Infectious Disease Mitigation in Airports and on Aircraft

DETAILS

29 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-28349-6 | DOI 10.17226/22512

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 91

Infectious Disease Mitigation in Airports and on Aircraft

ENVIRONMENTAL HEALTH & ENGINEERING, INC.
Needham, MA

Subscriber Categories
Aviation • Environment

Research sponsored by the Federal Aviation Administration

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2013
www.TRB.org

AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

ACRP REPORT 91

Project 02-20A
ISSN 1935-9802
ISBN 978-0-309-28349-6
Library of Congress Control Number 2013946258

Published reports of the

AIRPORT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

and can be ordered through the Internet at

http://www.national-academies.org/trb/bookstore

Printed in the United States of America

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FOREWORD

By Joseph D. Navarrete
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ACRP Report 91: Infectious Disease Mitigation in Airports and on Aircraft provides practical guidance for mitigating the risk of disease spread via droplet, airborne, and contact transmission modes. The easy-to-use guidebook identifies 24 recommended actions to mitigate disease transmission at airports and aboard aircraft that are classified into three broad categories to assist managers with identifying actions that are specific to their area of oversight: buildings, airplanes, and people.

The transmission of disease through air travel is an important public health concern. In general, the risk of disease transmission at airports and on aircraft is similar to risks associated with other highly dense public settings and activities. Airports and aircraft afford opportunities for disease transmission due to close human contact (e.g., queuing areas, aircraft cabins); sharing of communal spaces (e.g., restrooms, waiting areas, dining tables); and a high number of touched surfaces (e.g., kiosks, handrails, security bins). In addition, however, air travel also highlights the unique factors resulting from the interaction of large numbers of individuals from geographically diverse regions, with differing immunity and endemic diseases. These additional factors represent unique challenges for airports and aircraft operators.

The research, led by Environmental Health & Engineering, Inc., began with a review and synthesis of available literature. The team then identified exposure opportunities within airports and aboard aircraft, and considered transmission-relevant behavior of passengers, visitors, and employees. The relative risks associated with three transmission modes (i.e., droplet, airborne, and contact) were then determined. Working with an expert committee comprising infectious disease specialists, microbiologists, epidemiologists, building engineering specialists, and public health experts, the team developed a list of mitigation measures. Based upon this research, the team then prepared the guidebook.

The guidebook begins with an introduction that describes how infectious diseases are commonly transmitted, discusses the unique aspects of air travel that can affect how diseases are transmitted, and reviews the role of HVAC systems and surface cleaning practices in mitigating disease spread. The guidebook then provides three sections of mitigation measures focused on buildings (i.e., terminals and other facilities); airplanes; and people (i.e., measures that organizations and individuals can undertake to reduce disease transmission risk). In turn, these measures are prioritized based on the strength of supportive evidence-based research. Each recommended action includes a brief rationale for the recommendation. The guidebook also includes a glossary of infectious disease-related terms.

In addition to the guidebook, the research team prepared a technical report detailing the research steps and findings. This technical report is available online at http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3028.

PREFACE

Environmental Health & Engineering, Inc., conducted the following research on behalf of the Transportation Research Board (TRB) of the National Academies to complete Project 02-20A of the Airport Cooperative Research Program (ACRP). The objectives of ACRP Project 02-20A were the following:

- To determine high-risk areas and activities conducive to human disease spread via droplet, airborne, and contact transmission modes (i.e., exposure opportunities) at airports and on aircraft;
- To identify mitigation measures to address those risks; and
- To provide practical guidance to help airports and aircraft operators use these measures to develop targeted strategies to respond to various types and levels of disease threats.

This document is intended for use by airport operators and airline operators and not necessarily the flying public. Further, due to the charge by the ACRP to provide a guidance document with a focus on implementable actions, scientific references and lengthy supporting documentation are not provided here; a complete report for this project, including details of each task and outcome is available on the Project website at http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3028.

This research was conducted from July 2011 through December 2012, by a multidisciplinary team of experts (Table P-1). The scope of work was limited to identifying mitigation measures for U.S. airline and airport operators (including international, domestic and regional airports). Mitigation measures also had to be within the purview of the airline and airport operators for implementation, and therefore excluded consideration of potential measures such as travel restrictions, quarantine, and contact tracing after an outbreak. Furthermore, the contract dictated that research pertaining to air cargo operations, zoonotic, food-borne, water-borne, and vector-borne diseases, and agents related to bioterrorism, was outside the scope of this project. See Table P-2 for a glossary of terms included in this report.

Table P-1. List of experts who contributed to the project through participation in expert panel discussions, report writing and/or report review. (Note: listing here does not imply authorship of this document).

Contributor	Affiliation(s)	Title
John McCarthy, SeD	Environmental Heath & Engineering (EH&E)	Principal Investigator / President
John Spengler, PhD	Harvard School of Public Health (HSPH)	Akira Yamaguchi Professor of Environmental Health and Human Habitation
Joseph Allen, DSc	EH&E HSPH	Principal Scientist Research Associate
David Macintosh, SeD	EH&E HSPH	Chief Science Officer Adjunct Associate Professor
Theodore Myatt, SeD	Brigham and Women's Hospital (BWH) EH&E	Director of Partners Healthcare Institutional Biosafety Committee Senior Scientist
James McDevitt, PhD	HSPH	Instructor of Exposure, Epidemiology and Risk
Lisa Saiman, MD, MPH	Columbia University Medical Center	Professor of Clinical Pediatrics and Pediatric Infectious Diseases
Patricia Fabian, SeD	Boston University School of Public Health	Research Assistant Professor
Edward Nardell, MD	HSPH, BWH	Associate Professor in the Departments of Environmental Health and Immunology and Infectious Diseases
Jerry Ludwig, PhD, PE	EH&E	Director of Engineering
Christopher Zevitas	Volpe National Transportation Center	Research and Innovative Technology Administration

Table P-2. Glossary of terms *(in relation to infectious disease).*

Aerosols	droplets containing an infectious agent that may become airborne and be transmitted through inhalation
Biological agents	any microorganism, including bacteria and viruses, that cause disease in humans
Bloodborne	refers to indirect transmission of an infectious agent by blood-to-blood contact
Broad spectrum	refers to disinfectant activity against a wide range of disease causing microorganisms
Contact time	the length of time that the disinfectant is to remain in contact with a potentially contaminated surface to be effective
Endemic	describes a disease that is always present in a certain population or region
Exposure pathway	the complete course by which an infectious agent is transmitted from its source to another person
Exposure	the condition of being subjected to an infectious agent
Fomite	an inanimate object that may be contaminated with an infectious agent
Germicide	a substance or agent that kills germs
Host	an individual who has been infected with a disease-causing microorganism
Index case	the first identified patient in a group of related cases of a particular disease
Infectious dose	the smallest quantity of an infectious agent that produces an infection in the host
MERV	minimum efficiency reporting value; a measure of filter efficiency and performance
Microbial load	the total number of living microorganisms on a particular surface or contained on various media
Microbiocide	a disinfectant used on inanimate objects to kill microorganisms
Microorganism	a microscopic organism such as bacterium or virus
Pandemic	a widespread outbreak of an infectious disease that spreads through human populations across a large region
Pathogenicity	the capability of an agent to cause disease
Relative risk	a quantitative value of the likelihood of acquiring an infectious disease relative to exposure within a particular environment
Secondary infection	a state of health that occurs when the host is infected by an agent that makes him/her susceptible to additional infections
Susceptible	individuals capable of being infected, due to lack of immunity or resistance
Vector-borne	indirect transmission of an infectious agent from one host to another by organisms such as insects
Virulence	the relative capacity of a pathogen to overcome body defenses
Water-borne	refers to indirect transmission of an infectious agent by water
Zoonotic	an infectious agent or disease that can be transmitted from animals to humans

CONTENTS

SUMMARY

Infectious Disease Mitigation in Airports and on Aircraft

The objectives of this project were to evaluate the risks of disease transmission in airports and on aircraft, identify measures that could be implemented to minimize those risks, and provide a summary document to airport and airline operators with recommendations. The work was completed with input from a panel of subject matter experts and resulted in the identification of 24 recommended actions, categorized in three broad domains: Buildings, Airplanes, and People.

CHAPTER 1

Introduction

Commercial air travel has seen a steady increase in passengers over the last 20 years, including higher passenger densities per aircraft. Perhaps even more importantly, transformational change to the nation's air traffic control systems, embodied by the Federal Aviation Administration's (FAA) Next Generation Air Transportation System (NextGen) initiative, is planned to accommodate a 2.3 times increase in aviation growth by 2025 over the baseline year of 2005. As such, millions of people currently pass through regional, national, and international airports every day, and it is clear that an even larger volume will need to be accommodated in the future. During these travels, passengers, visitors, and airport and airline employees may be exposed to viruses and bacteria shed by fellow passengers and airline and airport employees who harbor infectious diseases. Therefore, infectious disease transmission is a significant and growing concern during air travel and at airports for flight crew members, airport employees, the flying public, and airport guests.

