



PREPAREDNESS OF THE INTERNATIONAL AIRPORTS AGAINST BIOLOGICAL THREATS: ANALYSIS AND EPIDEMIOLOGICAL RECOMMENDATIONS

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Introduction: The ease of traveling, especially by air, has increased the risk of spreading new, dangerous microorganisms. Taking this into account, it should be observed that international airports may become gateways for influx of people with infectious diseases.

Problems: It is immensely important to prepare various rescue services for new threats and to develop effective decision-making procedures countering epidemic threats. Tight cooperation between medical rescuers, airports services, municipal and regional services together with coordinating their actions play a key role.

Conclusions: International airports must have established procedures of activities in case of emergence of biological threats. It is indispensable to equip rescue services with appropriate equipment and personal protection gear, ensuring safety both for the medics and for transportation of the infected.

Keywords: airports, biological threats, epidemics of dangerous infectious diseases, International Health Regulations

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INTRODUCTION

In the recent years we have witnessed epidemics and pandemics of infectious diseases, confirming the unpredictability of biological hazards. The unexpected development of epidemics of known diseases (i.e. Ebola hemorrhagic fever, influenza), as well as new, previously unrecognized infectious diseases (MERS, SARS, Zika virus, Chikungunya), compelled us to undertake broad-scale preparations and cooperate with numerous partners in order to effectively protect public health.

Despite the involvement of numerous institutions, enormous planning efforts, and new tools elaborated based on previous experience, infectious disease epidemics are still associated with not only morbidity and mortality, but also with disrupted functioning of key institutions and organizations in many regions of the world. It pertains not only to the health sector, but also to transportation, tourism, trade, or even education and culture.

International airports are particularly vulnerable to the negative effects of epidemics or pandemics of infectious diseases. Firstly, these are the places where movements of large groups of people from various regions of the world take place, leading to potential spreading of disease-causing agents. We witnessed such events during 2009 influenza pandemic, where the first confirmed cases were brought to Poland on an aircraft. Therefore, it is important that the airport staff that comes in contact with travelers is properly informed about potential hazards. The staff should be equipped with appropriate personal protection gear and trained to use that equipment in specific situations [9]. Employees of all airport services and institutions may play a key role in stopping the spread of epidemics. Their effective response may prevent or slow down the spread of an epidemic. It is of particular importance from the point of view of Polish international airports due to quite rapid development of the aviation sector and constantly growing number of connections to the most distant and exotic regions of the world.

Secondly, decisions made on national or international levels with regard to response strategies in the event of a biological hazard have great impact on airport functioning. We witnessed it during previous epidemics of infectious diseases (SARS, A(H1N1)pdm09 influenza or, more recently, Ebola). Decisions, which are often political, regarding for example cessation of airborne traffic or introduction of specific forms of passenger screening, are associated not only with significant financial expenditures but also with complications relating to

the movement of people or evacuation of citizens from regions where the outbreak has occurred (as during an Ebola outbreak in 2015). It also greatly affects the organization of everyday operations of airport services. Experience shows that sometimes the decision to implement passenger screening may be associated with large queues, delays, or problems with passenger transit [9].

Great impact of infectious diseases on functioning of civil aviation and a key role of the airport staff in spreading of epidemics prompted international organizations to undertake specific actions to involve the representatives of airports, airlines, ground handling agents, and other key services in preparation for the event of infectious epidemic. These actions were based on international regulations that had been updated due to extremely dynamic development of air services.

PROBLEMS

International regulations

Despite great differences in the levels of preparedness and response strategies to biological hazards among various airports the World Health Organization (WHO) undertook efforts directed at developing standards and tools to improve preparedness in the event of infectious epidemic, taking into account the civil aviation sector. International Health Regulations (IHR 2005) were developed as a result of those actions and many years of consultation [5]. The document took into account not only the actions of public health services, but also the need to prepare airports against biological, chemical, and radiation hazards. These guidelines, updated in 2005 and implemented 2 years later, were verified during numerous real-life crisis situations, including the influenza pandemic in 2009 and MERS epidemic in 2012, or the most recent Ebola epidemic (2014-2015). It imposes certain obligations on WHO as well as individual countries. Its cross-sectoral character should also be emphasized. In this document, priorities focus on such anti-epidemic actions that allow avoiding or minimizing possible disturbances in the tourism, transport, and trade sectors. During development of this document the WHO took into consideration various aspects arising from continued progress in these sectors, including facilitation of travel or transfer of goods, as well as possible threats resulting therefrom.

