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RESPONSE OF THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES IN PROTECTING CIVILIAN AMERICANS IN JAPAN DURING THE FUKUSHIMA NUCLEAR CRISIS

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Abstract

Following the earthquake and tsunami in northern Japan on 11 March 2011, and the ensuing damage to the Fukushima Daiichi nuclear power plant complex, a request by the U.S. Ambassador to Japan to the U.S. Department of Health and Human Services (DHHS) Assistant Secretary for Preparedness and Response (ASPR) resulted in deployment of a five-person team of subject matter experts to the U.S. Embassy. The primary purpose of the deployment was to provide the U.S. Embassy in Tokyo with guidance on health and medical issues related to potential radiation exposure of U.S. citizens in Japan, including employees of the U.S. Department of State at consulates in Japan and American citizens living in or visiting Japan. At the request of the Government of Japan, the deployed health team also assisted Japanese experts in their public health response to the radiation incident. Over a three-week period in Japan and continuing for weeks after their return to the U.S., the team provided expertise in the areas of medical and radiation oncology, health physics, assessment of radiation dose and cancer risk, particularly to U.S. citizens living in Tokyo and the surrounding areas, food and water contamination and the acceptable limits, countermeasures to exposure such as potassium iodide (KI), the use of KI and an offered donation from the United States, evacuation and re-entry issues, and health/emergency-related communication strategies. This paper describes the various strategies used and observations made by the DHHS team during the first two months after the Fukushima crisis began.

Keywords

public health; emergency response; radiation exposure; medical countermeasures; nuclear power plant

INTRODUCTION

U.S. citizens living or traveling abroad occasionally face threats to their physical and economic well-being. During the combined disaster in Japan that was precipitated by the 11 March 2011 earthquake, there were major health and safety consequences from the land damage and tsunami, continued infrastructure loss from aftershocks and the possibility of radiation exposure and the consequential early and late health effects. During incidents such as this, U.S. citizens are advised and protected to the extent possible by regional involvement of the U.S. Department of State through embassies and other local offices, recognizing that these citizens are guests in those sovereign nations. While health and medical guidance is provided, travel alerts and warnings may sometimes limit travel, business and certain residential activities. In the case of Japan, there is one central embassy in Tokyo and five regional consulates (Sapporo, Nagoya, Osaka, Fukuoka, and Okinawa). An estimated 150,000 U.S. citizens, excluding military, were resident or visiting Japan at the time of the earthquake. Because most non-military U.S. citizens live in the Tokyo metropolitan area, the U.S. Embassy was heavily involved in issues related to safety and health protection its citizens.

The damage to the Fukushima Daiichi nuclear power plant continues to be an unprecedented catastrophe to the country of Japan, partly due to the cost of repairing or rebuilding the damaged reactors, complex problems of land contamination, the economic impact from the prohibition of crops, and the displacement of residents. In addition to causing unprecedented damage to Japan and its citizens, the disaster resulted in a complex array of circumstances that potentially endangered U.S. citizens in Japan. This report details the efforts and on-site experiences of a health team deployed by the Department of Health and Human Services (DHHS) Office of the Assistant Secretary for Preparedness and Response (ASPR) to the U.S. Embassy in Tokyo to assist in the protection of U.S. citizens.

THE CRISIS

The Fukushima Daiichi nuclear power plant disaster was precipitated by the Tohoku earthquake and tsunami on 11 March 2011 and was marked by a series of infrastructure and equipment failures, nuclear meltdowns, and releases of radioactive materials from the Fukushima Daiichi nuclear power plant complex. The plant maintained by the Tokyo Electric Power Company, or TEPCO, experienced multiple catastrophic failures due to loss of cooling power and damages following encroachment of seawater.

Considerable detail is now published about the damage to the reactor and release of radionuclides. Environmental radiation and radioactivity measurement data have continuously been obtained by the Japanese Ministry of Education, Culture, Sports, Science & Technology and released to the public (MEXT 2011). The status of the reactor, damages and international assessments have been updated frequently by the International Atomic Energy Agency IAEA (2011). Readers should consult these sources as well as other publications in this issue for details.

