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Planning and Response to Communicable Disease on US Domestic Air Flights

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Abstract

Globalization along with the ongoing spread of novel infectious diseases including influenza, coronavirus, and Ebola has spurred growing interest and significant research on the impact of commercial air travel as a factor contributing to the spread of disease from one geographic location to another. Despite this, there has been little to no research on the appropriate response to this public health challenge and the coordination of response capabilities across key responders. We conducted a tabletop exercise to explore a scenario that simulated a U.S. domestic commercial flight transporting a passenger infected with probable MERS-CoV. Participants included a broad range of stakeholders in a medium-sized Mid-western U.S. city. The tabletop exercise revealed gaps in public health preparedness among response partners that require improved collaboration among public health, airport operations and airline personnel, and fire and emergency management services.

Keywords: Communicable disease; Domestic air flights; Ebola; Influenza

Introduction

In an era of rapid globalization, the spread of communicable diseases from one geographic location to another via commercial airplanes has become a growing topic of public health concern and an area of considerable research [1-4]. This research has had two broad areas of focus. The first area of focus considers the extent to which commercial airlines contribute to the spread of disease from one geographic location to another. This research focuses on passengers who spread communicable disease in the community of their final destination after they land rather than while in flight. For example, the 2003 SARS outbreak demonstrated how commercial airliners could accelerate the geographic spread of the disease [5]. In 2009, research found a strong association between air travel from Mexico and the global spread of H1N1 [6]. This line of research has also considered the role of commercial air travel in the reemergence of vaccine-preventable diseases such as measles to the United States [7,8]. A growing body of this research is now focused on using simulations and computer modeling to better understand how commercial air travel may impact the spread of communicable disease across geographic regions [9-11]. The second area of focus considers the probability that communicable diseases can and will spread among airline passengers while in flight [12-14]. Research has found it is possible for communicable diseases such as influenza to be transmitted and spread from person-to-person on aircraft [15-18]. Even so research has suggested that transmission of communicable diseases on commercial airplanes is uncommon and unlikely [19,20]. Part of the challenge in fully understanding the risk are the number of variables involved that complicate risk calculations including the movement behaviors of passengers, crew and the index patient [21], the characteristics of the exhalation of the droplets carrying the infectious agent [22] and variations in cabin airflow patterns [23]. The Ebola outbreak in 2014 once again stimulated discussion about the potential risks of passengers becoming infected with a communicable disease on commercial airplanes in particular during domestic air flights [24]. Despite this, there has been little to no research on the appropriate public health planning algorithm or response model to address communicable diseases on commercial airplanes. To improve our understanding of these types of scenarios including collaborative relationships and preplanning essential for a successful response protective of public health, we conducted a tabletop exercise with a broad range of stakeholders in a medium-sized Midwestern city of the US that simulated a domestic commercial flight traveling with a passenger with probable MERS-CoV infection to a destination airport.

Method and Material

Tabletop exercise structure and format

We used a tabletop exercise format familiar to first responder agencies and described in greater detail elsewhere [25,26]. The exercise had 3 steps, was entirely discussion-based and lasted for approximately 3.5 hours. The first step of the scenario involved a full domestic flight from a major national air carrier that was inbound with 2 hours left in the direct flight. Participants were informed that there was a probable case of MERS-CoV on the flight reported by the CDC to airport authorities. This step included discussions on initial notification, information exchange between agencies and incident command activation by airport officials. The second step of the scenario took place immediately after the flight landed and involved initial assessment and strategic response development with a focus on both

epidemiologic and medical management considerations. The final step of the exercise involved a debriefing where participants were asked to engage in preliminary action planning based on what they learned during the exercise discussions as well as providing practical and realistic recommendations on next steps to improving local emergency operations plans. Participants sat at a u-shaped table to facilitate discussion. They were given a brief semi-structured survey to complete immediately prior to the exercise and another survey to complete immediately after the exercise concluded. The exercise was conducted at a conference center located directly adjacent to the airport in late spring 2014.

Quantitative analysis

The pre- and post-test survey data was analyzed using Stata Statistical Software: Release 13 [27]. Unpaired two-tailed student's t-tests with unequal variances were used to assess group differences between public health workers and all other participants. Paired two-tailed t-tests were conducted for change in scale scores for questions that were asked at both the pre-test and post-test. ANOVA was used to test overall group differences among the groups of participants (public health, fire and EMS, and all others).