The overall goal of the above mentioned International Health Regulations is to prevent cases of disease spread on an international scale, protec-

tion against development of such cases, combating and ensuring public health system response directed against such cases in a proportional manner and limited to public health threats in a way to avoid unnecessary interference with international travel and trade [5,10].

One of the key responsibilities of individual countries described in the 2005 IHR involves identification of points of entry by those countries. According to this document, these are places where the exchange of people, animals or goods takes place. The definition of a point of entry encompasses not only airports, but also seaports and land border crossings that handle international traffic. Baggage, cargo, mail and transport enter or leave any given country through these entry points. Preventive measures that may be undertaken at the entry points encompass i.a., monitoring of health status of people leaving as well as entering the country, vaccinations against infectious diseases, disinfection of transportation vehicles, or issuing health certificates.

Along with the requirement concerning designation of entry points by each country, the WHO has developed a number of guidelines, which serve to assess the state of preparedness of individual airports and at the same time are very helpful for development of recovery plans, if the IHR requirements have not been yet fulfilled [12]. Evaluation covers preventive measures (e.g. veterinary checks of products of animal origin), early warning (including early detection of risks and transmission of information to relevant departments), and response (surveillance, isolation, transport support). The actions provided for the airport services refer to risk management, assessment and crisis management.

The goals of those actions include:

- protection of human health through avoidance or minimization of disease spreading,
- maintaining proper sanitary state of the airports, seaports and land border crossings as well as aircrafts, ships and other vehicles to ensure freedom from infection and contamination,
- enabling detection of the source of infection or contamination in a way that would ensure rapid response and implementation of relevant guidelines while avoiding unnecessary restrictions to trade and travel.

Evaluation criteria developed by the WHO experts were included in the document entitled. "Assessment tool for core capacity Requirements designed at airports, ports and ground crossings". They encompass not only the actions of medical services, but also take into consideration prepar-

edness of other services and entities at the airport, including airlines, ground handling agents, fire department, veterinary and phytosanitary services.

These guidelines, despite their complexity and attention to detail, do not impose specific preparation strategies onto the airports. For example, in the course of preparation the ports can still expand their own infrastructure; however, based on these agreements, it is possible to use the resources of municipal or regional services. All depends on specific legislation adopted in the country.

In Poland, the airports have been reviewed with respect to meeting the requirements for entry points. Such assessment was performed, among others, in the process of securing medical care for the UEFA EURO 2012™. The assessment took into consideration i.a., the procedures in operation at a given airport, available powers and resources, as well as the mechanisms of cooperation between municipal and regional services with regard to, e.g. organization of quarantine or isolation and transport of individuals suspected of having a transmittable disease to the nearest hospital for infectious diseases. Evaluation criteria encompassed also the issues related to communication, cooperation between the airport and the airlines, or passenger care. On numerous occasions the evaluation process presented an opportunity to develop new effective solutions, especially in terms of coordination.

Taking into account additional parameters, such as the intensity of passenger traffic or direction of connections at a given airport was a key issue in the assessment of preparations. Preparations at the Polish airports were based on tight cooperation with municipal and regional services in accordance with Polish legislation. Airport procedures took into consideration own powers and resources, but also contained paragraphs referring to other documents, e.g. regional plans of conduct in the event of an epidemic. They were crucial, especially in the context of entries relating to isolation, quarantine, or transport of individuals suspect of having an infection or a transmittable disease.