The enormous physical damage to the coastal villages in Fukushima prefecture and loss of life was the initial focus of attention, but as news of the damage to the nuclear power plant emerged, the fear of radiation release dominated news reports in Japan and worldwide. Almost all early news media releases were about the visible damages to the reactor and speculations about the degree of contamination of the countryside and the ocean. Little authoritative information was available in the American and Japanese news media about the meaning of the contamination to human health for at least three reasons: news reporters had limited or no knowledge of the science, it was much easier and faster to write short sensational articles, and it was impossible to know exactly where and to what degree the

contamination had spread. While there is considerable expertise in Japan about radiation health effects in the context of the atomic bomb studies (RERF 2007, 2011), the regional and international news media did little to acknowledge the radiological expertise within Japan. Consequently, the early crisis that affected most U.S. citizens was largely characterized by lack of credible information, misunderstanding, and fear of radiation exposure. Despite the obvious lack of information, policy decisions had to be made by U.S. officials for evacuation, repatriation, food controls, and the provision of medical countermeasures.

THE RESPONSE

The combined physical disaster of the earthquake, tsunami, and reactor meltdown led to a response by the U.S. Department of Defense (DOD) in *Operation Tomodachi* (PACOM 2011) as well as by multiple federal agencies and interagency groups including the National Security Staff of the White House, Nuclear Regulatory Commission (NRC), U.S. Department of Energy (DOE) and the National Nuclear Security Agency (NNSA), U.S. Office of Foreign Disaster Assistance (USOFDA) within the U.S. Agency for International Development (USAID) (OFDA 2011), and the U.S. Department of Health and Human Services (DHHS) through the Office of the Assistant Secretary for Preparedness and Response (ASPR) and its Office of Preparedness and Emergency Operations (OPEO). This response included extensive efforts both in the U.S. and in Japan using teams of subject matter experts.

Role of the U.S. Department of Health and Human Services, Assistant Secretary for Preparedness and Response

ASPR was created under the Pandemic and All Hazards Preparedness Act in the wake of Hurricane Katrina in 2005 to lead the nation in preventing, preparing for, and responding to the adverse health effects of public health emergencies and disasters. ASPR has four responsibilities: preparedness planning and response; federal emergency medical operational capabilities; countermeasures research, advanced development and procurement; and grants to strengthen the capabilities of hospitals and health-care systems in public health emergencies and medical disasters. The office provides federal support, including medical professionals through ASPR's National Disaster Medical System, to augment state and local capabilities during an emergency or disaster.

Shortly after the earthquake and tsunami, the health status of people in Japan was monitored by the DHHS Secretary's Operations Center. The Disaster Assistance Response Team (DART) from USAID led the medical response and mobilized its own team to the U.S. Embassy in Tokyo. A request by the U.S. Ambassador to Japan to DHHS resulted in the deployment of a team of experts in various areas of radiation health and medicine to the U.S. Embassy in Japan.

U. S. Department of Health and Human Services' Health Team

The U.S. Embassy's complete on-site health and medical team was comprised of members of the Embassy's medical staff, supplemental medical staff from neighboring embassies in the Pacific region, other Embassy staff with a range of scientific expertise, the DART team members and the DHHS experts who started to arrive on site within a week of the incident. The expertise of the DHHS team members included radiation medicine, medical and physical countermeasures including the distribution of potassium iodide, health physics, radiation dose and risk assessment, and emergency risk communications. The DHHS team was assembled collectively from the National Cancer Institute (NCI) of the National

Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC) and the U.S. Food and Drug Administration (FDA).

The first DHHS contingent arrived 21 and 22 March 2011. Among the crucial first steps taken was to rapidly gather situational awareness from available data on the potential release of radionuclides through discussions with experts deployed to the U.S. Embassy from the DOE, NRC and DOD. The data at that time were limited due to the extensive infrastructure damage in the Fukushima Prefecture and, therefore, early “worst-case” models about the potential spread of radioactive contamination and related exposures were generated based on conservative and speculative assumptions. Perhaps the most essential need was for information about radiation exposure and the possibility of radiation-related health effects on the members of the U.S. Embassy. Anxiety and concern were high, especially about the risk to children, pregnant women and family members of working staff. There were ongoing earthquake after-shocks which generated uncertainty about many aspects of life that were no longer routine, and included interruptions in electrical power, water and food availability and transportation-related services.