This document is designed to provide aircraft operators and airline operators with guidance for strategies that can be implemented in the air travel industry to mitigate the risk of disease transmission in airports and aircraft. The document begins with a brief introduction to the risk of acquiring a disease and the various means by which diseases can be transmitted. That background information is followed by an explanation of how these mechanisms influence possible exposures with an emphasis on the key environments that are relevant to the airline industry. The document then provides specific guidance for strategies that can be implemented in the air travel industry.

Infectious Disease Risk

The spread of infectious diseases is dependent upon many factors, perhaps the most important and obvious of which is the close contact of a contagious individual with susceptible individuals. Disease transmission is reliant on sustained transmission to new hosts. In the absence of new hosts to become infected, the disease will be self-limiting. While there are other factors that play a role in disease transmission, including host susceptibility to infection and vaccination status as well as duration of exposure and conditions of the environment, a key factor is the mixing of an infectious individual or population with susceptible individuals.

Air travel has long been identified as an environment of interest for disease transmission. The risk of disease transmission in airports and on aircraft is, in many ways, similar to other settings where people congregate in high-density, high-usage and confined space environments and pass through the same choke points (e.g., schools, malls, movie theatres). However, the airport environment is also unique in that there is an interaction of a large number of individuals from geographically diverse regions with differing population immunity and endemic diseases, who all interact with airline and airport operation staff, as well as with each other.

Routes of Transmission

An understanding of how infectious diseases are transmitted from an infected individual to an uninfected individual is needed to develop strategies to prevent transmission. While infectious organisms can be spread through many routes, including via insects and sexual contact, the focus of this project is on infectious organisms that are spread by three general routes of transmission:

1. Aerosols that remain airborne and can be inhaled.
2. Large droplets that settle on surfaces.
3. Direct contact with secretions, bodily fluids, or contaminated surfaces.

Infectious diseases spread by the aerosol route are transmitted by particles most often generated by coughing and sneezing. However, these particles may also be generated by other common activities, such as talking or breathing. These particles are very small (around 10 micrometers); can remain airborne for hours at a time; and can even be transported to other areas of a building by heating, ventilation, and air conditioning (HVAC) systems. Tuberculosis represents the prototypical airborne transmission disease, as the organism, Mycobacterium tuberculosis, is small enough to remain suspended in air for long periods of time (Mycobacterium tuberculosis must not only be inhaled, but reach deep into the lung to start an infection). For other diseases, like influenza, aerosols play a role in transmission, but other routes can contribute to the spread of disease as well.

The physical acts of sneezing and coughing can generate large droplets in addition to the aerosols described herein. These large droplets cannot remain airborne for more than a minute or so, and fall to surfaces and the ground within several feet of their release location. These large droplets can be transmitted directly to susceptible individuals that were near the infectious individual during the act of sneezing or coughing or can contaminate inanimate objects that can then be contacted by susceptible individuals. Many infectious diseases (e.g., influenza) that can be transmitted by aerosols can also be transmitted by large droplets.

Infectious diseases transmitted by direct contact can be spread when a person comes in contact with contaminated surfaces or bodily fluids (e.g., vomit, blood, feces). For these infectious organisms, surfaces become contaminated through the spread of contaminated large droplets, nasal secretions, feces, vomit, or other means. These organisms, if they survive and remain infectious, may then be picked up by susceptible individuals, through contact with these surfaces. Following contact, the susceptible individuals typically expose themselves by contacting their contaminated hands to their mouth, eyes or nose. Studies have shown that individuals whose hands are contaminated with a live virus may contaminate up to

seven additional clean surfaces. Studies in which surfaces are evaluated have shown that the majority of commonly touched surfaces, such as faucets, ATM screens, and escalator railings are contaminated with microorganisms. Surfaces can remain contaminated for a long period of time if adequate disinfection is not performed, as evidenced by a norovirus outbreak on an airplane where flight crew from different shifts became ill up to five days after an infectious passenger vomited on the airplane. Transmission by direct contact can be mitigated with barrier precautions, such as gloving, thorough washing of the hands, and effective cleaning of contaminated surfaces. Examples of microorganisms that can be spread through direct contact include the common cold virus (rhinovirus) and influenza.

Research Directions for Infectious Disease Transmission in the Air Travel Industry

For many infectious organisms, the route of transmission is known. For example, Mycobacterium tuberculosis is transmitted via aerosol generation from a contagious individual followed by inhalation of the aerosol by a susceptible host. However, for other infectious agents, the route of transmission or the relative importance of the various routes of transmission is not known with a high degree of certainty. By including mitigation measures that target all routes of transmission that are generally accepted by the scientific community, the findings and approach detailed in this document are not limited by the fact that knowledge about the details of transmission routes continues to evolve for many infectious agents. Furthermore, as new infectious agents enter the realm of possible meaningful exposure, the basic principles of exposure described herein will remain relevant.

It is well understood that much research remains to be conducted to fully understand the disease transmission process for many infectious agents. For example, at a recent symposium titled "Research on the Transmission of Disease in Airports and on Aircraft," 18 areas of foundational research were discussed as needing additional investigation. The research areas identified ranged from improvements of quantification of infectious particles and droplets for human exhalation to identifying environmental and personal factors that make individuals more or less susceptible to infection. More broadly, additional research is needed to determine the most important pathways for disease transmission for many important infectious agents. Although the areas of additional research need to identify the uncertainty surrounding elements of infectious disease transmission, it is clear that the fundamental, broad-based approaches presented in this document will be effective in helping minimize risk to the traveling public as well as workers at airport facilities and on aircraft.

Transportation Hubs and Disease Transmission: The Airport and Airplane Environments

In order to identify areas where interventions should be targeted, it is necessary to have an understanding of the systems currently in place, both mechanical and operational, that influence disease transmission in the airport and airplane environments. The following two sections provide a general description of relevant systems found in these two environments, but are not necessarily representative of all situations.

The Aircraft Cabin

The aircraft cabin environment is presumed to be relevant to disease transmission due to: close proximity of passengers, long duration of close contact during flight, confined space, mixing of passengers from disparate geographical regions, and large numbers of travelers that use the space with only limited cleaning/disinfection between uses throughout a given day. As described above, disease transmission can occur through inhalation of aerosols or droplets, or through direct contact with contaminated surfaces. Opportunities for disease transmission may occur while directly adjacent to an infectious person during flight, but can also occur during boarding or disembarking as the passenger traverses a contaminated area or touches a contaminated surface. Beyond personal behavior and hygiene, control of biological agents in the cabin environment is primarily accomplished by two means: the environmental control system (ECS) and surface cleaning.

Aircraft are equipped with ECSs to maintain suitable temperature, humidity, pressure, ventilation and ozone concentrations in the cabin. Ventilation specifications for aircraft require a minimum of 0.55 lbs/minute/person in the aircraft, which provides a high air exchange rate in the cabin (10–15 air changes per hour). The ECS generally provides a 50:50 mix of outdoor and recirculated air. The outdoor air, sterile and particle-free at cruising altitudes, enters the ECS from the engines after undergoing compression and conditioning. This air is mixed with recirculated air from the cabin. The recirculated air passes through a high-efficiency particulate air (HEPA) filter capable of removing a minimum of 99.97% of 0.3 micron particles. (Note: The removal efficiency is generally greater for particles both larger and smaller.) Particles generated by sneezing or coughing and that contain bacteria or viruses that enter the recirculation mode of the ventilation system are effectively removed by HEPA filters. Air delivery diffusers in aircraft are located in the ceilings with return air collection systems located at floor level on the cabin walls of the aircraft. The air flow in the cabin is designed to move from ceiling center-to-side which should act to limit the transport of particles along the length of an aircraft (Figure 1). However, perturbations to this air flow pattern can occur during normal cabin activities (e.g., passenger and flight

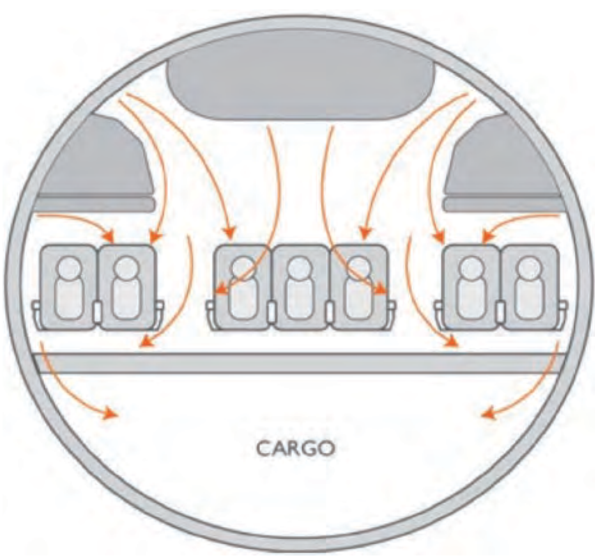


Figure 1. Cross-section of airflow in an airplane cabin (adapted from the World Health Organization. Tuberculosis and Air Travel: Guidelines for Prevention and Control. WHO/TB98.256. Geneva, Switzerland: World Health Organization, 1998).

attendant movement through the cabin). On the ground, aircraft ventilation is provided by auxiliary power units. In some instances, ventilation systems may not be operational or only minimally operational while aircraft are parked at the gate. These periods of low ventilation and high front-to-back movement in the aircraft during boarding/disembarking may be an important window of exposure for disease transmission.

