US Screening of International Travelers for Radioactive Contamination After the Japanese Nuclear Plant Disaster in March 2011

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ABSTRACT

On March 11, 2011, a magnitude 9.0 earthquake and subsequent tsunami damaged nuclear reactors at the Fukushima Daiichi complex in Japan, resulting in radionuclide release. In response, US officials augmented existing radiological screening at its ports of entry (POEs) to detect and decontaminate travelers contaminated with radioactive materials. During March 12 to 16, radiation screening protocols detected 3 travelers from Japan with external radioactive material contamination at 2 air POEs. Beginning March 23, federal officials collaborated with state and local public health and radiation control authorities to enhance screening and decontamination protocols at POEs. Approximately 543 000 (99%) travelers arriving directly from Japan at 25 US airports were screened for radiation contamination from March 17 to April 30, and no traveler was detected with contamination sufficient to require a large-scale public health response. The response highlighted synergistic collaboration across government levels and leveraged screening methods already in place at POEs, leading to rapid protocol implementation. Policy development, planning, training, and exercising response protocols and the establishment of federal authority to compel decontamination of travelers are needed for future radiological responses. Comparison of resource-intensive screening costs with the public health yield should guide policy decisions, given the historically low frequency of contaminated travelers arriving during radiological disasters.

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Key Words: radiological disaster, traveler screening, preparedness, response, partnerships

On March 11, 2011, a magnitude 9.0 earthquake struck off the east coast of Honshu, the main island of Japan. The earthquake spawned a tsunami, causing significant loss of life and property damage. These natural disasters caused a series of events at the Fukushima Daiichi nuclear reactor complex, resulting in core meltdowns at multiple reactors and widespread environmental contamination from radionuclide release. By March 12 Japanese officials had established a 20-km evacuation zone around the reactor complex and begun evacuations of residents.[1] By March 16, media reports of contaminated airline passengers from Japan arriving in China[2] prompted international concerns about harmful levels of radioactive materials being carried by travelers leaving the country.

Gaps in international planning and response to large-scale radiation incidents have been documented.[3-5] Although the United States has robust response plans for domestic nuclear incidents,[6] policy and response plans to address contaminated international travelers had not been developed. Historically, high-profile nuclear incidents have precipitated global traveler health concerns. After the Chernobyl disaster, a 1986 British study of 45 air passengers from Eastern Europe used whole-body assessments and measurement of thyroid radioiodine and detected radiological contamination at 56 times the background level.[7] Some American travelers returning from the Chernobyl site found their clothes and luggage were also contaminated.[8]

The 2006 poisoning of a Russian ex-KGB officer in London led to detectable levels of radioactive polonium-210 in several locations visited by the victim and the suspected perpetrator.[9] The British Health Protection Agency (HPA) notified US public health officials of 200 US residents who were at risk of contamination with polonium. State health departments contacted these travelers and advised them to contact a physician (Centers for Disease Control and Prevention [CDC] internal e-mail communication, 2011). In addition, British Airways (BA) identified and published a list of 221 flights involving potentially polonium-contaminated aircraft. BA advised nearly 33 000 travelers to contact HPA.[10]

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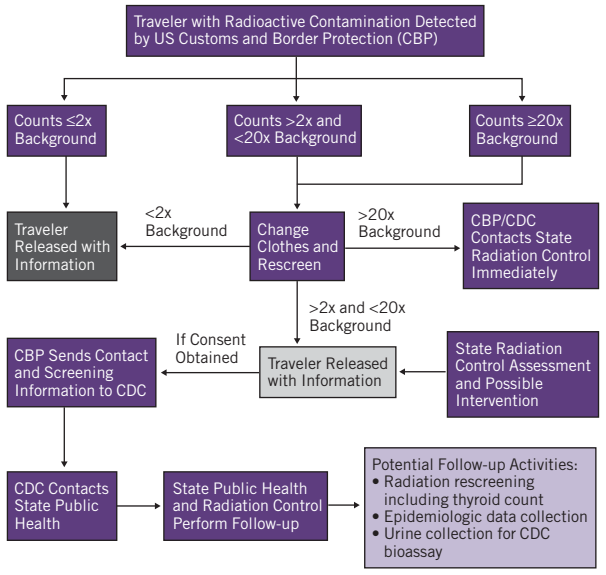
FIGURE 1

Centers for Disease Control and Prevention (CDC) Radiological Screening Program Algorithm for Travelers Returning to the United States From Japan After the Fukushima Daiichi Incident.