Within a day after the first DHHS team members arrived, a presentation focused on radiation health was provided to a standing room-only town-hall meeting of the U.S. Embassy staff in conjunction with presentations from the Ambassador, an expert who addressed psychological stress, and other speakers responsible for the safety and well-being of the embassy staff and U.S. citizens in Japan. Presentations were recorded and portions were made available to the public via social media outlets. The arrival of additional DHHS expertise was timely because of a report of radioactive iodine in the Tokyo water supply that caused great concern but could not be adequately addressed by the usual Embassy staff. Given the distance of Tokyo from the Fukushima nuclear power plant complex, it was clear that the radiation exposure issues would not be those of acute radiation syndrome but would revolve around food and water safety and the long-term risk of radiation-induced cancer from low-level exposure. With knowledge of the importance of stress as a major medical consequence from Chernobyl (Bromet et al. 2011), providing credible and comprehensible information to the many concerned Embassy and U.S. citizens was a key objective. While other stateside expertise was also available, the time difference to the United States (~12 h) and the importance of having expertise on-site at the Embassy was deemed critical to allow immediate interpretation of incoming data for decision-makers and to communicate with concerned U.S. citizens.

In addition to working with Embassy staff, a key responsibility of the DHHS team was to work closely with the experts from the other U.S. agencies who had been deployed to Japan and to provide timely updates of the current situation and potential emerging issues to the DHHS Secretary's Operations Center and the CDC Emergency Operations Center, both which provided round-the-clock support. There was an enormous response coordinated through the National Security Staff to address complex radiation issues for people in the United States. This included the potential for the spread of radioactive contaminants in the United States by weather phenomena, people traveling to the United States from or through Japan, and food imports and other imported products coming through or from Japan. The ongoing collaboration and coordination among radiation experts in the U.S. during the past decade to prepare for radiological/nuclear terrorism, as well as the collaboration of radiation subject matter experts through the Global Health Security Initiative (GHSI 2011), greatly facilitated the overall U.S. response and coordination with Japan and other countries.

Advisory Capacity to U.S. Department of State and U.S. Embassy

The initial purpose of the deployed DHHS team was to serve as on-site advisors to the Ambassador and other U.S. Embassy staff. For three weeks after the earthquake, there was a

daily morning briefing in the Embassy headed by the Deputy Chief of Mission to accumulate new information from the various U.S. agencies represented. The Ambassador had an advisory team that met both morning and evening to acquire detailed and updated information. The DHHS health team, supplemented by a DOD liaison officer, was assigned a working space in the Embassy that became the hub for our efforts and for Embassy staff to seek consultations. Because of the large size of the Embassy in Tokyo, having an identifiable work location enabled many important informal discussions with others in the Embassy, including those with questions about whether family members should leave or return to Tokyo.

One subject of discussion was the differences in protective action guidelines that are used by the various international agencies and how they differed from those used by the United States. The difference in Japanese and U.S. guidance, including topics such as evacuation and exclusion zones and criteria, was a cause of confusion and concern for the Japanese and the U.S. citizens. At the request of the Embassy that was transporting DOE experts and others into the 50-mile exclusion zone recommended by the United States, the DHHS health team discussed radiation risk and monitoring to assure safety. The use of different criteria for establishing evacuation and cautionary zones remains an ongoing issue requiring resolution.

Following a formal request from the Government of Japan for collaboration with the U.S. Government during the early days of the DHHS deployment, the role of the DHHS team expanded to working with the Japanese on addressing three research issues: 1) identifying Japanese who might need long-term medical follow-up, 2) ascertaining the proper dosage and regimen of KI and how that might vary for the Japanese who normally have a high iodine diet, and 3) how best to communicate information and risk to the public. While it is beyond the scope of this paper to address all issues in detail, follow-up plans were discussed at an International Expert Conference in Fukushima (ICRP 2011).

Issues of Potassium Iodide (KI) and the Strategic National Stockpile

The rapid administration of KI following a release of nuclear fission products can help mitigate the potentially harmful effects to the thyroid gland from internal contamination with radioiodines. The possible need for KI for protection from the harmful effects of radiation was foremost in the minds of many of those exposed, or thought to have been exposed, not only in Japan, but also in much of the world as there were concerns of radioactive plumes traveling over vast distances and oceans. Many in the public did not understand that KI is only protective of the effects of internalized radioiodine uptake by the thyroid gland, and not from any other radioactive elements or the effects of external radiation exposure.