On numerous occasions the evaluation process was accompanied by exercise on reacting to suspected presence of infectious disease on the aircraft or the airport. The EPIFAKTOR exercise organized at the Warsaw Chopin Airport in 2011 on the initiative of the Ministry of the Interior and Administration was an example of such large-scale event. The drill scenario involved a situation where a dangerous infectious disease would be brought to Poland onboard an aircraft. The exercise tested

not only the cooperation of various airport services in a crisis situation, but also the rules of their cooperation with municipal and regional services. Coordination of actions between Chopin Airport Services and the main carrier operating at that airport, the LOT Polish Airlines, was also an important aspect of this drill. The exercise was also attended by representatives of the Ministry of Defense, including the Armed Forces Epidemiological Response Center (CRESZ). Involvement of the Illinois National Guard was an excellent opportunity to exchange experiences at an international level. American experts provided support both during the preparations as well as the evaluation of the exercise. Exchange of information with regard to decontamination or use of military forces in case of a bioterrorist attack turned out to be an important part of this event. Also, the matters relating to rebuilding critical infrastructure and rapid restoration of full capacity of the services were continued through other Polish-American projects.

Returning to the issues of international legal regulations, the Chicago Convention (Journal of Laws 1959, No. 35, item 212, as amended) is another important document pertaining to the preparation of civil aviation against biological hazards [6]. Article 14 of this document obliged all State Parties to apply effective means aimed at preventing the spread of infectious diseases via airborne transport. These regulations were refined in the annexes to the Convention and resolutions of the International Civil Aviation Organization (ICAO) encompassing technical and operational aspects of the actions undertaken by competent civil aviation authorities, carriers, airport management, as well as other partners. One of the requirements imposed on particular countries by the above-mentioned documents includes development of national civil aviation plans in case of an infectious disease outbreak.

Such plans should include:

- description of specific actions the civil aviation sector should undertake to prepare against biological hazards,
- determination of exact competences of services and institutions in various areas of response,
- identification of gaps in the existing plans and procedures.

The priority of activities described in the national guidelines is to improve coordination between public health sector and civil aviation sector. In Poland, the Civil Aviation Authority in cooperation with the State Sanitary Inspection carries the works on this document. Experience gained

during airport assessment with regard to the fulfillment of IHR 2005 requirements for entry points shows that besides drawing out a national strategy for further preparations, this document might provide excellent support for coordination of actions among the ports and all entities operating at the airports.

In order to provide support to the member countries in the process of preparation and development of plans, the International Civil Aviation Organization and the WHO appointed a common initiative, known as Cooperative Arrangement for the Prevention of Spread of Communicable Disease through Air Travel (CAPSCA). Other than individual countries, this project also involved specialist agencies, such as:

- American Center for Disease Control and Prevention in Atlanta (CDC),
- International Air Transport Association (IATA),
- Airports Council International (ACI),
- International Organization for Animal Health (OIE),
- World Tourism Organization (WTO),
- International Atomic Energy Agency (IAEA).

Its cross-sectorial and international character is an important aspect of this initiative, facilitating multidirectional preparations. The main goal of this project is to improve coordination of preventive actions against biological hazards, as well as chemical and radiation threats. It is aimed to intensify collaboration at international, regional, national, and local levels.

Specific objectives of this initiative encompass:

- public health protection, with particular focus on travelers and employees of the civil aviation sector,
- providing assistance to countries and regions in development of national preparation plans according to the relevant ICAO, WHO, ACI and IATA regulations and guidelines,
- tightening cooperation among relevant authorities of the civil aviation sector, public health, airports, airlines, and other crucial services and institutions,
- intensification of regional cooperation between countries, particularly with regard to exchanging experience, supplies and resources,
- provision of training to individuals designated to assess the level of preparedness at the airports, creating an airport evaluation program from the point of view of public health and civil aviation,
- formation of new and improvement of already existing guidelines for the aviation sector.

The CAPSCA project brings together experts during international meetings as well as regular regional conferences. Poland expressed its support for the project in an official correspondence of the President of State Civil Aviation Authority. Polish experts participate in the European CAPSCA meetings on regular basis.

Based on the above guidelines, actions aimed at supporting preparation of civil aviation were also undertaken by European agencies, including the European Center for Disease Control (ECDC). The RAGIDA (Risk Assessment Guidance for Infectious Diseases transmitted on Aircraft) project was an important initiative in that regard was commenced in 2007. It concerned the assessment of risk of spreading infectious agents onboard an aircraft [2]. The project consisted of two parts:

1. Review of available literature.
2. Development of guidelines on infectious diseases of particular importance for the project.

