa experience, it was pointed out that spray volume per square metre was too high. Much lower volumes could be feasible in some circumstances depending on the surfaces being treated. This needs investigation.
- If seats are treated with this method, passenger exposure to pesticides is increased.[1]
- This method cannot be applied in galley areas because it poses potential health and food safety risks.[2] Behind “walls” can be treated if panels can be easily removed temporarily.

Advantages

- This method is effective in treating both the cabin and cargo holds.
- This method does not require the subsequent use of any additional methods but is effective enough to be used on its own.
- This method does not interfere with the timing of the flight, as it is applied during routine maintenance of the aircraft.
- This method is performed by professional operators.
- In countries where restrictions apply to the use of permethrin, this method can be conducted offshore periodically, e.g. flights between the USA and Australia can be treated residually in Australia.

[1] New Zealand and Australia do not require that seats be treated, although there is an element of drift when treating surfaces above the seats.

[2] Generally, the floor area only is treated in the galleys and treatment occurs in the absence of food carts.

Actions

- This method should be recommended as the most effective method, but airlines must be given the options of pre-departure and pre-embarkation methods to decide at their discretion.
- It should be recommended that this method be applied with a hand compression sprayer with control flow valves, to ensure a precise dose discharged at a constant rate of flow. The fogging apparatus should be calibrated to ensure correct droplet size, flow rate and target dose.
- This method could be complemented by the use of gels or other methods in galley areas for non-flying insects (e.g. cockroaches).
- The Chair noted that in WHO's 1995 document the amount of liquid recommended for residual treatment was too high and should be reduced to 3 mL/m^2.

Establishing the need for disinsection

- Since the extent to which the international spread of disease vectors facilitated by air travel is unclear, it was proposed that mosquito traps be placed in passenger walkways (air bridges) to identify whether mosquitoes are present and, if so, at what time and during which season. This should be a responsibility of the national public health authorities and should be noted as such in the guidelines.
- Most of the exotic mosquitoes trapped at Australian airports were in baggage handling areas or associated with cargo; therefore, surveillance devices need also to be placed in such areas.
- There was a short discussion about the control of other pests such as cockroaches and bed bugs and the need to disinfect the galley areas and food trolleys. Bedbugs, head lice and even rodents have been found on aircrafts in the past, but it was decided to right now focus WHO's guidelines on disinsection intended to eliminate mosquitoes.

Safety of permethrin

In 2005, WHO issued a publication on permethrin, which stated it was suitable for disinsection. In 2013 the Organization published an IPCS report on the risk assessment of aircraft disinsection. The calculations of risk were based on modelling sizes of aircraft, surface areas of parts of the human body likely to be exposed, and how long a cabin crew member would be exposed to the pesticide over a month. The calculations resulted in an exposure that was 25–50% less than the accepted safety threshold for the substance, so long as the equipment was in correct working order and was used correctly.

7. Closed session on recommendations

The Chair thanked the industry representatives and others present for their contributions to the discussions. The meeting continued in a closed session with members of the expert group only in order to draw up a list of recommendations for consideration by WHO in drafting new recommendations on aircraft disinsection. Participants acknowledged the difficulties industry faces in implementing international regulations when regulations are difficult to understand (due to confusing information) and difficult to implement (due to limitations on pesticides). The lack of compliance with recommended methods was recognized and concern was expressed for the health and welfare of airline personnel.

7.1 Key challenges

- The largest problem faced is the EU/US recommendation on dosage of permethrin to be applied, which is contrary to current WHO guidelines.
- The registration of pesticide is a complex process requiring country-by-country approval increasing costs and timelines.
- Currently limited products are available and there is a lack of clarity on the recommendations to be followed and the scenarios that apply.
- Residual treatment is important, but the choice of products is limited.
- There is a lack of updated guidance and training documents; currently available documents are extremely complex and in places contradictory.
- Staff who carry out disinsection operations are often not trained properly.
- There is a lack of information on countries where disinsection is required.
- New or alternative pesticides and methods of nonchemical disinsection are lacking and need to be developed
- Pyrethroid resistance is increasing which requires new products to be developed.
- The limited market for disinsection products means there is limited investment in research and development. Incentives are needed to boost product development.
- Existing efficacy testing guidelines are not practical to fully comply and trials costs associated with the prescribed trial design are usually high.
- Active recording and reporting of airport vector surveillance data is needed.