The availability of KI as a countermeasure is of greatest value to infants and young adults whose thyroid glands are most active and of smaller size. KI, taken prior to or within a few hours of exposure, saturates the thyroid gland and prevents or reduces absorption of radioactive iodine (ATA 2011). There is a finite period of time relative to time of exposure for KI administration to be most effective: optimally 6-12 hours prior to exposure of a plume or the first few hours after inhaling or ingesting radioactive iodine (AAP 2011, ATA 2011, FDA 2001). This short time window necessitates having the KI almost immediately available after a radioactivity release. In the United States, through the Nuclear Regulatory Commission, KI in tablet form has been staged in areas surrounding some domestic nuclear power plants as a preparedness measure in the event of a reactor accident (National Research Council 2004). Dependent upon plans in individual geographic regions, KI is distributed sometimes in advance to individual households within ten miles of a nuclear power plant. While KI can be an effective method to protect the thyroid gland if it is taken

within a short time after a radioactive iodine release, it should always be used as an adjunct measure secondary to sheltering, evacuation, and appropriate interdiction of food and water supply.

DHHS, through the Project BioShield program established in 2004 (Gotttron 2011), had liquid KI available in the Strategic National Stockpile (SNS) that is managed by CDC. Within the first week after the earthquake and tsunami that damaged the Fukushima nuclear power plants, President Barack Obama stated, "...we are bringing all available resources to bear to help Japan cope with its widening natural and nuclear disaster" (USA Today, March 17, 2011). Part of the offerings from the U.S. Government was liquid pediatric doses of KI held within the SNS inventory. Fortunately, the Japanese KI stockpiles were quickly replenished, and because the threat of another radionuclide release was diminishing, there was no longer a need for liquid KI in Japan. For that reason, none was transferred. However, the logistical, regulatory and legal issues regarding the transfer of a pharmaceutical from one country to another came into focus and will be addressed as part of the lessons-learned process.

KI program for Americans

It was the intent of the U.S. Embassy to provide guidance and appropriate protection for U.S. citizens in Japan while, at the same time, not cause undue concern from those messages. As a precautionary measure, on 21 March 2011, the U.S. Embassy began to provide a stand-by seven-day regimen of KI tablets to U.S. citizens who presented at the U.S. Embassy or the New Sanno Hotel, a military lodging facility in Tokyo (EUSJ 2011a). Distribution was limited to U.S. citizens and his/her non-citizen family members who were not able to obtain KI from their physicians, employer or other sources. Family members over 18 who requested KI were required to present their U.S. passports as proof of identity and citizenship and to sign a waiver. Each was given a CDC fact sheet on KI (CDC 2011) and explicit instructions both at the time of pickup and on the website of the Embassy of the United States in Tokyo (EUSJ 2011a). Because the demand was low, the dispensing of KI limited to only the U.S. Embassy location.

Messages from the U.S. Embassy were very clear stating "...we do not recommend anyone take KI at this time" and "...it should only be taken on the advice of emergency management officials, public health officials or your doctor" (EUSJ 2011b). Complicating this advice, however, were intermittent media reports in the United States of radioactive iodine in the drinking water (BBC 2011). These reports subsequently prompted calls of concern from state-side family members of those U.S. citizens living in Japan. In spite of clear directions, some persons approached health team members at town hall meetings to ask for basic information on radiation risks and on whether it was safe to stop taking their KI. Based on the U.S. State Department's updated travel alert on Japan, the availability of KI tablets at the U.S. Embassy in Tokyo was discontinued mid-April (EUSJ 2011c).

In addition to the precautionary dispensing of KI tablets at the U.S. Embassy, there remained a stockpile of KI tablets at the Embassy for the estimated number of private U.S. citizens who remained in the Tokyo, Hokkaido and T hoku consular districts and those most likely to be affected by a potential future radioactivity release. The U.S. Embassy consequence management group, Embassy consulate staff and representatives from DHHS, developed contingency distribution and dispensing plans for U.S. citizens in the Hokkaido and T hoku regions in the event of another radiological incident. By the end of deployment of the DHHS health team in early April, about 3,100 Americans had obtained the one-week supply of KI.

It is notable that KI, while available as an over-the-counter product in the U.S., was only available by prescription in Japan. Additionally, Japanese physicians had been given

instructions not to issue prescriptions for KI unless directed by the government. Also notable were differences in recommended daily dosage by Japanese authorities (100 mg) compared to recommendations for Americans (130 mg). While differences in recommendations can be attributed to differences in typical levels of stable iodine in the diet, this was an issue that generated considerable discussion and concern.