Over 3 700 publications on tuberculosis, influenza, SARS, invasive meningococcal disease, measles, rubella, diphtheria, Ebola and Marburg hemorrhagic fevers, Lassa fever, smallpox and anthrax were reviewed as a part of the project. The analysis took into account previous guidelines elaborated by the civil aviation experts as well as public health specialists. The project, aside from the data regarding disease characteristics or previous experiences, took into consideration other important issues, such as technical aspects of the aircraft (e.g. air conditioning) or typical passenger behaviors that might influence spreading of infection onboard an airplane. The project proved exceptionally important during influenza pandemic in 2009 as well as the Ebola epidemic (2014-2015), particularly in the context of the rules of conducting epidemiological investigation and case monitoring.

Preventive measures undertaken during an epidemic that are crucial for airport functioning

Strategies of preparation, both national and local, encompass a number of preventive measures that may be distinguished into pharmaceutical means (vaccines and medicines) and non-pharmaceutical means, including: closing schools, implementing bans on mass gatherings, recommendations on the use of protective masks. This group of measures also encompasses the ability to close state borders, introduction of passenger screening or recommendations for travelers.

All of the above actions require specific, long-term strategies, cross-sectoral actions and prepar-

atory arrangements, as well as exercises, which are crucial for improving response. Very often introduction of those measures is associated with controversial political decisions, which draw media attention and may serve to improve epidemiological situation, but unfortunately may also lead to great losses in the transportation, tourism and trade sectors, as was the case during SARS epidemic or 2009 influenza pandemic.

Certainly, introduction of clear, evidence-based recommendations for travelers as well as airport and airline workers is one of the most effective and universal methods [8]. Guidelines often refer to the measures travelers can undertake in order to avoid infection, but may also include a recommendation to change the date of travel due to epidemiological situation in the relevant region. Recommendations for the airport and aircraft employees have also proven important in the past. There were situations when employees would refuse traveling to specific areas due to the local epidemiological status and guidelines on proper protection and management were useful on such occasions.

Another measure, the airport screening usually associated mainly with thermoscreening, in fact encompasses a broader range of actions. Exit screening and entry screening may involve gathering information using questionnaires (including contact information in case of a need for conducting an epidemiological investigation), direct transfer of information regarding potential threats and/or temperature measurements (preferably using a touchless thermometer). This group of measures has been implemented with limited success so far. The costs of implementation are very high and are associated with the need for involvement of large numbers of personnel and possible impediments to transfer of passengers (e.g. additional queues at the airport).

Closing state borders is the most controversial and dramatic among this group of measures. Due to a political character of this measure and complications connected with its implementation it is rarely taken into consideration in national policies. Experience gained from the exercises demonstrates that its implementation would exert negative effect not only on country's airborne transport or tourism, but also on the entire economy, trade, and everyday life of its citizens.

Ebola hemorrhagic fever epidemic – a challenge for entry points

It should be emphasized that despite the above described duties, a number of guidelines, recom-

Tab. 1. Examples of non-pharmaceutical counter-measures depending on the purpose of its application (source: CDC, www.influenzatraining.org).

Purpose of implementation	Counter-measure (example)
To limit spreading of the infectious agent through state and regional borders	<ul style="list-style-type: none"> • screening of travelers • recommendations for travelers • closing borders
To limit spreading of the infectious agent among groups of people	<ul style="list-style-type: none"> • closing schools • implementing a ban on mass gatherings • isolation, quarantine
To limit spreading of the infectious agent among individuals	<ul style="list-style-type: none"> • use of personal protection equipment (e.g. masks) • adherence to basic rules of hygiene

mendations and projects, the latest epidemics showed that infectious diseases still pose a great challenge for the airports and carriers. Response strategies encompassing i.a. issuing proper recommendations for travelers or airport services, broadly defined screening of travelers, or even implementation of restrictions on travel are helpful, but insufficient in the face of biological threats [11,12].