7.2 Recommendations for control of mosquitoes

As the meeting concluded, participants agreed the following recommendations to WHO and identified a number of challenges.

- Pre-embarkation should be the method of choice. However, it uses permethrin 2% AE (aerosol), which is not available in Europe and this lack of a suitable pesticide formulation needs to be resolved. The “blocks-away” (recommended to be named “pre-departure”) method could be considered as a second option using 2% *d*-phenothrin (or 1-*R*-*trans*-phenothrin) where 2% permethrin AE is not permitted although any deposit with *d*-phenothrin will be less persistent than permethrin.
- Vector surveillance and control should be carried out both in and around airports, including active surveillance of passenger bridges and cargo areas in order to build evidence base on mosquito entry in cabin through these passages. The holds probably have an increased chance of mosquitoes flying into them due to the size of the hold doors, not connected to airbridges.

- Recommendations should take into account environmental impacts as well as occupational health concerns.
- Updated disinsection guidelines should be issued, and training materials and communication documents must be developed for aircraft disinsection.
- Constant updating and streamlining of protocols, processes and standard operating procedures on disinsection are needed.
- Practical training of staff involved in or associated with aircraft disinsection is essential.
- A new initiative should be developed to promote research on vector control and programme implementation.
- A new initiative should be developed to promote research on the control of other non-mosquito vectors of disease.
- Top-of-descent is of little use but the benefits of discontinuing this method need to be clearly justified by evidence.
- The efficacy testing guidelines for chemical disinsection/techniques should be reviewed to simplify the test requirements.
- There is a need for new nonchemical aircraft disinsection methods, performance standards (scenario-dependent) and testing protocols.
- To find a solution to regional regulations of pesticides, the expert group encouraged industry to develop new pesticide formulations.
- Different recommendations should be considered for nonstop flights where disinsection is required and flights with multiple stops where disinsection is required.
- Relevant documentation must be brought together in an accessible format on the WHO website. Archives of historical documents should be made, but clearly labelled as not current procedures.
- The Meeting prepared a table (Table 2) on what methods were practical and most efficient for use in different situations such as:
  - where the aircraft is making multi-stops in areas requiring disinsection; and
  - methods that can be used on one sector flights (or where the aircraft is not stopping in an area requiring disinsection).

Table 1. Current WHO-recommended methods for aircraft disinsection

Disinsection Options	Passengers/ Crew on board	Cabin treated	Insecticide and formulation	Final dose area/ space	Frequency of application	Applied by	Application equipment	Hold/Cargo treated	Considerations
Residual	None	All cabin except excluded areas[a]	Permethrin (25:75) 50% EC to be diluted to 2% permethrin for use[b]	0.2 g/m^2 for internal surfaces; 0.5 g/m^2 for floors;[c] flow rate 10 mL/m^2	Intervals not exceeding 2 months	Professional pest control operatprs (PCO)	Compression sprayer with a constant flow valve and flat fan nozzle; or semi-automated fogging device; aerosol sprayed in electrically sensitive areas	Yes	Airconditioning run for at least 1 h before passengers and crew embark
Pre-flight	Crew only	Passenger cabin incl. toilets, crew rest, open overhead, side wall and coat lockers, and flight deck	Permethrin (25:75) 2% AE in spray can	35 g formulation/ 100 m^3 (= 0.7 g a.i. per 100 m^3)	Before all departures where required	Ground staff	Aerosol cans	Not specified	Airconditioning switched off; to be applied within 1h before doors are closed
Blocks-away	Passengers and crew	Passenger cabin incl. toilets, crew rest, open overhead, side wall and coat lockers, and flight deck	d-phenothrin 2% AE in spray can	35 g formulation/ 100 m^3 (= 0.7 g a.i. per 100 m^3)	All departures where required	Flight crew for cabin; ground staff for holds and flight deck	Aerosol cans	Aerosol treatment before departure	Airconditioning switched off; overhead lockers closed after spraying is complete
Top-of-descent[d]	Passengers and crew	Passenger cabin	d-phenothrin 2% AE in spray can	35 g formulation/ 100 m^3 (= 0.7 g a.i. per 100 m^3)	All flights as required	Flight crew	Aerosol cans	No	Air re-circulation set at normal flow

[a] Excluded areas can include flight deck and food preparation areas.