Food, Water, Agriculture and Recommendations

A major source of concern for American citizens living in Japan was the potential impact on their health due to radiation exposure from the damaged nuclear power plant. While the public was concerned about radiation in general, the major technical concern early on was of radionuclides released into the environment that could contaminate food and water. Of special concern was the potential risk to infants and children from ingesting contaminated milk and water. However, due to the relatively short half-life of ^{131}I , that risk quickly dissipated, to be replaced by the longer term risk from exposure to ^{134}Cs and especially ^{137}Cs . While most of the contamination of crops harvested in the early phase was on the surface of plants, it was quickly realized that there was a need to address the regional crop-planting and crop-harvesting cycles because contamination of the land presented the opportunity for radionuclides to be incorporated into crops through root transfer. This need was urgent due to the impending planting season for rice in late April to early May, which would fall only weeks after the releases from the damaged reactors.

Some of the concern expressed by U.S. citizens concerned the adequacy of Japanese protective measures and guidelines. This concern was exacerbated by reports about differences in U.S. guidelines for food and water contamination compared to those that had been adopted by the Japanese Government. Further complicating matters was the use of different units for radiation dose and radioactivity in different reports. The public's general lack of familiarity of concepts of radiation and risk added to the confusion. Goals of the DHHS health team included evaluating the Japanese Government standards and criteria for food and water interdiction, assessing the adequacy of the monitoring program for food and water, and communicating these findings to Embassy staff and U.S. citizens.

In the U.S., the standards for protection of the food supply following an accidental release of radioactive materials is based on the 1998 FDA recommendations (FDA 1998). The Protective Action Guide (PAG) represents the dose that one attempts to avoid by protective actions. The presently recommended PAGs for food are 5 mSv committed effective dose equivalent or 50 mSv committed dose equivalent to a specific organ, whichever is more limiting. The guideline for restricting food is the quantity known as the Derived Intervention Level (DIL), which is the concentration of radioactivity in food (Bq kg^{-1}) if consumed continuously for a year, could potentially lead to an individual receiving a dose at the level of the PAG. It should be noted that the assumptions underlying the derivation of DILs are sufficiently conservative that even continuous consumption for a year would not likely result in a dose at the level of the PAG. Thus, the DILs represent a generally useful parameter for quickly making a decision to restrict contaminated food in the early emergency phase of an incident, while allowing for a more thorough assessment at later times. The FDA PAGs are based on the risk coefficients that were current at the time of their publication (i.e., National Research Council 1988, UNSCEAR 1988) and corresponded to a risk of lifetime cancer mortality of 2.25×10^{-4} .

Shortly after the extent of damage to the Fukushima Daiichi nuclear power plant complex was realized, the Government of Japan instituted controls on food by adopting guideline levels established by the Nuclear Safety Commission of Japan and updated in 2007 (NSCJ 2007) as "provisional values" (Table 1). The Japanese guideline levels are based on a PAG that is equivalent to that used by the FDA (i.e., 5 mSv effective dose and 50 mSv equivalent

dose to the thyroid), although they are based on more recent 1990 recommendations of the International Commission on Radiological Protection (ICRP 1991). The Japanese Government's guidance levels are numerically different from FDA's, primarily due to a different calculation approach and the use of food classes. For comparison, FDA's method is based on the total diet, whereas, Japan follows the current international approach and calculates guidance levels for food groups (FAO/WHO 1989). The use of ingestion dose coefficients that have become available more recently than those used by the FDA result in some additional differences in the calculated guidance levels. Similar to the United States, Japan assumes that 100% of the diet is contaminated for the case of ^{131}I . However, in the case of ^{134}Cs and ^{137}Cs , Japan assumes that 50% of the diet is contaminated, compared to the U.S. assumption of 30%. Despite these various differences, we found that the Government of Japan's standards for allowable radioactive contamination in food to be comparable to those of the FDA.

Within days after the radionuclide releases, the Government of Japan directed prefectures to conduct sampling in accordance with previously published guidelines and existing statutes for food safety and nuclear preparedness requirements. The "Manual on Radiation Measurements of Food in Emergency Situations" (MHLW 2002) provided guidance on the analytical methods required. As evidenced by early and frequent publication of sample results, the Japanese demonstrated the ability to quickly detect and interdict contaminated food. Frequent meetings of the DHHS health team with counterparts from the Japanese government were helpful in understanding the actions that were being taken and in interpreting sample results.