Ebola fever epidemic in West Africa prevailed from February 14, 2014, particularly affecting Guinea, Liberia, and Sierra Leone. The greatest morbidity and mortality was noted in those countries [14]. Isolated reports of disease spread were also noted in several temperate zone countries, i.e. the USA, Great Britain, or Italy. There were also some cases of nosocomial infections from patients transported from Africa (USA, Spain).

Epidemic of Ebola hemorrhagic fever posed a challenge for healthcare systems. Dynamically changing situation prompted recommendations of specific actions involving the entry points as well. In order to improve coordination, the WHO and the ICAO released a number of recommendations aimed at limiting the negative impact of the epidemic on airborne transport. The "Ebola Event Management at Points of Entry" guidelines was one of the most important documents developed as a result of collaboration between WHO, ICAO, IATA and CDC [13]. It emphasized that to ensure effective response all entry points should be equipped with proper procedures, which:

- will ensure early identification of infected individuals,
- will prevent spreading of the disease on an international scale, while helping to avoid implementation of unnecessary sanctions and delays in the air transport.

In the countries with confirmed virus transmission the WHO recommended exit screening not only at the airports, but also in seaports and strategic land crossings. Such screening should encompass at least use of questionnaires and

temperature measurements. In case of a traveler with fever - risk assessment and determination of further management should occur.

Preparing response plans consistent with WHO guidelines and ICAO requirements was recommended for entry points in other countries. Key recommendations included designation of a suitable place to assess the health status of passengers in the event of a suspected infection, as well as development of rules of transferring a symptomatic passenger to the designated hospital. The key was to ensure appropriately trained staff that should be equipped with appropriate means of personal protection.

It is crucial that training in procedures for entry points was provided not only to the medical staff, but also other airport services, aircraft crew and ground handling agents [1]. International organizations drew particular attention to raising awareness among employees, so that they would be able to alert proper medical services in the event of a threat. Special recommendations pertained to the use of passenger locator form and need for personnel training with regard to its application.

Facilitating communication among entry point medical services and the services responsible for epidemiological supervision as well as relevant civil aviation authorities was also important.

The WHO stressed the necessity to determine strategies that would allow responding at any moment. Information regarding a suspected case may come in at any time during the travel (e.g. on departure, arrival, during transit or while the passenger is still onboard). The WHO developed a separate response algorithm for each one of those cases.

During the Ebola epidemic it was once again proven that selection of appropriate communication strategies encompassing the rules of communication with passengers as well as airport staff and airline personnel is one of the key aspects of the response. Moreover, proper protection and training of the latter should be a priority for effec-

tive planning. Still, it would be useful to elaborate clear, evidence-based guidelines for passengers.

Another important matter is to consider passenger screening both on arrival as well as on departure from the country. It should be emphasized that planning in this regard should be long-term, involve numerous exercises, and should not be influenced by political decisions. This measure requires involvement of many services and huge financial outlay, but has not proven effective in all infectious diseases. Along with its introduction it is necessary to determine the criteria and rules of conduct in a suspected case.

Experiences from the Ebola epidemic as well as previous epidemics showed that introduction of various screening methods is very costly and rarely yields the desired results [4,7]. During its implementation of screening it should be specified which flights it should involve (e.g. only the direct flights from regions with confirmed cases of illness). Decisions in this respect may also depend on the actions undertaken in countries where disease cases have been identified. Effective exit screening organized in a country where the epidemic has occurred may eliminate the necessity for entry screening in other countries. Also, the Ebola epidemic demonstrated the need for simplification of questionnaires used for the screening, including the Passenger Locator Form.

Aside from preparations for introducing the above-mentioned preventive measures, it is crucial to continue actions aimed at implementation of IHR requirements. As stressed by the WHO, sole designation of entry points does not mean that the process of preparation has come to an end. All IHR requirements must be introduced and maintained at all times regardless of epidemiological situation [11,12]. Special attention is focused on the means of communication between individual airport services and other local services as well as central and national IHR contact points.

On an international level it is still necessary to take actions aimed at improving IHR-based global early warning and response system as well as coordination of the international response system. On the airport level it is necessary to secure the access of medical services, provide transportation for individuals exhibiting signs of infectious disease, conduct regular checks of means of transport, and combat vectors of infectious diseases. Moreover, it is also necessary to designate proper places for isolation and quarantine of both people as well as animals. Although the WHO allows various solutions in that regard depending on national policies.