The aircraft ECS, when operating at cruise altitude and according to specifications, provides a high ventilation rate of cleaned air. For example, in a study that evaluated the temporal variation of airborne bacteria and fungi on aircraft, higher levels were seen during boarding and deplaning when the ECS was not likely to be operational. The airborne microbial levels dropped during flight due to the HEPA filtration. This is important and relevant for minimizing the risk of disease transmission during flight, especially for diseases transmitted by aerosols (e.g., tuberculosis), which will be removed by the HEPA filtration during recirculation of air from the cabin. The risk of exposure to diseases that are primarily spread via large droplet or inanimate objects will not be mitigated effectively by the ventilation system. Mitigation for infectious agents with these exposure pathways is primarily achieved through cleaning and personal hygiene (e.g., washing hands, covering a cough). A general cleaning of the aircraft typically occurs after each flight, with a more thorough, detailed cleaning protocol followed during overnight servicing. Ineffective cleaning, either due to technique or choice of disinfectant, may not only fail to remove the infectious agent, but may also aid in its spread to other surfaces.

The Airport Terminal

Airport terminals and other transportation hubs are relevant for disease transmission for many of the same reasons that airplanes are a relevant environment: mixing of passengers from diverse regions; large numbers of unique visitors; close contact; sharing of communal spaces (e.g., restrooms, waiting areas, dining tables); and high number of commonly touched surfaces (e.g., kiosks, handrails). Unlike airplanes, the terminal has many different micro-environments, each of which has its own exposure/risk profile (e.g., security screening v. waiting area).

Mitigation of risk from biological agents within the terminal is achieved in a similar manner as on airplanes—through the ventilation/filtration and cleaning of surfaces. Building HVAC systems provide a mechanism for diluting and filtering airborne contaminants in a building. While most buildings are ventilated at lower rates compared to inside an aircraft, the volume per person in buildings is generally much larger. As most biological agents are in a liquid aerosol form, and much of the aerosol will quickly evaporate in buildings that have their thermal environment maintained to provide occupant comfort, the much larger volume of space per person, when contrasted with that of an aircraft, will generally lessen the exposure potential from a biological contaminant released by another person in close proximity to their physical space.

Airport terminal buildings generally contain a variety of occupancy classifications that include Business, Assembly, and Mercantile. These classifications, while all having similar per person ventilation requirements to meet code and provide comfort conditions, may have large differences in the number of occupants per volume of space, with Assembly areas having occupancy densities as high as 120 persons/1000 ft^2 versus 5 to 7 persons/1000 ft^2 for Business occupancies. Many areas of the airport terminal have high-density occupancy, particularly in Assembly areas. These areas include departure/arrival gates, waiting areas, and corridors. Generally these areas are also characterized as having highly transient occupancy profiles. Other areas of the building, such as the “jet-ways” and inter-terminal transport trolleys will have micro-environments more similar to buses and aircraft, while Business areas will be similar to more typical office environments.

The HVAC systems in the airport terminal have the ability to minimize transmission of airborne infectious agents by two primary mechanisms: dilution and filtration. HVAC systems dilute point source pollutants, such as aerosols released by infectious individuals, both by the introduction of outdoor air, and by spreading point source pollutants over a much larger volume (i.e., dilution). Air filtration in buildings for infectious agents is generally achieved by passing air through filters that rely on particle diffusion, impaction, and interception to remove aerosols. Filters that rely on other mechanisms, such as electrostatic charge, are also available, but are not in widespread use in U.S. buildings. In recent years, particulate filtration in U.S. commercial buildings has generally been improved by the growing use of guidance from the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED©) requirements in the selection of equipment and supplies. The introduction of LEED© ratings for building construction and operations has led to more buildings equipped with filters with higher minimum efficiency report value (MERV) ratings. Filters with higher MERV ratings can provide better filtration for all particle sizes, including the size range in which infectious disease-bearing particles are typically found.

Airport terminals can be complicated structures, involving an array of complex building systems. The quality assurance process of commissioning increases the likelihood that a newly constructed building or space will function as designed. Commissioning spans the entire design and construction process, and includes inspecting the building systems during construction and when the project is near completion, to ensure they are performing as expected. Among the benefits of commissioning, there is an expectation that commissioned spaces will be more energy efficient; have lower operation costs (due to properly sized and functioning equipment); and be less likely to have HVAC system issues.

Since the September 11, 2001 terrorism event, numerous security changes have been made to the nation's airports for the purposes of providing safer air transportation. These changes have included enhancing areas for security screening of passengers before entry to departure and arrival gates. These security screening areas are often high-density occupancy areas that previously were not used, or designed, for high-density occupancy. In some airports, security areas may have been created in areas that do not permit full consideration of the factors that would typically be taken into account in the design of a densely occupied space. As a result, the dilution and filtration mechanisms traditionally offered by a properly sized and designed HVAC system may not be provided in these improvised, high-density areas.

Surface cleaning can be a means of limiting the spread of infectious agents that are transmitted through contact with contaminated surfaces. While surfaces are never sterile and are populated with a wide variety of microorganisms, surface contamination can lead to the spread of infectious diseases that are transmitted via direct contact (e.g., norovirus, influenza, MRSA). However, the frequency of cleaning is important as heavily touched surfaces are quickly recontaminated. Several significant issues related to cleaning are that cleaning of surfaces is typically performed to a visual standard and is generally not based on bacterial or viral loading, and cleaning protocols and strategies are not standardized across airports. Further complicating the issue is the fact that even within airports, several different groups are often responsible for maintaining different areas and coordination may be limited, or non-existent. For example, the airport operator is responsible for the terminal, while the food service operators are responsible for cleaning dining areas, and airlines are responsible for airplanes and check-in areas.

Other Travel-Related Environments

Air travel, by its nature, is not limited to the time spent in the airport terminal or time spent on airplanes. The air travel experience includes time spent in many other micro-environments that are relevant to disease transmission. A typical traveler may take a bus, train, or taxi to the airport—micro-environments that represent spaces shared by many people, some of whom may be infectious and may contaminate these spaces. Even prior to the actual ride to the airport, the traveler is likely to spend time in transportation hubs that would have similar exposure profiles to an airport terminal (e.g., train station, bus depot). After arrival in the destination city, the traveler is again exposed to potentially crowded, communal environments as they leave the airport by taxi, bus, or train, and then spend time in a hotel or motel. These micro-environments are beyond the control of airport administrators and airline operators. However, the risks of disease transmission attributable to time spent in the airport and airplane cannot be fully disentangled from these other travel-related environments. The goal of this report, however, is to provide mitigation strategies for airports and aircraft, without consideration of other travel-related exposures or comparison of airport risks to other settings (e.g., hotels, hospitals, buses, trains).

Process for Selection of Mitigation Measures

The recommended mitigation measures developed by the Expert Committee were divided into the following three categories as a simplifying scheme to aid in the implementation of the measures:

- Buildings,
- Airplanes, and
- People.

Final selection of the recommended mitigation measures was a result of a six-phase process that culminated in an expert workshop, all of which is described in a separate report available on the Project website. The main objective of holding the workshop was to draw upon the knowledge of the members of the Expert Committee and identify specific mitigation measures that target the highest risk exposure opportunities for each of the three transmission pathways, leveraging the knowledge gained in the initial phases of this research project. An initial and broad list of mitigation measures drafted prior to the meeting was evaluated in order to screen and prioritize the selections with the goal of developing a consensus list of recommendations. The final list of specific mitigation measures was developed by having the Expert Committee select measures that were evidence-based (or were able to be evaluated by applying knowledge from other environments, such as hospitals) and could realistically be implemented in the airport and aircraft environment. An overview of the selected mitigation measures is presented in Table 1. Details of each measure are presented in the following sections.

Each recommendation in the following sections is listed with information on the area of the airport or air travel experience targeted, the population targeted, and the route of transmission targeted. Further, each recommendation is categorized on the basis of existing scientific data, rationale, applicability, and feasibility. The recommendations are evidence-based wherever possible. However, certain recommendations are derived from empirical infection-control or engineering principles, theoretic rationale, or from anecdotal evidence. Each recommendation was rated according to the following categories:

- **Highly Recommended.** Highly recommended for implementation and supported by experimental, clinical, or epidemiological studies.
- **Recommended.** Recommended for implementation and supported by suggestive clinical or epidemiological studies, or a theoretical rationale.
- **Suggested.** Suggested for implementation and supported by indirectly relevant studies or anecdotal evidence.