[b] Can also be supplied in a ready-to-use form as a 2% solution.

[c] The aim is to spray the floor surfaces with 0.2 g/m^2 (i.e. a total of 0.4 g/m^2); however as spray aimed at other surfaces may also be deposited from fall-out of larger droplets on the floor, especially along aisles, the maximum dose at floor level is estimated to be 0.5 g/m^2.

[d] This method can be used in conjunction with pre-flight methods as a 2-part process where required.

Table 2. Comprehensive aircraft disinsection methods recommended by the meeting

a. Flights with multi-stops where disinsection is required

Treatment options	Passengers/ crew on board	Cabin	Insecticide and formulation	Final dose by area/ space	Applied by	Application equipment	Frequency of application	Hold/Cargo	Considerations
Residual	None	All cabin except excluded areas[a]	For cabin and hold: Permethrin (25:75) 50% EC to be diluted to 2% permethrin for use[b]	0.2 g/m^2 for internal surfaces; 0.5 g/m^2 for floors;[c] flow rate 10 mL/m^2	Professional PCO	Compression or cold fogger calibrated for droplet size, flow rate, target dose	At least every 8 weeks	Yes	1. Areas deep cleaned or refurbished within the treatment interval must be retreated; 2. Airconditioning run for at least 1 h before passengers and crew embark.
Pre-embarkation[d]	Crew only	All cabin (incl. toilets, crew rest, lower galleys, lift access and flight deck)	Permethrin (25:75) 2% AE	35 g formulation/ 100 m^3 with droplet size of 10-15 µm	Flight crew or ground staff	Aerosol cans	All departures where required	Residual treatment with permethrin EC, or use an aerosol containing 2% permethrin and 2% d-phenothrin	1. Airconditioning switched off; 2. To be applied within 1h before doors are closed.
Pre-departure (formerly "blocks away")	Passengers and crew	All cabin (incl. toilets, crew rest, lower galleys, lift access and flight deck)	2% d-phenothrin (or 1R-trans-phenothrin)	35 g formulation/ 100 m^3 (= 0.7 g a.i. per 100 m^3)	Flight crew for cabin; ground staff for holds and flight deck	Aerosol cans	All departures where required	Residual treatment with permethrin EC, or use an aerosol containing 2% permethrin and 2% d-phenothrin	1. Airconditioning switched off; 2. Overhead lockers closed after spraying is complete.
During flight (formerly "top of descent")	Passengers and crew	All cabin except excluded areas[a]	2% d-phenothrin AE (or 2% 1R-trans-phenothrin AE)	35 g formulation/ 100 m^3 (= 0.7 g a.i. per 100 m^3)	Flight crew	Aerosol cans	All flights where required	Residual treatment with permethrin EC, or use an aerosol containing 2% permethrin and 2% d-phenothrin	1. Air re-circulation set at normal flow; 2. Does not disinsect all areas of the cabin; 3. Potential exposure to vector-borne diseases from infective mosquito bites during flight.

[a] Excluded areas can include flight deck, direct spraying of seats, food preparation areas and crew rest areas. Electrically sensitive areas can be sprayed with 2% permethrin AE.

[b] Can also be supplied in a ready-to-use form as a 2% solution.

[c] The aim is to spray the floor surfaces with 0.2 g/m^2 (i.e. a total of 0.4 g/m^2); however as spray aimed at other surfaces may also be deposited from fall-out of larger droplets on the floor, especially along aisles, the maximum dose at floor level is estimated to be 0.5 g/m^2.

[d] Method used in Australia/New Zealand; replaces the WHO Pre-flight method.

b. Nonstop flights or flights that stopover in locations where disinsection is not required