Another step in implementation of IHR will involve improvement of inter-sectoral cooperation so that the main burden of maintaining requirements for entry points would not be placed solely on medical services. More frequent testing of current solutions, including those relating to communication and exchange of information, will also be necessary.

All those actions will be aimed at the most effective use of IHR objectives in order to maximize the effectiveness of response to new biological hazards. At the same time, taking into consideration the great role of airports in the crisis response system and as an important element of critical infrastructure, it should be emphasized that these preparations will be of great significance not only with regard to response to biological hazards, but also from the point of view of national security.

Protection of medical service personnel against infections is one of the key elements of risk prevention at the airports. Annex no. 1 to the International Health Regulations defines the minimum requirements that must be met by designated entry points – airports and related services, including medical services, that function or will be functioning in special conditions, such as under a threat to public safety [5].

These requirements include:

- knowledge of action plans in the event of arrival at the airport of an individual/group of individuals with suspected or confirmed infectious disease that might pose a threat to public health,
- availability of personal protection equipment for the personnel providing medical assistance,
- familiarity with use of the available personal protection equipment,
- ability to use the personal protection equipment,
- availability of equipment facilitating transport of a patient suspected of an infectious disease in a manner safe to the medical staff as well as other people at the airport [5].

It is especially important to ensure proper personal protection equipment for the personnel of medical response services that might be even potentially exposed to contact with an individual with suspected or confirmed illness due to a particularly dangerous infectious disease.

High number of medical workers who became ill and died during the Ebola hemorrhagic fever epidemic shows the importance of providing medical personnel with appropriate personal protection equipment as well as adhering to strict sanitary regime while in contact with infected individuals as well as secretions and excretions of

affected patients. According to the World Health Organization data regarding this epidemiological focus, the total number of cases in Guinea reached 226 by the end of April 2014. Notably, 25 of those individuals were healthcare workers, of whom 16 have died [3].

Airports should develop relevant rules of conduct in hazardous situations taking into account the described guidelines and international policies. Proper procedure should involve activities of all airport safety services as well as encompass cooperation with relevant territorial authorities. Without going into the details, depending on the decisions of those in charge of the airport, the procedure should above all take into consideration:

- securing proper equipment, including the equipment for biological protection, safe transportation of patients, decontamination,
- putting the airport services on standby from the moment of notification about possible threat of dangerous infectious disease onboard by the aircraft captain,
- towing the aircraft to a previously set up danger zone after landing and ensuring its tightness,
- appointing a special medical team that will enter the aircraft, gather information from the crew and passengers, examine the persons with suspected infection and provide relevant information to the director of the medical team, who will then decide on appropriate measures, i.a.:
 - isolation,
 - hospitalization,
 - quarantine,
 - transport of individuals who are ill or are suspected of illness,
 - decontamination of people and equipment.
- creating spaces for short-term isolation for people awaiting transport to the hospital or quarantine,
- developing methodology for conducting epidemiological investigations by the sanitary services,

- establishing a method of decontamination of people and equipment used during the intervention, including the aircraft,
- establishing a method of securing waste after decontamination and its safe transport to designated locations.

It should be once again stressed that due to dynamic growth of airborne transport of passengers and goods, the airport may be a place of spreading a dangerous infectious disease in every country.

The recommendations and guidelines presented here may minimize this threat, or at least significantly limit its aftermaths. Therefore, proper response to this kind of threat requiring quick identification and isolation of the infected individual as well as efficient diagnostic, therapeutic and epidemiological management is essential.

CONCLUSIONS:

1. International airports, due to ongoing rapid growth of the civil aviation system, are at particular risk of emergence of a dangerous infectious disease.
2. Prevention against threats, including the epidemiological ones, requires strict coordination of all emergency services, airport and airline personnel, as well as local authorities.
3. It is crucial that emergency services should be outfitted with appropriate equipment for protection of medical teams as well as for safe patient transport.
4. International airports must develop and exercise detailed procedures in the event of biological hazards. It is necessary to use guidelines developed by specialist international organizations operating in healthcare and aviation sectors.

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