Table 1. Summary of recommended mitigation measures.

BUILDINGS	
Category	**Mitigation Measure**
Strongly Recommended	Deploy hand sanitizer stations in strategic locations throughout the airport
	Use broad spectrum EPA-registered disinfectants to clean surfaces
	Ensure that biohazard kits are available to employees in airport terminals
Recommended	Implement the use of hands-free bathroom appliances and transaction tools
	Ensure that buildings and building modification projects include commissioning activities
	Evaluate facilities to ensure that high occupant density areas meet minimum ventilation requirements if Commissioning is not performed
	Evaluate facilities to ensure that the filters installed in HVAC Systems are appropriately maintained if Commissioning is not performed
Suggested	Use HEPA filtered vacuums when cleaning carpets and upholstery
	Develop standardized cleaning and disinfecting practices within the airport
	Implement cleaning audits to validate cleaning and disinfection protocols
	Conduct an analysis of passenger data to identify potential high risk time periods and locations
	Install upper-room UV

AIRPLANES	
Category	**Mitigation Measure**
Strongly Recommended	Decrease ventilation downtime on aircraft parked at the gate
	Ensure that biohazard kits are available to employees in aircraft, during flight
	Encourage the use of hand sanitizer before, during, and after the flight
	Use broad spectrum EPA-registered disinfectants to clean surfaces
Suggested	Use HEPA filtered vacuums when cleaning carpets and upholstery

PEOPLE	
Category	**Mitigation Measure**
Strongly Recommended	Develop a "Healthy Traveler" campaign
	Develop a "Healthy Worker" campaign
	Implement a seasonal influenza vaccination campaign
	Participate in pandemic planning prior to the outbreak of an infectious disease
	Implement a hand hygiene/ cough/sneeze etiquette campaign
Recommended	Establish and maintain contact with their local DPH and CDC representatives
	Create an inter and intra airport agency committee on infectious disease

SOPs standard operating procedures
HEPA high efficiency particulate air
EPA U.S. Environmental Protection Agency
DPH Department of Public Health
CDC Centers for Disease Control and Prevention

Additional Information

The recommendations that are described in this report are based for the most part on primary scientific literature. This literature is cited in ACRP Project 02-20A's Final Report available at http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3028 and in an online reference repository maintained by the John A. Volpe National Transportation System Center at http://volpedb.volpe.dot.gov/outside/owa/vntsc_outside.emrdtaa_lib.display_lib#search:'

CHAPTER 2

Buildings

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	○	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	○	✓		

Airport Operators Should Consider Implementing the Use of Hand Sanitizer Stations in Strategic Locations Throughout the Airport

Highly Recommended

Rationale. Use of hand sanitizer has been demonstrated to reduce infectious disease transmission by reducing microbial loads on hand surfaces. Data from schools, extended care facilities, and acute care facilities show a reduction in absenteeism and infection rates with increased use of hand sanitizer. While hand sanitizer stations are commonly used in many airports, locations of the stations should be considered fully such that the intended user (e.g., passengers, employees) travel experience is incorporated into the placement of the stations. For example, place stations (and appropriate signage) at check-in counters and immediately after the security line are two locations where passengers come in contact with frequently touched items (e.g., touch-screen kiosks and bins for screening carry-on bags). Hand sanitizers are to be used in addition to, and not to replace, soap and water hand washing.

Points to Consider for Implementation

1. Use hand sanitizers that contain at least 60% alcohol, per the recommendation by the Centers for Disease Control and Prevention (CDC).
2. Consider the passenger experience in determining strategic locations for hand sanitizer stations.
3. Ensure highly visual signage near hand sanitizer stations to encourage use.
4. Appoint staff as responsible person or group to maintain stations and ensure adequate supplies of sanitizer product.

Airport and Airline Operators Should Consider Using Broad-Spectrum U.S. Environmental Protection Agency (EPA)-Registered Disinfectants

Highly Recommended

Rationale. Frequently touched surfaces (e.g., railings and chairs) and floors become contaminated with microorganisms from settling airborne bacteria, by contact with hands, shoes, wheels, and other objects, and occasionally by spills and or splashes of human blood or bodily fluids (e.g., vomit). Studies conducted in healthcare facilities have shown that mopping with soap and water (80% reduction) was less effective in reducing the numbers of bacteria than was a phenolic disinfectant (94%-99.9% reduction). Other studies have shown that with normal use, detergents become contaminated and can increase the bacterial load on multiple surfaces after "cleaning." Studies also have shown that, in situations where the cleaning procedure failed to eliminate contamination from the surface and the cloth is used to wipe another surface, the contamination is transferred to that surface as well as the hands of the person holding the cloth.

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	○	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	✓	✓		

The EPA requires that all disinfectants be registered, which includes conducting standardized organism specific efficacy studies. The efficacy study data is submitted to the EPA and used to support claims for disinfection. Substantiated efficacy claim information is available on an EPA website (http://www.epa.gov/oppadOOl/chemregindex.htm). Studies have shown that products with limited efficacy can lead to increased transfer of microorganisms from one surface to another. Therefore, it is important to ensure the disinfectant products that are used are proven to be effective against the organisms of interest that are transmitted via contaminated surfaces, such as norovirus and influenza. Appropriate disinfectants have been demonstrated to reduce microbial loads.

Disinfectants must be used according to manufacturer's instructions for the intended purpose. To ensure proper use, a standard operating procedure (SOP) should be developed that includes key information such as how to make up working solutions from concentrate, the length of time the working solutions should be used before they lose effectiveness, the contact time for the disinfectant, and any safety precautions that should be taken when working with the disinfectant. Staff should be trained on the SOP.

Points to Consider for Implementation

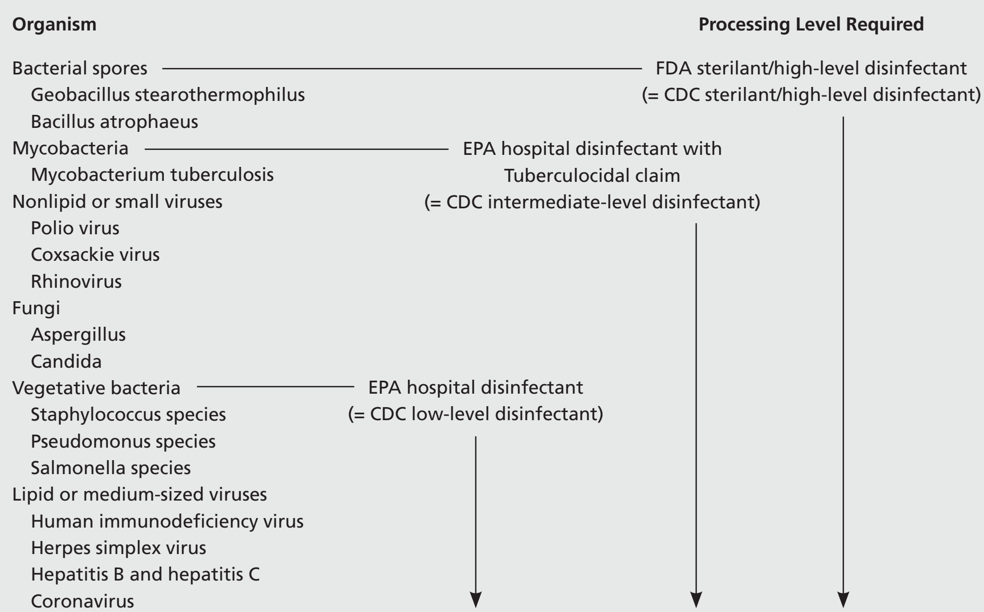
1. Ensure that broad-spectrum, EPA-registered disinfectants are used for the general cleaning of frequently touched surfaces and floors, even in areas other than bathrooms.
2. Regularly clean and disinfect high-touch surfaces with EPA-registered, intermediate-level disinfectants.
3. Frequency of cleaning should be based on cleaning audits, such as visual assessments.
4. To ensure effectiveness, make certain that disinfectant's manufacturer's instructions are followed for preparation (e.g., appropriate dilution) and use (e.g., contact time).
5. During periods of heightened concern for infectious diseases that are transmitted via surfaces (e.g., influenza, norovirus) ensure that the frequency of disinfection on frequently touched surfaces is increased.

EPA-Registered Disinfectants

In the United States, liquid disinfectants that are used on environmental surfaces are regulated by the US EPA in the Antimicrobials Division, Office of Pesticide Programs, under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947, as amended in 1996. Under FIFRA, any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, including microorganisms but excluding those in or on living humans or animals, must be registered before sale or distribution.

To obtain a registration, a manufacturer must submit to the EPA specific data regarding the safety and the effectiveness of each product. As part of the registration process, manufacturers are required to submit data on microbicidal activity, along with proposed labeling. If EPA concludes a product may be used without causing unreasonable adverse effects, the product and its labeling are given an EPA registration number, and the manufacturer may then sell and distribute the product in the United States. FIFRA requires users of products to follow the labeling directions on each product explicitly. Not following the specified dilution, contact time, method of application, or any other condition of use is considered misuse of the product.