Finally, in support of Japan's need to make decisions about future crops and agriculture, the DHHS health team was able to consult with experts and discuss methods for predicting the impact on the food supply from contamination in soil, specifically the methods of the Federal Radiological Monitoring and Assessment Center (FRMAC) and recent developments from the Operational Guidelines Task group (DOE 2009). Analyses conducted at Argonne National Laboratory provided further support for an approach to decision making (Yu et al. 2011).

Radiation Measurement Data and Radiation Risk

The issues of radiation risk pertinent to the DHHS health team were focused on the population in the Tokyo area, primarily because it is the main center of population and business and most non-military U.S. citizens live in its metropolitan area. Issues of radiation risk were related mainly to concern for the protection of families with an emphasis on women and children and, secondarily, concern for personal safety of adults. Radiation is poorly understood by the general public, regardless of educational level. For that reason, media reports of any non-zero measurements of radioactivity in air, food and water caused considerable concern among the U.S. community. While it was the responsibility of the U.S. Embassy in Japan to ensure protection of U.S. citizens there, the Embassy implicitly relied on expertise brought by the DHHS health team.

In late March and early April, limited data were available on which to base quantitative estimates of exposure that might have been received in the Tokyo area. The lack of confirmed data made it difficult to form convincing arguments that family members should not evacuate. Fortunately, a variety of monitoring and measurement instruments had been placed in operation on the roof of the Embassy by the NNSA and the U.S. Marine Corps and were maintained and read every two hours by U.S. Navy staff deployed to the Embassy. These instruments included air samplers, exposure rate meters and gamma/beta detectors. Data from the instruments were appended to a continuous electronic data stream and

distributed daily among U.S. agency staff via electronic mail through 19 May 2011 when the instrument package was taken out of service.

The data from the instruments on the Embassy were of immense value for determining an absence of any significant ongoing radiation threat to Embassy staff in early April. The findings were consistent with other sparse data being published by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan on its website that had been linked to the Embassy website. The agreement in data sources also suggested that Americans in the broader Tokyo area were equally at low risk. In particular, gamma exposure rate measurementsⁱ consistently read about the level of background ($\sim 0.02 \text{ mR h}^{-1} = \sim 1.4 \times 10^{-12} \text{ C kg}^{-1} \text{ s}^{-1}$) except for small spikes, about twice background, measured on 25 March and 29 March, 2011.

The instrument package at the Embassy had not been made operational until 25 March, approximately two weeks after the primary releases that occurred at the Fukushima reactors 1, 2, and 3. Hence, the Embassy instruments presumably missed recording brief increases in radiation levels that likely would have been detected after the primary releases that occurred between 12 March and the time when the instruments became operational. At the time of the health team's deployment, there was no way to quantify any exposure that was missed by the absence of detectors, but the judgment was made that the risk was minimal due to the nearly absent residual radioactivity on the rooftop of the Embassy which was essentially undisturbed by foot traffic.

During the deployment of the DHHS health team and for about six weeks after the end of deployment, the radiation instrument data stream was maintained. During those weeks, it was a primary function of the team to advise the Embassy staff on any deviations of the measurements from their low levels and to interpret those measurements for subsequent decisions, including the need for evacuation and for re-entry for voluntary evacuees.

Issues of Relocation and Re-entry

On 16 March, less than one week after the earthquake, the U.S. Department of State authorized the voluntary departure from Japan of eligible family members of U.S. Government personnel in Tokyo, Nagoya, and Yokohama. This decision was based on ongoing uncertainty about a range of complex issues in addition to radiation, including loss of infrastructure, utilities, and possible lapses in medical care. With regard to the prevention of unnecessary radiation exposure, the NRC (2011) recommended a 50 mile (80 km) zone in which U.S. citizens should evacuate. The recommendation was issued on March 16 as a U.S. Department of State warning to U.S. citizens about the deteriorating situation at the Fukushima Daiichi nuclear power plant. Differences in evacuation and relocation guidelines between Japan and the United States led to confusion and to some loss of confidence and credibility in the authorities. These complex issues remain to be resolved. Some U.S. citizens with families experienced added complication in that once voluntary evacuation was taken, return to Japan had to be authorized by the U.S. Department of State. Families with students in school who hoped to graduate in the spring term of 2011 were particularly concerned that an extended absence would preclude graduation. The U.S. Department of State authorized return of voluntary evacuees on 15 April 2011.