Disinsection Options	Passengers/ Crew on board	Cabin treated	Insecticide and formulation	Final dose area/ space	Applied by	Application equipment	Frequency of application	Hold/Cargo treated	Considerations
Residual	None	All cabin except excluded areas[a]	For cabin and hold: Permethrin (25:75) 50% EC to be diluted to 2% permethrin for use[b]	0.2 g/m^2 for internal surfaces; 0.5 g/m^2 for floors;[c] flow rate 10 mL/m^2	Professional PCO	Compression or cold fogger calibrated for droplet size, flow rate, target dose	At least every 8 weeks	Yes	1. Areas deep cleaned or refurbished within the treatment interval must be retreated; 2. Airconditioning run for at least 1 h before passengers and crew embark.
Pre-embarkation (formerly "pre-flight")	Crew only	All cabin (incl. toilets, crew rest, lower galleys, lift access and flight deck)	Permethrin (25:75) 2% AE	35 g formulation/ 100 m^3 (= 0.7 g a.i. per 100 m^3)	Flight crew or ground staff	Aerosol cans	All departures where required	Residual treatment with permethrin EC, or use an aerosol containing 2% permethrin and 2% d-phenothrin	1. Airconditioning switched off; 2. To be applied within 1h before doors are closed.
Pre-departure (formerly "blocks away")	Passengers / crew	All cabin (incl. toilets, crew rest, lower galleys, lift access and flight deck)	2% d-phenothrin AE (or 2% 1R-trans-phenothrin AE)	35 g formulation/ 100 m^3 (= 0.7 g a.i. per 100 m^3)	Flight crew for cabin; ground staff for holds and flight deck	Aerosol cans	All departures where required	Residual treatment with permethrin EC, or use an aerosol containing 2% permethrin and 2% d-phenothrin	1. Airconditioning switched off; 2. Overhead lockers closed after spraying is complete.

[a] Excluded areas can include flight deck, direct spraying of seats, food preparation areas and crew rest areas. Electrically sensitive areas can be sprayed with 2% permethrin AE.
[b] Can also be supplied in a ready-to-use form as a 2% solution.
[c] The aim is to spray the floor surfaces with 0.2 g/m^2 (i.e. a total of 0.4 g/m^2); however as spray aimed at other surfaces may also be deposited from fall-out of larger droplets on the floor, especially along aisles, the maximum dose at floor level is estimated to be 0.5 g/m^2.

Annex 1. Agenda

OBJECTIVES

a) To critically review the challenges faced by the end users of disinsection products in carrying out aircraft disinsection;
b) To review current and potentially new procedures for aircraft disinsection;
c) To review the need for new insecticide formulations for aircraft disinsection; and
d) To make recommendations on the selection of disinsection methods to be used.

EXPECTED OUTCOMES

a) Updated WHO recommendations on the selection and use of aircraft disinsection products and methods.
b) Recommendation on the development of Standard Operating Procedures for all the methods of aircraft disinsection.
c) Identified need for development of suitable training materials/tools in collaboration with WHO Member States (video etc.).

AGENDA

Participants will include Expert members, industry representatives and observers.

3 July 2018 (Tuesday)	
Open session: full day*	
09:00–09:15	Opening remarks and welcome – Director NTD
09:15–09:20	Administrative remarks, Declaration of interests (DOI), Appointment of Chair/Rapporteurs – Dr Raman Velayudhan
09:20–09:40	Overview of current aircraft disinsection methods and insecticides recommended by WHO – Dr Rajpal Yadav
09:40-10:00	Applying insecticides in aircrafts – Professor Graham Matthews
10:00–10:30	Pre-embarkation residual treatment method for aircraft disinsection – Mr Steve Gay
11:00–12:30	Challenges faced by airlines, associated industry and product manufacturers in aircraft disinsection a) Airline industries - Callington Haven Pty Ltd - UUDS – *"design commitment on result solutions"* - Deutsche Lufthansa AG - PSA-Paris
12:30–13:30 Lunch break	
14:00–15:30	Challenges (cont'd) b) Discussion (all participants)
16:00–16:45	Detailed review of current WHO-recommended methods of aircraft disinsection and identification of key priorities for expert review (Discussion: all participants)

16:45–17:30	Overview of potentially new preventive/disinsection techniques under development – Dr Ashwani Kumar
4 July 2018 (Wednesday)	
09:00–10:30	Discussion on the outcomes of the feedback from industry and observers and the way forward
11:00–1230	Developing revised *draft* recommendations on aircraft disinsection methods
12:30–13:30 Lunch break	
Closed session (limited to WHO E*xperts and Secretariat*)	
13:30–17:00	Finalization of the recommendations on aircraft disinsection including for the development of SOPs and training packages
17:00–17:15	*Closing of the meeting*

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