Both the EPA and CDC classify disinfectants. While the EPA classifies disinfectants based on the microbiocidal activity claims (e.g., effective against norovirus or Mycobacterium tuberculosis), the US Centers for Disease Control and Prevention (CDC) uses terms such as "low-level" and "high-level" disinfectants. CDC designates any EPA-registered disinfectant without a tuberculocidal claim (i.e., ability to kill Mycobacterium tuberculosis) as a low-level disinfectant and any EPA-registered disinfectant with a tuberculocidal claim as an intermediate-level disinfectant. A general guide is included below, but as a rule, manufacturer's label claims and instructions should always be followed. More information, including lists of EPA-registered disinfectants and their labels, can be found at http://www.epa.gov/oppad001/chemregindex.htm



Airport Operators Should Consider Ensuring That Biohazard Kits Are Available to Employees in Airport Terminals

Highly Recommended

Rationale. Infectious diseases, such as norovirus, can be transmitted through vomit. Bloodborne pathogens like hepatitis and HIV can be transmitted through contact of broken skin with contaminated blood. Workers who encounter any biological fluid, including phlegm, blood, and vomit, do not know if it came from a contagious person and should therefore treat the fluid as potentially infectious. It is important to minimize the risk of transmitting infectious diseases through bodily fluids by donning appropriate personal protective equipment and promptly and effectively cleaning and disinfecting the area following a release. Case reports have demonstrated that inadequate responses to passengers who have vomited can result in transmission of infectious illnesses to others in the area. Any personnel involved with cleaning/disinfecting areas should be properly trained (including training on how to report an occupational bloodborne pathogen exposure event and obtain immediate medical evaluation) and equipped with appropriate personal protective equipment to ensure their safety.

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	○	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	✓	✓		

Points to Consider for Implementation

1. Biohazard kits should be available throughout the airport to ensure a timely response to a release.
2. Biohazard kits should include: gloves, face shield, biohazard bags, towels or other absorbent material, disposable scoops, disinfectant, training materials (or short step by step guide for cleaning up vomit and other bodily fluids).
3. Ensure disinfectant in biohazard kit has a long shelf life.
4. Designated personnel who perform cleaning of bodily fluids should be trained on bloodborne pathogens and cleaning procedures on an annual basis.
5. Ensure that training includes all required elements of U.S. Occupational Safety and Health Administration (OSHA) Bloodborne Pathogens Standard, including how to report an exposure event and obtain a medical evaluation.
6. Airport procedures for disposal of waste containing bloodborne pathogens should include typical and atypical quantities.

Biohazard Kit

All biological fluids (for example: phlegm, blood, vomit) should be treated as potentially infectious. Biohazard kits are convenient clean up kits, allowing for quick action in an event where bodily fluids have been released from a sick passenger or employee. Kits include:

- Alcohol towelettes
- Aprons
- Towels/Other absorbent material
- Face shield
- Gloves
- Masks
- Sharps containers
- Biohazard bag
- Disposable scoops
- Surface disinfectant spray bottles
- Thermometer

When properly trained, flight attendants and airport staff can respond to situations where biological fluids need to be cleaned from surfaces while keeping both themselves and travelers safe from infectious diseases and limiting the possibility of sustained transmission or cross-contamination of other areas.

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	○	✓	○	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	○	✓		

Airport Operators Should Consider Increasing the Use of Hands-Free Bathroom Appliances and Transaction Tools

Recommended

Rationale. Many infectious diseases are transmitted via contact with contaminated surfaces. Surfaces that are frequently touched by a large number of individuals are most likely to be contaminated. Examples of high-touch surfaces in bathrooms include door handles, faucets, toilets, urinals, and soap dispensers. Other examples of high-touch surfaces include ticketing kiosks and counter tops. Minimizing high-touch surfaces will reduce the risk of exposure to infectious microorganisms.

Points to Consider for Implementation

1. Incorporate hands-free appliances, such as toilets, soap dispensers, paper towel dispensers, faucets and hand dryers, into design requirements for new construction and renovations of bathroom facilities.
2. Expand and encourage the use of mobile devices for ticketing and printing ticketing outside the airport to avoid touching ticketing kiosks.

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	○	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	○	○		

Airport Facility Personnel Should Consider Ensuring That Their Buildings and Building Modification Projects Include Commissioning Activities to Ensure That the HVAC Systems Serving the Space Are Operated Appropriately and Provide All of the Benefits of Proper Building Design Such as Pressurization, Air Filtration, Outdoor Air Ventilation, and Air Circulation

Recommended

Rationale. Among other things, the airport's mechanical systems control filtration and ventilation, two important indoor environmental parameters that can influence disease transmission. In addition, a properly commissioned building HVAC system ensures that the system that is designed, installed, and operated in the building is functioning properly, which provides many collateral benefits, including: (1) the building will be properly pressurized; (2) the air supplied by the HVAC system to the occupied space is from an air intake location that has been chosen to minimize introduction of outdoor pollutant sources, and has passed through the HVAC system filters, dehumidification coils, and other components; (3) the HVAC system's economizer cycle will supply more than the code required minimum amount of outdoor air when outdoor air thermal conditions allow it; and (4) the HVAC systems will operate in an energy efficient manner while maintaining thermal comfort for the building occupants.

Points to Consider for Implementation

1. Ventilation—The goal is to ensure that the HVAC system's supply air is (a) sufficient in volume to effectively dilute the concentration of generated aerosols, and (b) efficiently mixed in the occupied zones of the building to minimize the extent to which indoor air pollutants, including bacteria and viruses, concentrate in localized areas of the building. This is particularly important in high-density, low-volume areas (e.g., security screening queues).
2. Filtration—Many filters are capable of capturing airborne bacteria and viruses. Effective design, review and commissioning of the systems will increase the overall performance of the system as a whole, including the effective filtration.

If Commissioning Is Not Performed, Airport Operators Should Consider Evaluating Their Facilities to Ensure That High-Occupant Density Areas Meet Minimum Ventilation Requirements

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	○	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	○	○		

Recommended

Rationale. Ventilation is an important determinant of exposure to airborne pollutants, including bacteria and viruses. A facility in which all occupied areas meet current ventilation codes and guidelines better assures that the air quality is maintained in the space. Areas that are not meeting these guidelines may have amplified risk for airborne pathogen transmission. Changes in security procedures may have impacted the locations and densities of high-occupant areas in the airport. These current high-density areas may not have existed at the time the facility was first opened.

Points to Consider for Implementation

1. Conduct a design review to assess the ventilation of the facility as it is currently operating, making note of high-density locations such as security screening areas.
2. An occupant-generated tracer such as carbon dioxide (CO) may provide a useful indicator of the ability of high-density areas to meet appropriate ventilation guidelines.
3. For those areas that do not meet the code required ventilation guidelines, adjustments should be made to the minimum outdoor air flow rates; the ventilation air distribution system; the ventilation system operating sequence (i.e., consideration of demand control ventilation); or some combination of all of these. An architect and engineer may be required to design the appropriate changes and adjustments.

If Commissioning Is Not Performed, Airport Operators Should Consider Evaluating Their Facilities to Ensure That the Filters Installed in HVAC Systems Are Appropriately Maintained

Recommended

Rationale. Filtration can be an effective means of controlling airborne pollutants, including bacteria and viruses. Proper maintenance of HVAC air filtration systems in a building can provide significant benefits to the building owner in terms of improved indoor air quality for building occupants and reduced maintenance. Filters that are not appropriately maintained can become excessively resistant to airflow, which will reduce air flow performance of the HVAC system. This will reduce the system's ability to heat, cool, de-humidify, ventilate and properly mix air in the

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	○	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	○	○		

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	○	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	✓	✓		

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	✓	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	✓	✓		

occupied space. Filters that are severely clogged can collapse, causing air to bypass the filter. During the collapse, the filter can release materials that were collected on the filter into the airstream, which can then be distributed onto the components downstream of the filter in the HVAC system and possibly be delivered into the occupied space.

Points to Consider for Implementation

1. Use the filter with the highest MERV rating that does not create unacceptable pressure drop in the system.
2. Ensure the filters are changed based on either a regular schedule or on a measured maximum pressure drop.
3. Facility personnel should incorporate the inspection and maintenance of the filters into the regularly scheduled maintenance program. Filters and other equipment should be inspected according to manufacturer's instructions or more frequently if deemed to be appropriate by the facility or carrier.

Airport Operators Should Consider Using HEPA-Filtered Vacuums When Cleaning Carpets and Upholstery

Suggested

Rationale. Typical vacuums have been shown to not only collect, but to also aerosolize large amounts of surface dust, which may contain infectious microorganisms or more commonly, allergens, such as fungal spores. The regular use of vacuums in good repair and that are equipped with HEPA filters will minimize secondary dust dispersion.