The DHHS health team provided information to the Embassy staff on potential medical consequences of radiation exposure from external and internal contamination. This information was also provided to U.S. citizens in Japan in a series of three town-hall style

ⁱCanberra™ Military Radiac AN/PDR-77

meetings at the American Chamber of Commerce in Japan with more than 1,000 Americans attending. As one would expect, the issues of relocation and re-entry depend on both measured radiation levels and radionuclide concentrations and also on the individual's perception of risk. The DHHS health team assisted the Ambassador in the decision to modify the travel warning to an alert as well as the discussions regarding the size of the exclusion zone. The expertise of the DHHS team was beneficial in discussing individual and family decisions with Embassy personnel and appeared to be helpful to them in determining their plans.

Emergency Risk Communication

The information and outreach provided to U.S. citizens and Embassy staff played a crucial role in our allaying the concerns of those living at a distance from Fukushima. The presence of U.S. experts in Tokyo was in itself reassuring to residents, and the team's ability to witness events first hand and interact directly with Japanese experts raised its credibility.

The team's expertise in disaster communication and use of a full range of media, including web-based social media, was very helpful to both the U.S. Embassy and to the Japanese. Communications strategies that were web-based used the Embassy website which is published in English and known to most U.S. residents. The Embassy website served as a focal point for distributing news, recommendations, guidelines and policies to the resident U.S. population.

Large forum informational meetings were arranged so that live presentations could be made to U.S. citizens about the basics of radiation and health. The DHHS health team was responsible for designing and presenting all messages, and these presentations were promoted by radio and through the Internet. Participation by the public was high for multiple presentations and included U.S. citizens of all educational levels and professions. For those that could not attend, the presentations were posted to the video-sharing website, YouTube™ and linked to the Embassy website where they remain availableⁱⁱ.

By providing basic information on radiation risk and potential effects and food protection measures, and then allowing for an extensive question and answer period, the team could directly address many of the public's concerns and place them in proper context. The public meetings accentuated the importance of question-and-answer sessions, especially in discussing the issues of food, water and child safety which came up repeatedly. Having the DHHS health team on site to listen, but also subject to the same level of risk as those in attendance, was important for stabilizing for the reassurance of Embassy workers and the public.

Although radioactive contamination of the public water supply in Tokyo was negligible and mostly limited to an isolated measurement early in the incident, this represented one of the greatest communication challenges during the response. Difficulties were due in large part to the disparity in guideline levels between Japan and the United States. In particular, U.S. citizens residing in Japan were naturally confused by the differences between the emergency levels established by the Japanese Government (100 Bq kg⁻¹) and the much lower levels currently adopted by the Environmental Protection Agency based on the Safe Drinking Water Act (0.037 Bq kg⁻¹, i.e., 3 pCi L⁻¹, EPA 2000). However, when the audience understood the underlying assumptions behind the two values, i.e., short-term consumption under emergency conditions versus lifetime consumption under normal operating

ⁱⁱ<http://www.youtube.com/watch?v=Qh7k3KKvSOI>; <http://www.youtube.com/watch?v=oo1OmXJcyc0>; <http://www.youtube.com/watch?v=pns7aIVOknM>; http://www.youtube.com/watch?v=ESyWlbcL_qE

conditions, the audience was much more receptive to our messages and more confident in their ability to understand the information they received.

Because the primary interests of U.S. citizens in the Tokyo area was to make personal decisions regarding the need to evacuate and the possibility of radiogenic cancers developing in their children as a consequence of exposure, messages had to specifically address those issues. With regard to the need for evacuation, the Embassy made these determinations following consultations with the DHHS health team and the U.S. Department of State. The DHHS health team was very careful to coordinate all messages with the Embassy to avoid any confusion. With respect to cancer risk, the health team relied on providing explanations about baseline (non-radiation related) cancer risks, which, worldwide, approach 40% for incidence and nearly 25% for mortality (ACS 2011). The primary message delivered in presentations and to individuals seeking expert information was based on the evidence that increases in cancer risk in the Tokyo area related to the minor radiation exposures, were felt to be too small to be either reliably estimated or measured.