In response to the public health threat posed by potentially contaminated travelers entering the United States from Japan—where more than 450 000 travelers to the United States originate each month,[11] the CDC mobilized an immediate response to assess and mitigate the level of risk. This response involved several federal and state agencies with jurisdiction or proficiency for radiological screening and decontamination of travelers.

At the federal level, the Department of Homeland Security (DHS), US Customs and Border Protection (CBP), protects America's borders and is responsible for, among other things, the processing and inspection of travelers and merchandise arriving at US ports of entry (POEs). Within CDC, an agency of the Department of Health and Human Services (DHHS), the Division of Global Migration and Quarantine has statutory authority to prevent the importation of communicable disease into the United States and maintains staff at 20 POEs.[12] CDC's Division of Environmental Hazards and Health Effects provides subject-matter expertise on radiation effects and health monitoring. Each US state has a radiation control program, represented by the Conference of Radiation Control Program Directors. State and local health departments are represented by the Association of State and Territorial Health Officials and the National Association of County and City Health Officials, respectively. The National Alliance for Radiation Readiness, which was formed in 2009, and among which the Council of State and Territorial Epidemiologists and the Association of Public Health Laboratories are founding members, brings together expertise in public health, radiation protection, epidemiology, and laboratory analysis to address radiological public health issues.

We describe the US public health response to address risks to travelers from Japan who were potentially contaminated with radioactive material, highlight important challenges identified during this response, and make recommendations for responding to future events requiring the screening of travelers for contamination with radioactive materials.

METHODS

On March 11, the CDC Emergency Operations Center was activated to support the US government (USG) Japan earthquake and nuclear disaster response. CBP routinely employs a variety of radiation-detection technology at POEs to detect the presence of radioactive materials or contamination. CBP officers are equipped with personal radiation detectors that alert the wearer of elevated radiation levels. CBP standard operating procedures for radiation detection employ a layered approach that requires that all detections of radiation are adjudicated. To identify the source of an alarm, CBP officers use radiation isotope-identification devices to identify the level and type of radiation. CBP had already extended its normal radiation detection protocol to provide additional radioactive material screening during off-loading of cargo from aircraft and ships arriving from Japan. The CDC and CBP determined that this protocol should be extended further to address another risk: traveler contamination from an international radiological accident.

Through the World Health Organization (WHO), CDC attempted to contact the government of Japan regarding plans for radiological contamination screening of travelers exiting the country. Japan's focus, understandably, was on evacuating the accident site and caring for its residents. CDC and its domestic partners thus sought to determine risk and, ultimately, create protocols for screening, detecting, and decontaminating travelers contaminated with radioactive materials arriving to the United States.

CDC officials reviewed existing air traveler screening protocols (prepared for pandemic influenza) to determine how they could be modified for this response, and developed recommendations for follow-up of travelers identified by CBP as being contaminated. CDC collaborated with the aforementioned partners and the American Association of Poison Control Centers to rapidly develop draft recommendations and assessment tools, and to obtain feedback and agreement from key stakeholders in each partner organization prior to implementation.

Radiological Screening at POEs

Screening and decontamination protocols were developed for this response (Figure 1). Recommendations for external contamination intervention levels according to the National Council on Radiation Protection and Measurements Report 161 were followed.[13] Any traveler found to be contaminated at levels greater than 2 times but less than 20 times background radiation ("intervention advisable") would be offered the opportunity to decontaminate by changing into clean clothing, wash-

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ing face and hands in selected airport bathrooms (at no risk to the public), and being rescreened. This protocol would be followed by a more complete decontamination (ie, showering) on arrival to their final destination. In addition, the traveler would receive voluntary follow-up with state radiation control and state health department at the final destination. For travelers found to be contaminated at levels greater than 20 times background radiation ("intervention required"), state radiation control program personnel would be contacted immediately. Those persons would then assist with counseling, decontamination, and rescreening the traveler prior to continued travel.

To ensure adequate public health follow-up, CDC disseminated additional guidance and tools to state radiation control programs and state and local public health officials. These materials included an epidemiologic assessment form, recommendations for state radiation control program officers, and materials and instructions for collecting urine specimens for bioassay analysis at CDC. Per individual state public health protocols, either state radiation control program officers or state/local public health officials would use these tools to conduct more detailed follow-up.