Points to Consider for Implementation

1. Ensure that the use of HEPA-filtered vacuums is specified in contracts with organizations responsible for cleaning airport waiting areas and other carpeted areas used by passengers and guests.

Airline Operators Should Consider Working Together to Implement Standardized Cleaning and Disinfecting Practices Within the Airport

Suggested

Rationale. Multiple groups may be responsible for cleaning various locations within an airport. For example, the airport operations may be responsible for the cleaning contractor that cleans general areas of the terminal (such as the waiting areas); the airlines may be responsible for cleaning at the check-in areas including kiosks; while a third group may be responsible for cleaning at food service areas. This may lead to a lack of consistency in cleaning and disinfecting practices between areas in an airport.

Points to Consider for Implementation

1. Convene a working group of representatives from organizations responsible for cleaning and disinfecting to review cleaning practices and areas cleaned.
2. Coordinate cleaning with appropriate cleaning/disinfecting products to enhance overall disinfection at airports.
3. Perform a coordinated and detailed review to ensure that all high-touch surfaces are included in the appropriate responsible party's inventory of areas to clean.

Airport and Airline Operators Should Consider Implementing Cleaning Audits to Validate That Cleaning and Disinfection Protocols Are Effective at Reducing Bacteria/Loads on High-Touch Surfaces

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	✓	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	✓	✓		

Suggested

Rationale. Cleanliness of high-touch surfaces, such as airport bathrooms, is typically assessed visually. While visual assessment audits are important to ensure cleaning is performed adequately and at sufficient frequency, healthcare based studies have shown that visual assessments are not good indicators of microbial contamination. Additional studies have shown that infectious microorganisms can be detected on visibly clean surfaces following the use of detergent based cleaners. Alternative methods to visual assessments, such as microbial sampling and bioluminescence testing, which is used in the food preparation industry, have been used to assess the efficacy of cleaning protocols. The use of microbial sampling and/or bioluminescence testing to evaluate the disinfection of high-contact surfaces would reduce risk of exposure to infectious organisms by ensuring effective cleaning has been performed.

Points to Consider for Implementation

1. Conduct systematic, unannounced audits to assess cleaning group performance.
2. Explore the possibility of the use of limited microbial sampling and/or bioluminescence testing to supplement visual assessments with groups responsible for cleaning/disinfecting.

Airport Operators Should Consider Conducting an Analysis of Their Passenger Data to Identify Potential High-Risk Time Periods and Locations

Suggested

Rationale. A prudent first step in attempting to mitigate disease transmission in airports is to determine the populations and micro-environments at risk. Once established, the next step needs to be an analysis of temporal patterns to determine time periods of potential higher risk. This Expert Committee has performed the first step by defining at risk populations and micro-environments that are generalizable to most, if not all, airport environments. The temporal component, however, is not generalizable and is therefore the responsibility of each airport operator.

By identifying time periods of maximum passenger densities, airport operators can target mitigation efforts to these time periods. Maximum passenger loads will also likely vary by terminal type (e.g., international v. domestic); airport location (e.g., east cost v. west coast); time of day; and week of year due to regional events (e.g., NASCAR event, Disneyworld during winter break).

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	○	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	✓	✓		

Points to Consider for Implementation

1. Evaluate location-specific flight data (i.e., terminals) to identify highest density areas by time (day of week, time of day, week of year).
2. Align cleaning frequency with passenger density.

Airport Operators Should Consider Installing and Operating Upper-Room 254 Nm (UVC) Light to Minimize Transmission of Aerosol-Transmitted Microorganisms in High-Risk Locations Throughout the Airport

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	○	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	○	○		

Suggested

Rationale. Air disinfection using upper-room 254 nm (UVC) light can lower the airborne concentrations of microorganisms in the lower part of the room, and thereby control the spread of airborne infections among room occupants without exposing occupants to a significant amount of UVC. Upper-room UVC may be an effective option for high-risk locations, such as quarantine or isolation areas, and other high-density queuing areas, where high-filtration HVAC systems may not be an option. This can also be implemented during high-risk time periods (e.g., pandemics) for infectious diseases that are transmitted through inhalation of aerosols. UVC fixtures must be installed properly to ensure that the UVC exposure risk from upper-room fixtures to airport guests and workers is minimal.

Points to Consider for Implementation

1. UVC is only effective for microorganisms that are transmitted exclusively or predominately through the airborne route, such as Mycobacterium tuberculosis.
2. UVC requires dedicated, specialized resources to monitor lower-room UVC levels and changing and cleaning lamps. Additionally, training is required for all staff that are anticipated to need access to equipment in the upper-room to prevent occupational exposures.
3. UVC can be implemented in high-risk locations (e.g., isolation rooms) and/or during high-risk time periods (e.g., pandemics).
4. Each facility must make its own determination as to its utility and cost effectiveness.

CHAPTER 3

Airplanes

Airline Operators Should Consider Decreasing Ventilation Downtime on Aircraft Parked at the Gate

Highly Recommended

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	○	✓	○
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	○	○	○	✓	○
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	✓	○		

Rationale. The ventilation systems in operating aircraft are designed to bring in fresh air, filter the air, and circulate the air within the cabin. All of these actions reduce the potential transmission of infectious aerosols. However, once the aircraft is shut down, these systems are also shut down and the risk of transmission of infectious aerosols increases. Many airports have gate-based ventilation systems which are attached to the aircraft once the aircraft engines are shut down. As a result, air movement is maintained within the cabin. However, not all airports or gates are equipped with these gate based ventilation systems. In many cases, when these systems do exist, they are not routinely used.

Points to Consider for Implementation

1. Install gate-based aircraft ventilation systems at all gates in an airport, when possible.
2. Attach gate-based ventilation systems to aircraft as soon as the aircraft is shut down.
3. Do not detach gate-based ventilation systems until shortly before aircraft start up.
4. Installation of these systems, as well as their operation, may be expensive. Based on these costs, routine operation may not be warranted in all instances. However, in the case of an emergency or a pandemic, these costs would be justified. Airport operators and airlines should make preparations to provide gate-based ventilation to all parked aircraft in the event of an emergency or pandemic.

Airline Operators Should Consider Ensuring That Biohazard Kits Are Available to Employees in Aircraft

Highly Recommended

Rationale. Infectious diseases, such as norovirus, can be transmitted through vomit. Bloodborne pathogens like hepatitis and HIV can be transmitted through contact with broken skin or mucosa or mucous membranes with contaminated blood. Airline workers,

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	○	✓	○
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	○	○	○	✓	○
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	✓	✓		

including cabin crews, who encounter any biological fluid, including phlegm, blood, vomit, do not know if it came from a contagious person and should therefore treat the fluid as potentially infectious. It is important to minimize the risk of transmitting infectious diseases through bodily fluids by donning appropriate personal protective equipment and promptly cleaning and disinfecting the area following a release. Case reports have demonstrated that inadequate responses to passengers who have vomited can result in transmission of infectious diseases to others in the area. Any personnel involved with cleaning/disinfecting areas should be properly trained (including training on how to report an occupational bloodborne pathogen exposure event and obtain immediate medical evaluation) and equipped with appropriate personal protective equipment to ensure their safety.

Points to Consider for Implementation

1. Biohazard kits should be available on the aircraft to ensure a timely response to a release.
2. Biohazard kits should include: gloves, face shield, biohazard bags, towels or other absorbent material, disposable scoops, disinfectant, training materials (or short step by step guide for cleaning up vomit and other bodily fluids).
3. Ensure disinfectant in biohazard kit has a long shelf life.
4. Designated personnel who perform cleaning of bodily fluids should be trained on bloodborne pathogens and cleaning procedures on an annual basis.
5. Ensure that training includes all required elements of U.S. OSHA Bloodborne Pathogens Standard, including how to report an exposure event and obtain a medical evaluation.
6. Airline procedures for disposal of waste containing bloodborne pathogens should include typical and atypical quantities (e.g., how to appropriately handle a contaminated airline seat that must be taken out of service and ultimately disposed of).

Airline Operators Should Consider Encouraging the Use of Hand Sanitizer Before, During and After the Flight

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	○	✓	○
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	○	○	○	✓	○
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	○	✓		

Highly Recommended

Rationale. Use of hand sanitizer has been demonstrated to reduce infectious disease transmission by reducing microbial loads on hand surfaces. Data from schools, extended care facilities, and acute care facilities show a reduction in absenteeism and infection rates with increased use of hand sanitizer. The use of hand sanitizer prior to boarding, during flight, and during disembarkation should be encouraged to minimize the potential for disease transmission during the flight, and also to minimize the potential of cross-contamination of the airplane from the airport environment. Hand sanitizers are to be used in addition to, and not to replace, soap and water hand washing.