Activities Post-deployment

Because of continued findings of radioactivity in food, the DHHS health team has provided ongoing consultation to the Embassy in Tokyo, including the redeployment of one team member to Tokyo to conduct further assessments of food safety. These assessments involved additional meetings with Japanese officials and a review of public documents to better understand the monitoring and sampling program being employed. The assessment was that the local monitoring program was able to identify contaminated food products in a timely fashion and that the Japanese took quick action to remove these products from the marketplace. Products were not allowed back onto the market until they passed three consecutive tests to confirm they were below the established guideline levels. Although findings of contamination were of great concern to the populace, the open reporting of results and rapid intervention assured the integrity of the food supply.

In addition, the differences in KI dosing requirements are being examined by subject matter experts in the United States and elsewhere. Collaborations are ongoing among CDC experts and their Japanese counterparts on risk communication strategies.

Finally, the U.S. Government, led by the White House is engaged in a “lessons observed and lessons learned” process. A series of presentations soon will be available from an International Expert Symposium in Fukushima on radiation and health risks held September 11-12, 2011, at the Fukushima Medical University (<http://www.nippon-foundation.or.jp/eng/news/fukushima-sympo.html>). The initial lessons observed from the DHHS health team have been published (Coleman et al. 2011) and a model for managing the responses to future nuclear accidents has been proposed. The proposed strategy emphasizes the importance of onsite subject matter experts to advise decision-makers. The ability to make decisions and to communicate promptly not only yields the best possible response but can avoid information gaps that would be filled by media speculation, thereby, eliminating suspicions of “cover-ups” by the government.

CONCLUSIONS

The magnitude 9.0 earthquake and subsequent tsunami produced catastrophic loss of life, displacement of citizens from the local region and destruction to the Fukushima Daiichi nuclear power plant that will have a significant impact on energy policy and economics worldwide.

During the time of the Fukushima nuclear crisis and for weeks afterwards, DHHS responded by providing specialized services and support to the U.S. Embassy in Tokyo for the purpose of protecting Embassy and State Department staff and civilian U.S. citizens residing in and visiting Japan. While other U.S. agencies provided expertise on damage assessment and repair of the nuclear facilities, measurement of radioactivity in the environment, and provided aid to people in locations with severe infrastructure damages, DHHS has primary responsibility for protecting the health of U.S. citizens. Because the largest number of U.S. citizens resided in or near Tokyo and because the resources were centered at the Embassy, the need was greatest there.

High levels of concern and fear about radiation exposure among the Embassy staff for themselves and their families and for the U.S. citizens in Japan, which began from the earliest press releases on the damage to the reactor, was apparent to the Embassy staff and Ambassador. Recognizing the need for expertise outside their normal areas of business, the Embassy requested onsite assistance in radiation medicine and radiation protection to enhance their ability to address in real time, the rapidly evolving problems. The circumstances during the crisis were viewed as particularly challenging because the severe loss of infrastructure and the enormous need to take care of a large number of injured and evacuees, limited the data available to estimate and assess the magnitude and scope of the radionuclide releases.

On-site assistance was deemed necessary (Coleman et al. 2011) and DHHS/ASPR deployed a team of subject matter experts beginning 10 days after the earthquake and tsunami. The team included experts from DHHS/ASPR as well as experts in radiation health from the institutes and centers within DHHS, including NIH and NCI, CDC, and FDA.

The overall U.S. response to the combined disaster was helpful to the Japanese and was viewed favorably by the citizens of Japan. Of the breadth of expertise provided by those that deployed to Japan, radiation measurement specialists, physicians, health physicists, and communication specialists, played an important role. *Operation Tomodachi* (meaning “friendship”) demonstrated how radiation health and medical experts are a critical part of a nuclear crisis management team. The experience gained and lessons learned from this incident will be an important contribution to U.S. and international preparedness and response, should a radiological or nuclear incident occur in the future.

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Table 1

Indices relating to limits on ingestion for managing disasters at nuclear facilities (Bq kg^{-1}) (NSJC 2007).

Nuclide(s)	Food Type	Limiting concentration (Bq kg^{-1})
^{131}I	Drinking water	300
	Milk, dairy products *	
	Vegetables (Except root vegetables and tubers)	2000
$^{134}\text{Cs} + ^{137}\text{Cs}$	Drinking water	200
	Milk, dairy products	
	Vegetables	500
	Grains	
	Meat, eggs, fish, etc.	

* Provide guidance so that materials exceeding 100 Bq kg^{-1} are not used in milk supplied for use in powdered baby formula or for direct drinking to baby.