The epidemiologic assessment form[14] was designed to collect detailed contact information, demographics, flight information, locations, and activities in Japan following the radiation incident and results from radiation assessments conducted in Japan (if known) and by state radiation control program staff in the United States. Sample consent language and detailed instructions were also provided. This form was designed to enhance critical public health functions during the event, such as characterizing the affected population, identifying critical risk factors for intervention, determining appropriate public health and medical interventions, and providing data for entry into long-term registries for follow-up.

Targeted recommendations for state radiation control program officers, also part of the developed package, are available at the following websites:

- http://www.bt.cdc.gov/radiation/pdf/Japan_Incident-CDCRecommendationsforPublicHealthFollow-UpofTravelers.pdf;
- http://www.bt.cdc.gov/radiation/pdf/Japan_Incident-EpidemiologyFormforPublicHealthFollow-UpofTravelers.pdf;
- http://www.bt.cdc.gov/radiation/pdf/Japan-CDCRevisedRecommendationtoRadiationControlHealthPhysicsStaff4_13_2011.pdf,

along with all related guidance for travelers from Japan at:

- http://www.bt.cdc.gov/radiation/publichealth.asp.

Subject-matter experts provided instructions on (1) ensuring the effectiveness of external decontamination; (2) completing the epidemiologic assessment form; (3) performing a thyroid scan using a gamma radiation detector; and (4) evaluating the need for urine bioassay analysis, and, if warranted, collecting a urine sample for dose estimation after laboratory analysis.

RESULTS

During March 12 to 16, before the comprehensive radiological contamination screening plan was implemented at air POEs, CBP identified three travelers arriving from Japan as externally contaminated with radioactive material. All three travelers had very low levels of contamination, and were not considered to be a danger to themselves or others. On March 23, after review by state partners, CDC and CBP implemented entry screening at US aviation POE for travelers contaminated with radioactive materials at the US air POEs, with enhanced screening at the mainland airports receiving direct flights from Japan (Figures 2 and 3). This plan included thresholds for implementation of varying tiers of radiation screening and decontamination; traveler radiation screening protocols; plans for primary and secondary radiation screening and decontamination, if required; a POE-specific risk analysis based on traveler volume; assignment of agency responsibilities; and data collection and reporting procedures. From March 23 to April 30, 2011, CBP used this protocol to screen approximately 543 000 travelers for radioactive contamination who were arriving directly from Japan at 25 US airports (CBP written data). During this period, CBP identified no travelers with contamination levels that warranted a public health response.

DISCUSSION

Large-scale radiological and nuclear disasters are inherently international incidents that provoke international investigation and response.[4,5,15] Within the United States, under the National Response Framework (NRF), DHS CBP has lead responsibility for interdicting the inadvertent importation of radioactive materials as well as other incidents in which radiological material is detected at US borders. Other US departments and agencies may respond as well, for example, under NRF Emergency Support Function 8 (Public Health and Medical Services), DHHS is charged to respond to national public health threats. DHHS and CDC have coordinated (together with other federal agencies and state and local public health departments) responses for incidents affecting arriving travelers, such as severe acute respiratory syndrome (SARS), pandemic influenza A (H1N1)pdm 09, and cholera in Haiti. However, the described response marks the first time DHS CBP and DHHS CDC mounted a major response to an international radiological public health threat.

In the past, response to international radiological incidents has been hampered by a lack of international cooperation, suboptimal coordination among national and international agencies, delayed information delivery to mobile populations, and asynchronous public messaging.[4-6] Although for this response, collaboration and coordination among USG and state agencies were exemplary, those gaps remain threats to US domestic response efforts as well. Federal, state, and local entities responsible for these responses must be ready to communicate rapidly and clearly and to coordinate responses using all available assets and authorities.

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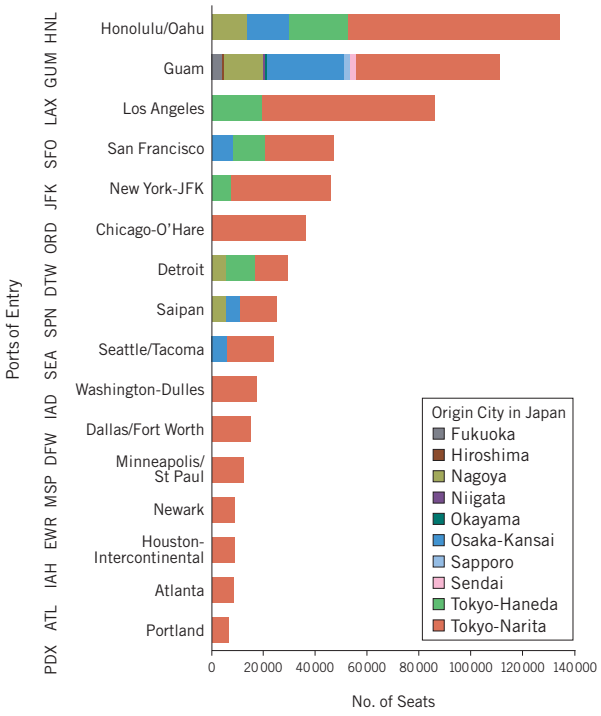
FIGURE 2

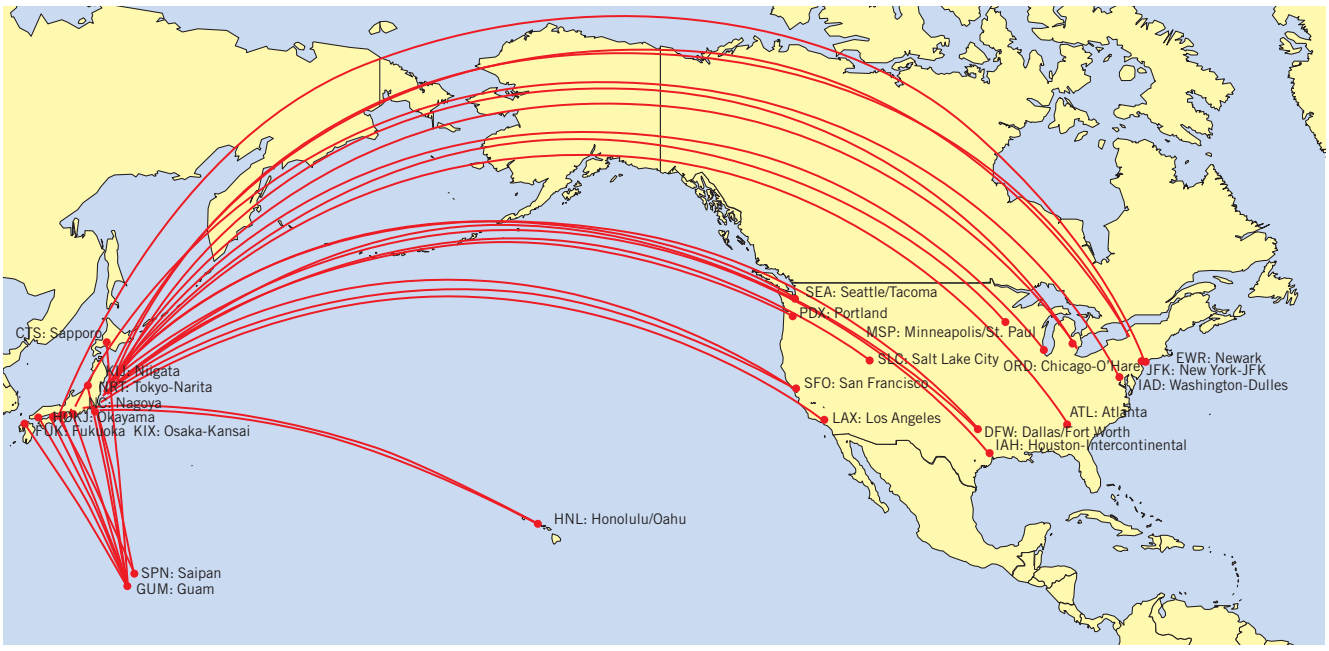
Available Seats on Scheduled Commercial Direct Flights From Japan to the United States in March 2011.



Based on DIIO's Global Flights Scheduled Data: http://www.diio.net. Abbreviations indicate airport codes for given cities.

FIGURE 3

Scheduled Commercial Direct Flight Routes From Japan to the United States in March 2011.



Based on DIIO's Global Flights Scheduled Data: http://www.diio.net. Abbreviations indicate airport codes for given cities.

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CBP detected only three travelers contaminated at levels that warranted public health follow-up, and none was contaminated at dangerously high levels. All three were detected in the first few days after the initial event. Thus, despite the serious nature of the incident, the outcome suggests that contamination of international travelers arriving in the United States was low. Radioactive contamination of travelers following a radiological or nuclear incident likely depends on multiple factors, including varying exposure amounts, travel restrictions imposed, plume dispersion across populated areas, and travel involving direct flights departing from contaminated areas. Risk is likely greatest in the immediate aftermath of the event. Decisions to implement resource-intensive population monitoring, radiological contamination screening, and decontamination plans should consider these and other factors to ensure a rational response based on the risk to public health. However, a radiological terrorism event, designed to produce maximum human radiation exposure and contamination, would present a far greater risk, as well as additional challenges for response. Continued planning, training, and exercising for screening and decontamination of travelers exposed to a radiologic event should take into account the variable risks of different exposure scenarios.

Several challenges were identified early in this response. First, no specific plans existed to respond to travelers contaminated with radioactive materials. Even though CDC and its partners developed plans to help mitigate risk to travelers, legal authority was lacking to detain contaminated travelers and compel them to undergo decontamination for public health purposes. The authority to detain travelers who may pose a health risk to others pertains only to communicable diseases.[16] Moreover, International Health Regulations (IHR, 2005) state that countries should take steps to prevent translocation of diseases across international borders, but the regulations do not contain provisions that require state parties to perform exit screening, and radiological contamination may not meet the IHR (2005) definition of disease threat. A lack of familiarity and experience among state radiation control officers in conducting radiological screening at US air POEs was another identified challenge. Furthermore, airports are logistically poor locations for radiation screening and decontamination. Finally, estimating the risk posed to travelers and the public from contamination of radioactive materials is difficult and imprecise.[17]

The radiological contamination screening process developed for this response would likely be inadequate for a full-scale radiological emergency that required personnel- and resource-intensive radiation screening of large numbers of highly contaminated travelers at all US air POEs. It relies on CBP protocols designed to identify and resolve security threats, not threats to public health. Also, training of air POE-response personnel (ie, CDC, CBP, emergency medical services, police, fire fighters) is not designed to support large-scale radiological disaster response. Of greatest concern, in spite of the lessons of the terrorist attacks of 9/11 and the intentional anthrax release in 2001, public health staffing at the state level has been reduced during the current economic crisis,[18,19] further eroding state preparedness and response infrastructure.

The Fukushima Daiichi incident was a serious threat to Japan's public health; hundreds of thousands of residents were evacuated from the 20-km exclusion zone.[1] Travelers arriving from Japan typically comprise 7.1% of the daily arrivals to the United States; during the crisis, that percentage dropped to 6.3%,[11] and international travelers departing Japan received no exit screening for radiological contamination.[20,21] Whereas the most efficient method of radiation screening of travelers would be exit screening at points of departure from an affected country, the willingness and ability of the affected country to devote resources to exit screening while responding to a large-scale disaster, the government's legal authority, and the logistical feasibility of screening to ensure detection of radiological contamination all pose significant challenges. Nonetheless, the IHR (2005) states that the WHO can make recommendations, with respect to response measures, to state parties during international public health events, but it is each state party's responsibility to determine the appropriate response measures and the timing of such measures. This topic should be addressed with the international community in future efforts to increase global preparedness.

CDC continues its efforts to integrate the disaster epidemiology-response principles and activities used during the Fukushima Daiichi response to create and support public health response for other radiological or nuclear emergencies. The use of standard epidemiologic assessment tools and urine bioassays to detect radiation exposure during radiological events is relatively new and may be unfamiliar to state public health officials. This incident provided an excellent opportunity to introduce state and local public health and radiation control programs to one another and to these public health tools. CDC will continue to collaborate with states, providing training and opportunities to test the utility of these tools during exercised responses for radiological incidents.

CONCLUSIONS

More than 15 000 travelers enter the United States each day from Japan.[11] However, in spite of the severity and widespread impact of this incident, large numbers of contaminated travelers did not arrive in the United States. The US planning and response effort afforded an excellent opportunity to test and expand protocol concepts previously used during pandemic influenza emergency preparedness drills and exercises. The response was built on relationships with state radiation control programs, while leveraging radiological contamination screening methods already in place at all 327 US POEs (land, sea, and air).

Future responses can be improved by ensuring that role clarity and pre-event contingency planning are coordinated and exercised among responders in and across all layers of government, including identification of planning gaps and an implementation plan to address them. Federal and state legal authorities to detain and evaluate travelers contaminated with radioactive materials for pub-

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lic health purposes (ie, harmful to self and others) must be identified or promulgated. Finally, consideration for the public health threat vs the cost of intensively screening travelers for radioactive contamination to protect the public should be carefully weighed before implementation for radiological or nuclear disasters.

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