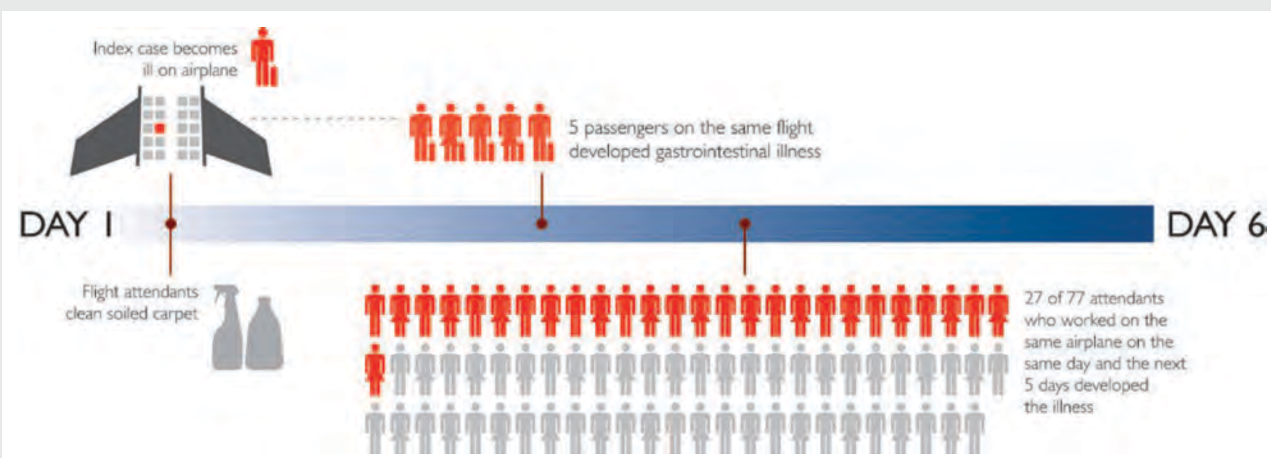
Points to Consider for Implementation

1. Use hand sanitizers that contain at least 60% alcohol, per the recommendation by the Centers for Disease Control and Prevention (CDC).
2. Consider placement of hand sanitizer dispensers in the jetway.
3. Ensure highly visual signage near hand sanitizer stations to encourage use.
4. Appoint staff as responsible person or group to maintain stations and ensure adequate supplies of sanitizer product.
5. Educate cabin crew that while hand sanitizer can be effective, the CDC continues to recommend that soap and water is the preferred hand cleaning method.

Norovirus Transmission on an Airplane

In October, 2009, an outbreak of norovirus was reported among flight attendants who had worked different shifts on the same airplane, up to 5 days after a sick passenger was onboard. Norovirus causes stomach flu with symptoms consisting of diarrhea and vomiting, the same set of symptoms reported among the flight attendants. The virus is shed usually before and after illness with transmission occurring through oral ingestion of shed virus particles in feces or vomit of infected individuals.

The index case was an unidentified male passenger seated in the economy section of the airplane. The index case vomited and soiled the carpet next to his seat which was cleaned during the flight by one of the flight attendants and disposed in a passenger restroom at the rear of the aircraft. Out of the total 77 flight attendants who had worked on the same airplane on the same day as the index case and the subsequent 5 days, 27 developed the illness, with onset being less than 51 hours after the end of their first shift. In addition, the airline had also received reports from five passengers on the same flight that had developed gastrointestinal illness. Results from the study suggested that flight attendants were infected through their work on the same airplane during separate shifts, despite the initial source of the virus (vomit) having been cleaned immediately after discovery on the first day.



Although the airplane may have been cleaned and disinfected between flights, this outbreak incident demonstrates that current cleaning practices may not adequately remove disease-causing agents from contaminated surfaces, with the potential for sustained transmission. As a result, the authors recommended the use of biohazard kits, including disinfectants effective against norovirus (and training on the use of the biohazard kits), on airplanes to limit the spread of infectious disease after these types of incidents.

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	○	✓	○
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	○	○	○	✓	○
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	○	✓		

Airport and Airline Operators Should Consider Using Broad-Spectrum U.S. EPA-Registered Disinfectants

Highly Recommended

Rationale. Frequently touched surfaces (e.g., bathroom surfaces, seatback trays, and seat armrests) and floors become contaminated with microorganisms from settling airborne bacteria, by contact with hands, shoes, wheels, and other objects, and occasionally by spills and or splashes of human blood or bodily fluids (e.g., vomit). Studies conducted in healthcare facilities have shown that mopping with soap and water (80% reduction) was less effective in reducing the numbers of bacteria than was a phenolic disinfectant (94%–99.9% reduction). Other studies have shown that use of detergents become contaminated and increase the bacterial load on surfaces after "cleaning." Studies also have shown that, in situations where the cleaning procedure failed to eliminate contamination from the surface and the cloth is used to wipe another surface, the contamination is transferred to that surface and the hands of the person holding the cloth.

The EPA requires that all disinfectants be registered, which includes conducting standardized organism specific efficacy studies. The efficacy study data is submitted to the EPA and used to support claims for disinfection. Substantiated efficacy claim information is available on the EPA website (http://www.epa.gov/oppadOOl/chemregindex.htm). Studies have shown that products with limited efficacy can lead to increased transfer of microorganisms from one surface to another. Therefore, it is important to ensure the disinfectant products that are used are proven to be effective against the organisms of interest that are transmitted via contaminated surfaces, such as norovirus and influenza. Appropriate disinfectants have been demonstrated to reduce microbial loads.

Disinfectants must be used according to manufacturer's instructions for the intended purpose. To ensure proper use, an SOP should be developed that includes key information such as how to make up working solutions from concentrate, the length of time the working solutions should be used before they lose effectiveness, the contact time for the disinfectant, and any safety precautions that should be taken when working with the disinfectant. Staff should be trained on the SOP.

Points to Consider for Implementation

1. Ensure that broad-spectrum, EPA-registered disinfectants are used for the general cleaning of frequently touched surfaces and floors, even in areas other than bathrooms.
2. Regularly clean and disinfect high-touch surfaces with EPA-registered, intermediate-level disinfectants.
3. Frequency of cleaning should be based on cleaning audits, such as visual assessments..
4. To ensure effectiveness, make certain that disinfectant's manufacturer's instructions are followed for preparation (e.g., appropriate dilution) and use (e.g., contact time).
5. During periods of heightened concern for infectious diseases that are transmitted via surfaces (e.g., influenza, norovirus), ensure that the frequency of disinfection on frequently touched surfaces is increased.
6. Review aircraft manufacturer specifications to ensure that disinfectants do not degrade aircraft materials, electrical systems or mechanical components.

Airline Operators Should Consider Using HEPA-Filtered Vacuums When Cleaning Carpets and Upholstery

Suggested

Rationale. Typical vacuums have been shown to not only collect, but to also aerosolize large amounts of surface dust, which may contain infectious microorganisms or more commonly, allergens, such as fungal spores. The regular use of vacuums in good repair that are equipped with HEPA filters will minimize dust dispersion.

Points to Consider for Implementation

1. Ensure that the use of HEPA-filtered vacuums is specified in contracts with organizations responsible for cleaning aircraft surfaces and other carpeted areas used by passengers and staff.

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	○	✓	○
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	○	○	○	✓	○
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	○	✓	✓		

CHAPTER 4

People

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	○	○	○	○
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	✓	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	✓	✓		

Airport Operators and Airlines Should Consider Implementing a "Healthy Traveler" Campaign

Highly Recommended

Rationale. Public relations campaigns, such as a "Healthy Traveler" campaign, can be an effective way to provide passengers with recommendations for staying healthy during their travels. A "Healthy Traveler" campaign encompasses many important mitigation measures that are included elsewhere in this document, such as wash your hands and cover your cough, but also includes the establishment of a unified program to raise awareness of these public health measures. A single checklist of the items included in the campaign could be developed and provided to all airport and airline managers to distribute appropriately. A coordinated campaign with similar images and messages across all airports and within an airport would be ideal for reinforcing these actions, as it would provide consistency for the passengers traveling through various airports during their trip. If the city or district an airport is located in has a similar public health campaign already in place, then it would be encouraged to collaborate with their local DPH and look to their campaign for guidance as well.

Points to Consider for Implementation

1. Encourage passengers to be aware of what diseases they may be exposed to at their travel destination, so they can prepare accordingly. Include reference to the CDC Traveler's Health for foreign travel as a way to encourage passengers to consider disease exposure.
2. Encourage passengers to rebook their flight for a later date if they are feeling ill.
3. Provide a checklist of recommendations, with specific examples, for what passengers should do prior to and during airline travel (e.g., get a good night's sleep the night before, stay hydrated, keep your hands clean). Best practices and other reference materials used in the health care field could be used as a template for this checklist.
4. Use multiple means of disseminating information to passengers, such as the airport website, mobile applications (apps), video screens at the airport, and airport signage.
5. Suggest the use of a mask if a passenger suspects that they have a respiratory illness but are not able to alter their travel plans.
6. Issue traveler health notices to keep passengers up to date on information regarding infectious diseases of concern and provide them with recommendations.
7. Implement the campaign at all times of the year, but heighten the campaign during flu season and during outbreaks.