Qualitative analysis

Two dedicated note-takers documented the entire exercise using Microsoft Word on MacBook computers. In addition, participants were asked to write responses to three open-ended qualitative questions after the exercise: what was the most valuable part of the exercise; what was the least valuable part of the exercise; and what was the most important thing you learned during the exercise. Participant responses were typed into Microsoft Word and converted into a PDF file. The raw notes from the exercise were also converted into a PDF file. Both PDF files were then imported into Atlas.ti v7.0 mobile for iPad [28] for inductive thematic analysis [29]. Qualitative data analysis involved coding, pattern identification and theme development.

Results

Participant characteristics

Thirty individuals representing 9 different agencies and organizations participated in the exercise, including: airport administration and operations; airline personnel; local public health authorities; emergency management; law enforcement; fire/EMS; a regional healthcare coalition; and, federal agencies including the Transportation and Security Administration (TSA), Customs and Border Protection, Centers for Disease Control and Prevention, Department of Homeland Security and Federal Bureau of Investigation (Table 1).

The majority of the participants were male (70%) and serving in a leadership role in their respective organizations (57%). Roughly half of the participants served in their current role for less than 5 years (47%).

Characteristic	Category	n	%
Gender	Female	9	30
	Male	21	70
Agency or organization*	Airport operations	5	17
	Airline and flight support	4	13
	Fire and EMS	8	27
	Local Health Department	5	17
	TSA, FAA, CBP	4	13
	Other	4	13
Current job title	Director or coordinator	10	33
	Supervisor or manager	9	30
	Officer or specialist	11	37
Number years on current job	0-5	14	47
	5-10	7	23
	10 or more	9	30
Number exercises past 5 years**	0-3	11	37
	4-6	10	30
	7 or more	8	36

Table 1: Descriptive Characteristics of Participant (n = 30). *TSA = Transportation Security Administration, FAA = Federal Aviation Authority, CBP = Customs and Border Patrol, **Percent doesn't equal 100 because of 2 missing values.

The majority of the participants reported participating in 4 or more exercises in the last 5 years (66%).

Quantitative analysis

Table 2 summarizes participant responses to Likert scale questions on the pre and post surveys. Prior to the exercise, the vast majority of participants (77%) reported that they were looking forward to the exercise. We assessed this because we wanted to gauge the buy-in of the participants and their willingness to fully engage in the exercise. Approximately 40% of the participants reported not working closely with public health in the past. Prior to the exercise, nearly a quarter of the participants (24%) reported that their agency was not fully prepared to respond to a communicable disease on a commercial airliner. This result was consistent across agencies and organizations represented in the exercise ($F = 1.21$; $p = 0.314$). Participants felt more strongly after the exercise than before the exercise that the spread of communicable diseases on commercial flights was a significant threat ($\mu = 4.2/5.0$ before; $\mu = 4.4/5.0$ after; $p = 0.012$). After the exercise this sentiment was most strong among participants from public health ($\mu = 5.0/5.0$ to $4.3/5.0$; $p < 0.001$). This finding suggests that from their vantage point, participants believed that the spread of communicable diseases on airplanes represents a real threat that they might have to face in the future. This is understandable because airline crew members travel in airplanes every day and their risk is higher than occasional travelers. In addition, participants of the exercise had all recently responded to a real situation involving a passenger with a suspected concerning communicable disease on a plane in their local area. The exercise coupled with their recent experience likely had an impact on their response to this question. Participants left the exercise feeling that their agency was more prepared to respond to a communicable disease on a flight than they did prior to the exercise ($\mu = 3.2/5.0$ before; $\mu = 3.6/5.0$ after; $p = 0.004$). Compared to participants from all other groups, participants from public health felt the strongest about their agency's ability to respond to a communicable disease on a commercial airplane after the exercise ($\mu = 4.0/5.0$ to $3.6/5.0$; $p = 0.038$).

Before Exercise	**Likert Scale (%)***					
Description	**1**	**2**	**3**	**4**	**5**	**Mean**
Spread of communicable disease on commercial airlines is a significant threat	0	3	13	37	47	4.2
Agency is fully prepared to respond to threat	7	17	30	47	0	3.2
Individual is fully prepared to respond to threat	13	7	37	30	13	3.2
Understand roles and responsibilities of partner agencies	10	10	33	30	17	3.3
Have regularly collaborated with local health department in the past	23	17	20	13	27	3.0
Looking forward to the exercise	0	3	10	17	60	4.4
After Exercise	**Likert Scale (%)***					
Description	**1**	**2**	**3**	**4**	**5**	**Mean**
Spread of communicable disease on commercial airlines is a significant threat	0	0	17	30	57	4.4
Agency is fully prepared to respond to threat	3	10	17	60	10	3.6
Exercise productive use of time	0	3	10	37	47	4.3
Will use information learned from exercise	0	3	10	30	57	4.4
Will discuss information learned with co-workers	0	3	7	30	60	4.4
Additional exercises would be useful	0	3	7	37	53	4.4

Table 2: Participant self-assessment before and after exercise (n = 30). *1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree.

Qualitative analysis

Table 3 summarizes the three general themes emerged in the qualitative analysis of the notes from the tabletop exercise: communications, management and coordination. Communications are critical during emergencies that involve air travel because of the compressed timeframe for response and challenges of getting directly in touch with pilots and other personnel in the air. Exercise participants struggled to articulate an overall communication strategy for communicating with the pilots, cabin crew and passengers. They debated issues such as: which agency or organization would take the lead in communicating with the crew of the aircraft? What should the crew be told to do (e.g., should the sick passenger be given an N95 mask, should the sick passenger be moved to a different part of the plane)? What should be told (if anything) to the passengers on the plane both while the flight was in the air and after the flight had landed? The exercise demonstrated that these and other questions would be challenging for airport authorities to quickly address during a time sensitive incident without prior planning and consultation with public health entities.

Response theme	Examples of key challenges
Communications	No overall communications strategy
	Confusion regarding agency or individual in charge of communications
	Lack of clarity regarding appropriate messaging for the pilots, cabin crew and passengers while the plane was in the air
Management	Incorrect assumptions about various aspects of public health response
	Lack of understanding and clarity regarding key legal authorities, ordinances, statutes, charters critical for appropriate response
	Incorrect assumptions regarding speed of public health response and public health activities
Coordination	Poor coordination of information collection across response agencies and organizations
	Disagreements about which agency or organization should be the "lead" for key aspects of response
	Lack of clarity regarding how local, state and federal responses would be coordinated

Table 3: Summary of qualitative analyses of participant response.

Response management involves addressing the different management and leadership styles of the response agencies involved. All participants acknowledged familiarity with the Incident Command System (ICS) model but some agencies currently use this model more regularly and more formally than others. Deciding the composition of the ICS team and establishing an Emergency Operations Center (EOC) was discussed among participants. What role would representatives from each agency and organization represented on the ICS team take? Exercise participants debated a series of topics related to the management of the situation including: whether or not to divert the plane to a different airport, relocating the parking position of the plane if the plane did land at the airport, providing transportation to a medical facility for the sick passenger, and how to appropriately disinfect and clean the plane.

Participants that did not work for local public health made several important assumptions regarding the speed of initial notification and subsequent length of the first operational response period that were not consistent with existing public health response models. Specifically these participants did not have realistic expectations regarding the timeframe needed by public authorities to: activate various personnel and systems after normal working hours; assess the public health threat; develop initial public risk messaging; collect necessary passenger and crew demographic data; develop a valid epidemiologic questionnaire and assessment tool; and, coordinate triage of symptomatic individuals for additional diagnostics, testing and treatments. For example, these participants did not fully appreciate the amount of time and the legal authorities that would be required to obtain and share passenger manifests across all response partners. In addition, airline personnel and airport operations personnel were not familiar with public health communicable disease reporting and follow-up activities including: the legal authority (ordinances, statutes, charters) that would enable public health agencies to shut-down airport operations, order decontamination of premises and property and require isolation and quarantine of symptomatic and exposed asymptomatic passengers, crew, first responders as well as other members of the public.

Another critical component of any response that involves multiple agencies and organizations is coordination. Coordination includes sharing information, conducting collaborative models for assessment of situational awareness, delegating responsibilities at appropriate times and limiting the duplication of effort. The exercise highlighted a number of coordination challenges across agencies and organizations potentially involved in the response to an infectious disease on domestic commercial aircraft. One example of these coordination challenges occurred during the discussion of how information would be collected from passengers after the plane landed. Participants debated what information needed to be collected at that time and who should collect this information. Fire and EMS initially reported that they would collect the information and that public health workers would not be required to come to the scene. Public health workers felt that they would best be suited to collect the necessary epidemiologic information from passengers in person. Coordination of local, state and regional emergency operations planning was a common assumption by many participants during the exercise discussion. However, the activation of both ICS and an EOC as a result of a communicable disease incident at the airport was somewhat ambiguous as to how federal, state and local public health authorities would be effectively integrated both in terms of timeline and within strategic decision-making (i.e. "home rule" and "playing in the sandbox together"). Participants were left to wonder: how does this really work and would it work?

Table 4 summarizes the qualitative feedback that participants provided about the exercise after it was complete. Participants consistently reported that they felt the most valuable part of the exercise was the opportunity to build relationships with response partners and hear their viewpoints. This is consistent with other research on tabletop exercises [30]. Participants noted the least valuable aspects of the exercise were the repetition of discussion on some topics, the "defensiveness" of some agencies and organizations in their response and the discussion occasionally going "off topic". Participants reported learning a number of key things during the exercise including: the number of agencies or entities involved in the response and their jurisdictional control, the fact that not all respondents were "clear on incident procedures", the need for "greater information sharing", the exact role of public health during the response, and "ownership" of the plane by various response agencies and organizations at different times during the emergency.

Question	Summary of key responses	n
What was the most valuable part of exercise?	Understanding the notification process and preparedness activities	4
	Interagency discussion; “hearing others viewpoints”	15
	Learning about agents like MERS-CoV how they are handled	1
	Meeting stakeholders; putting face(s) to organization(s)	9
What was the least valuable part of exercise	Repetitive nature of some issues; explaining of same information; rehashing “established protocols”	3
	Defensiveness of some participants and their respective agencies and organizations	2
	Discussion going “off topic” or failing to focus on the task portrayed	4
What was the most important thing you learned during the exercise?	Number of agencies or entities involved in response, different jurisdictional control, detail of various players roles	10
	Not all response partners agree on incident procedures; ease of miscommunication; lack of knowledge; need for more sharing information	3
	Health department might not be on the scene; public health's authority; public health issues; health department has counter measures; information that public health would want from passengers	5
	Plans airport has in place already; plane to tower command communication; airport has EOC; which agency or organization has "ownership" of plane at various times;	6
	Knowledge that the Fire department has a D-CON unit	1

Table 4: Participant assessment of exercise.

Discussion

The tabletop exercise revealed that response partners across sectors disagreed on basic operational plans to secure the airplane, passengers, staff, and broader community (e.g., a location to park the airplane). Participants also had disagreements with regard to strategic planning (e.g., quarantining passengers and crew). The exercise revealed that there was not a clear understanding of preemptive policy or a practice of chain or network of command.

A core competency of local public health agencies is the prevention and control of communicable disease within their jurisdiction of authority. This includes conducting surveillance and providing epidemiologic follow-up to reportable and novel reports of probable and confirmed infectious disease in the community. However, little attention has been given to the actual coordination of response to communicable diseases that are introduced and transmitted as a result of commercial airline travel in the US, especially related to domestic travel patterns. International and domestic flights increase opportunities for exposure to agents of disease across wide geography in relatively short periods of time. The varied geography and diversity of connecting flights increases the importance of establishing integrated and coordinated systems, as well as policies and practices that support those systems, to prevent and intervene in communicable disease outbreaks. Moreover, the systems that require integration and coordination span various sectors and require public-private partnership to expediently address public health issues and ensure safety and security of air travel within the continental U.S.

Research on scenarios related to communicable disease introduction and transmission via U.S. commercial domestic air flights is currently limited even though surveillance and reporting of novel and re-emerging infectious disease of overseas origin has increased over the past 10 years. The CDC has not published nor released guidance for local and state public health agencies on planning and response to communicable diseases on U.S. commercial domestic flights. There is an array of local, state and federal stakeholders that need to be involved in the planning and response to a commercial domestic air flight carrying a passenger with a probable novel infectious disease of public health importance. An effective and efficient response will require vertical and horizontal integration of types of responder (and the organizations that employ them), information systems, and the public and private sectors.

As the primary federal U.S. public health agency, the CDC, as a result of pandemic influenza planning and novel disease transmission such as the 2003 global SARS outbreak has focused on guidance related to international airline travel but has not issuing guidance related to connecting U.S. domestic flights. However, recent CDC data linking increases in nation-wide imported measles cases suggest that airline travel, whether international or domestic is increasingly important in introduction of communicable disease across destinations [22]. In addition, concerns over the 2014 Ebola outbreak in West Africa highlight why it is important to have clear policies on this issue for domestic as well as international flights.

Conclusion

The findings of this exercise suggest that local public health departments and other response partners may currently be inadequately prepared to address the introduction of passenger-related communicable diseases on commercial domestic air flights arriving at their local airports. Integrating airport communicable disease planning algorithms and models into existing local emergency operations plans being developed or in place by airports and public health agencies will strengthen overall response to such events in the future. However,

these plans also need to be integrated into ongoing training, practices, and policies.

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