8. Recommend a "Healthy Traveler Kit" as part of this campaign. The kit would consist of any or all of the following: masks, gloves, alcohol hand wipes, hand sanitizer. Passengers would also be made aware of their responsibilities if they are traveling with young children, such as to monitor their health as they travel and ensure that they have proper vaccinations. As part of this campaign, it should also be encouraged that the passenger should provide the airline with accurate contact information for their own safety, in case there is the unlikely need for contact tracing.
9. Provide information in multiple languages.

"Healthy Traveler" campaigns promote public health recommendations for protecting yourself and others from infectious agents. One example of an effective campaign is the "Got a cough? Cover it" health education campaign sponsored by the Infectious Disease Bureau of the Boston Public Health Commission. The campaign is based on the well-known "Got Milk?" advertisements and can be deployed around the airport to raise awareness of simple measures to protect individual and public health.

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	○	✓	✓	✓	○
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	✓	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	✓	✓		

Airport Operators and Airlines Should Consider Implementing a "Healthy Worker" Campaign

Highly Recommended

Rationale. A universal "Healthy Worker" campaign is a valuable means to encourage healthy behaviors of airport and airline workers. Many airport and airline workers come into contact with hundreds or thousands of passengers every day, and some also handle passengers' food and beverage. Therefore, it is important for these employees to remain in good health. All airport and airline workers working in all parts of the airport environment would be targeted.

Points to Consider for Implementation

1. Develop Human Resource policy to ensure workers are not penalized for being out sick if a similar policy does not already exist.
2. Reinforce that sick airport/airline employees should remain at home until they are completely recovered (e.g., for flu, fever free for at least 24 hours).
3. Provide vaccinations under the scope of wellness benefits of medical plans (e.g., influenza and all routine vaccinations, to include on-site influenza vaccination clinics).
4. Communicate through multiple modalities in easy to understand documents and signage that include recommendations, such as the importance of hand washing.
5. During an outbreak, provide information (e.g., employer specific FAQs) based on guidance provided by the CDC and other reputable sources that will allow airport/airline workers to recognize symptoms and seek out appropriate treatment.

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	○	○
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	✓	○		

Airport Operators Should Consider Implementing a Seasonal Influenza Vaccination Campaign and Make the Vaccination Available to All Populations in the Airport Environment

Highly Recommended

Rationale. The implementation of an influenza vaccination campaign in airports would allow passengers and airport and airline employees easy access to the vaccination during the flu season and provide an important public health benefit to the traveling community, airport, and airline employees and the non-traveling population. While similar campaigns could be implemented in other congregate settings, such as hospitals and schools, the airport serves as a single point of contact for millions of passengers every year during the flu season. High-priority groups (pregnant women, children, young adults) can be specifically targeted in the event of a pandemic.

Points to Consider for Implementation

1. Establish vaccination stations throughout the airport, including each terminal because targeting passengers during downtime prior to boarding may increase the response rate.

2. Distribute information to passengers at ticketing areas and airport entryways to promote the campaign.
3. Develop an airport-wide public relations campaign (e.g., signage, digital signage, video) to make passengers aware of the campaign.

Airport Operators and Airlines Should Consider Participating in Pandemic Planning

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	✓	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	✓	✓		

Highly Recommended

Rationale. The establishment of a pandemic plan would provide information for all members of the airport community about their roles and responsibilities in the event of a pandemic. Having a plan already in place during an outbreak greatly increases the control the airport/airline community has over the transmission of the disease. The International Health Regulations (IHR) issued in 2005 focus on serious public health threats with the potential to spread beyond a country's borders. Such events are defined as a Public Health Emergency of International Concern (PHEIC). IHR outline assessment, management, and information sharing for PHEICs. They aim to prevent, protect against, control and provide a public health response to the international spread of disease and provide guidelines and recommendations for the prevention of disease transmission through air travel that is meant to be used in the development of this type of plan. The development of a pandemic plan provides an important opportunity for all stakeholders to meet and understand their various roles in event of a pandemic. The group of stakeholders may also play a role in other recommendations in this document, including the development of "Healthy Traveler" and "Healthy Worker" campaigns. Airport operators and airlines should be aware of federal government initiatives such as Risk Based Border Strategies (RBBS). RBBS is a strategy that involves screening international passengers during initial phases of a pandemic. The pandemic plan should include provisions for guidance and/or direction from federal agencies during a pandemic.

Points to Consider for Implementation

1. Assign one position or group within airport operations as being responsible for maintaining the pandemic plan.
2. For those with existing pandemic plans, review the plan annually to ensure the document remains current, including contact information of the stakeholders.
3. When developing or reviewing plans, ensure all stakeholders participate in the development of the pandemic plan for the airport environment (e.g., local boards of health, local hospitals, fire and police).
4. Hold training courses to inform all airport and airline employees about their duties and responsibilities within the plan.
5. In addition to annual meetings to review pandemic plans, broaden the scope of these meetings to discuss other issues related to employee and traveler health, such as access to vaccinations and "Healthy Worker" and "Healthy Traveler" campaigns.
6. When reviewing pandemic plans, consider workloads that a pandemic can create in the initial phase of disease mitigation efforts.

7. Incorporate the pandemic plan into the overall Airport Emergency Response Plan as a way to ensure the document is considered annually and available to the necessary constituents.
8. Review CDC information for the latest information on pandemic plans, risk assessments, and governmental involvement.
9. Consider how to exercise the pandemic plan to ensure that all stakeholders are important contributors to the exercise.

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	✓	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	✓	✓		

Airport and Airline Operators Should Consider Implementing a Hand Hygiene/Cough/Sneeze Etiquette Campaign as a Method to Reduce the Transmission of Respiratory Infections and Infections Transmitted Via Direct Contact

Highly Recommended

Rationale. Most controlled studies show a protective effect of hand washing at reducing upper respiratory infections. The U.S. Centers for Disease Control and Prevention (CDC) state that "hand hygiene is one of the most important steps we can take to avoid getting sick and spreading germs to others."

Points to Consider for Implementation

1. Encourage passengers, airport and airline employees, passengers, and guests to wash hands frequently and effectively and to use proper cough/sneeze etiquette to minimize transmission and prevent exposure to respiratory organisms and organisms transmitted via the fecal/oral route through a unified campaign of highly visible signage in the rest rooms, public address announcements, and other means.
2. Develop guidance for airport staff and airline crew for social distancing of obviously ill and potentially infectious passengers (e.g., locate the passenger away from other passengers if possible).

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	✓	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	✓	✓		

Airport Operators and Airlines Should Consider Establishing and Maintaining Contact with Their Local Department of Health (DPH) and CDC Representatives

Recommended

Rationale. Local CDC and DPH offer great support in handling infectious disease prevention and response in airports, whether it is on a day-to-day basis, during the seasonal flu period, or during a pandemic. With a strong relationship between airports/airlines and these agencies in place, information pertaining to infectious diseases would be easily shared. Both organizations could also be valuable resources in the event of a pandemic. Communication between airports/airlines and the agencies is essential to controlling the spread of disease if such an event was to occur, and this communication would be greatly facilitated if airports/airlines have already been maintaining good relations with these agencies. A number of other recommended mitigation measures can be easily implemented once relationships with contacts at both organizations have been developed, such as the development and review of a pandemic plan. Partnerships with these organizations may also aid in the implementation of the "Healthy Worker" and "Healthy Traveler" campaigns, as these organizations could provide professional marketing counsel to get the campaigns' messages across in the most effective manner.

Points to Consider for Implementation

1. Assign one position or group within airport operations and airlines as the responsible party for maintaining contact with local DPH and CDC representatives.
2. Monitor CDC website for guidance and suggestions for best practices.
3. Ensure that processes are in place for the release of information pursuant to a proper public health agency request

Airport Operators and Airlines Should Consider Creating a Committee on Infectious Diseases That Includes All Agencies That Are Active Within the Airport Environment

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	✓	✓	✓
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
	✓	✓	✓	✓	✓
Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
	✓	✓	✓		

Recommended

Rationale. The creation of an airport agencies committee would have implications for all passengers, guests, and employees. This group would be the information resource and advisor for any and all actions pertaining to infectious disease control. This committee would allow for all of the different parts of the airport community to easily transfer information to one another and facilitate the identification of airport-wide concerns regarding disease transmission. The goal of the committee is to ensure that programs and plans like "Healthy Worker" plans are implemented successfully. Representatives from each agency that were involved in the development of the plans would be able to effectively communicate them to other members of their respective teams. The committee on infectious disease could be established as a subcommittee of a larger committee (e.g., airport Health and Safety).

Points to Consider for Implementation

1. Ensure committee membership represents all groups within the airport community in order to reduce the risk of unforeseen problems that could arise if only one or few groups were involved.
2. Ensure a broad scope for the committee by not targeting a specific disease or transmission pathway. Instead, focus on public health campaigns.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation