Assessing the Effects of the Gulf of Mexico Oil Spill on Human Health: A Summary of the June 2010 Workshop

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ASSESSING THE EFFECTS OF THE GULF OF MEXICO OIL SPILL ON HUMAN HEALTH

A Summary of the June 2010 Workshop

Margaret A. McCoy and Judith A. Salerno,
Rapporteurs

INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES

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The serpent has been a symbol of long life, healing, and knowledge among almost all cultures and religions since the beginning of recorded history. The serpent adopted as a logotype by the Institute of Medicine is a relief carving from ancient Greece, now held by the Staatliche Museen in Berlin.

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"Knowing is not enough; we must apply.
Willing is not enough; we must do."
—Goethe

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PLANNING COMMITTEE ON ASSESSING THE EFFECTS OF THE GULF OF MEXICO OIL SPILL ON HUMAN HEALTH: AN INSTITUTE OF MEDICINE WORKSHOP[1]

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[1]The role of the planning committee was limited to planning and preparation of the workshop. This document was prepared by rapporteurs as a factual summary of what was presented and discussed at the workshop.

Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's (NRC's) Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the process. We wish to thank the following individuals for their review of this report:

Georges C. Benjamin, American Public Health Association
Joan D. Flocks, Levin College of Law, University of Florida
Bernard D. Goldstein, University of Pittsburgh
Roger O. McClellan, Independent Advisor on Toxicology and Human Health Risk Analysis
David A. Savitz, Mount Sinai School of Medicine
Robert J. Ursano, Uniformed Services University of the Health Sciences

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the final draft of the report before its release. The review of this report was overseen by **Robert B. Wallace,** Irene Ensminger Stecher Professor of Epidemiology and Internal Medicine in the College of Public Health at the

University of Iowa. Appointed by the NRC and the Institute of Medicine, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the rapporteurs and the institution.

Preface

On April 20, 2010, 11 oil workers lost their lives when the Deepwater Horizon, a semi-submersible offshore drilling rig in the Gulf of Mexico, exploded and created one of the largest environmental disasters in U.S. history. In the weeks and months that followed, hundreds of millions of liters of crude oil spewed into the Gulf of Mexico, threatening the waters and surrounding lands, marshes, and beaches; damaging fish and wildlife; and disrupting the lives of many residents and communities in the Gulf region.

This is not the first oil spill disaster. Other oil spill catastrophes have occurred in the United States and around the world. But, the Gulf oil spill is distinctive in its magnitude, in its duration, and in the complexity of its assessment. Unlike most spills in which there is a single event and measurable release of oil, the Deepwater Horizon spill has been plagued not only by its resolution but also by its wide-reaching and likely prolonged impact on communities in the affected regions. The extensive, prolonged use of dispersants is also unprecedented, and the risks associated with their use are unknown, as are risks associated with fumes from the oil and controlled burns. In fact, it may be the sheer level of uncertainty that best defines the Gulf of Mexico oil spill.

Since the Gulf oil spill began, there have been concerns about the extent to which related hazards, such as physical and chemical exposures and social and economic disruptions, will impact human health. In addition to concerns about the spill's impact on the general population of the Gulf region, some populations are potentially at increased risk of short- and long-term physical and psychological health damage. The latter include clean-up workers and volunteers, who are exposed to extreme

heat and fatigue, fishermen and -women, oil rig workers, and countless others, who wait to hear when and if they can go back to their livelihoods and their ways of life. While studies of previous oil spills provide some basis for identifying and mitigating the human health effects of these exposures, the existing data are insufficient to fully understand and predict the overall impact of hazards from the Deepwater Horizon oil spill on the health of individuals—including workers, volunteers, residents, visitors, and special populations.

The Secretary of the U.S. Department of Health and Human Services, Kathleen Sebelius, asked the Institute of Medicine (IOM) to hold a workshop to inform efforts to monitor the health effects of the Gulf oil spill and to communicate information concerning these risks to the public. Reflecting the urgency of the issue and the dedication and hard work of the IOM staff, the workshop was held within 2 weeks of receiving the Secretary's request. I was honored to chair the planning committee, which included distinguished colleagues with diverse backgrounds and expertise. With only 1 week's notice, 37 experts and health officials and 4 community representatives participated in the workshop in New Orleans and gave excellent presentations. More than 300 other participants attended the workshop, and hundreds more have viewed the webcast. Public commentary was submitted via a specially developed portal on the World Wide Web.

This publication captures many of the observations, ideas, and suggestions offered by participants. In 2 days, it was not possible to design a surveillance system, but the discussion pointed to key considerations that should be used in designing such a system. By identifying what is already known and what is missing, policy makers, public health officials, academics, community advocates, scientists, and members of the public can work together to create a monitoring and surveillance system that results in "actionable" information that identifies emerging health risks in specific populations. Doing so can help target resources to high-risk populations for treatment and foster new approaches for the prevention of adverse health effects.

Workshop participants from the local area poignantly described the frustration and struggle faced by Gulf residents and reminded us of the importance of incorporating the concerns and expertise of community members. Surveillance activities will need to be coordinated and should involve federal, state, and local governments; academic institutions; advocacy groups; private industry; and community networks. By including all the relevant parties, we can develop more comprehensive and

effective surveillance systems to inform decision makers and the public about the physical and psychological health issues related to the Deepwater Horizon oil spill and other environmental disasters in the future.

Nancy E. Adler, *Chair*
Planning Committee on
Assessing the Effects of the Gulf of
Mexico Oil Spill on Human Health: An
Institute of Medicine Workshop

Acknowledgments

This publication is the product of a small army of dedicated individuals, and the Institute of Medicine (IOM) is grateful to all for their commitment, patience, and professionalism in developing and executing this workshop within a 2-week timeframe.

Substantial recognition must be extended to the Secretary of the U.S. Department of Health and Human Services, Kathleen Sebelius; to Nicole Lurie, Assistant Secretary for Preparedness and Response (ASPR); and the ASPR staff for their vision and generous support for this workshop.

This workshop would not have been possible without the expertise of the planning committee members and their skilled navigation of the questions and challenges. Under Nancy Adler's adept direction, the planning committee assembled an impressive agenda of distinguished speakers, whose presentations both informed and provoked thoughtful discussions during the course of the workshop.

Many devoted IOM staff members supported the planning and execution of the summit. Bruce Altevogt, Christine Coussens, Meg McCoy, and Kathleen Stratton provided steadfast support to the planning committee and project, while Clyde Behney, Cathy Liverman, Andy Pope, and Judith Salerno offered their guidance and leadership. Thanks go to Shelly Cooke, Pam Lighter, Janet Stoll, and Trevonne Walford for their assistance at the workshop; to Jill Grady and Hope Hare for their administrative support; to Marton Cavani, Lauren Tobias, and Jordan Wyndelts for their communications and technological expertise; and to Christine Stencel for her work with the media. The IOM extends special thanks to Katharine Bothner and Judy Estep for their initiative and management skills, and to Abbey Meltzer for her dedication

throughout the project. Additional recognition goes to IOM staff members who contributed to the development of the workshop and to the production and dissemination of this publication: Christie Bell, Jody Evans, Linda Kilroy, Bill McLeod, Donna Randall, and Vilija Teel.

The workshop was webcast by Digitell and transcribed by Debra Gilliam. The IOM is grateful to the staff of the Hotel Monteleone for their generosity and flexibility while hosting the workshop. Thanks go to Leslie Pray for her rapid writing; to Mark Goodin for copyediting the summary; and to Francesca Moghari for designing the cover.

Finally, the IOM would like to express its appreciation to each workshop speaker and participant for enriching the workshop discussions by sharing their diverse perspectives and experiences.

Contents

Overview

On June 22-23, 2010, in New Orleans, Louisiana, the Institute of Medicine (IOM) convened a workshop, Assessing the Human Health Effects of the Gulf of Mexico Oil Spill. The workshop brought together more than 350 federal, state, and local government officials, expert scientists, academic leaders, policy experts, health care providers, public health advocates, community representatives and residents, and other participants from diverse disciplines to examine options for measuring the Gulf oil spill's potential health effects on different human populations. This publication summarizes the background, presentations, discussions, and public comments that occurred during the workshop.

INTRODUCTION

On April 20, 2010, the Deepwater Horizon offshore drilling rig in the Gulf of Mexico exploded, causing a sea-floor oil leak 1 mile beneath the ocean's surface. The explosion killed 11 workers and unleashed one of the largest offshore oil spills in U.S. history, threatening the entire Gulf and Atlantic coastline. The depth of the oil source has made it difficult to accurately measure how much oil is being discharged. At the time of this workshop,[1] official estimates of the amount of oil released daily into the Gulf of Mexico ranged drastically (MacDonald et al., 2010). The effects of this much oil on a community so dependent on the Gulf waters will be

[1]This report summarizes a workshop that took place on June 22-23, 2010. All the information presented, including estimated flow rates, is stated as of those approximate dates.

far-reaching and pronounced, leading many to describe the situation in the Gulf of Mexico as an oil disaster rather than an oil spill.

From the leak's origin, to the amount of oil released into the environment, to the duration and ongoing nature of the spill, the Gulf oil spill has presented many unique challenges. The clean-up efforts have been the most demanding on-water response in U.S. history, involving the use of more than 1 million gallons of oil spill dispersants (Judson et al., 2010) and the deployment of thousands of skimming vessels (Deepwater Horizon Response, 2010), including local boat operators who assist with containment and response activities using their "vessels of opportunity." Many on- and offshore commercial workers, clean-up workers, and volunteers have subjected themselves to numerous physical hazards (such as chemical exposures, heat stress, and injury) through response activities involving chemical dispersants, booms, and skimmers. Long work days and weeks are common as workers and volunteers combat waves and plumes of oil that continue to threaten their communities, livelihoods, and ways of life.

In addition to the physical stressors, the Deepwater Horizon oil disaster has disrupted delicate social, economic, and psychological balances in communities across the Gulf region. Local fishermen and -women in the region are grappling with possibly permanent disruptions to their long-standing livelihoods. Fears associated with contaminated beaches and food continue to dissuade tourists from visiting an area still recovering from the devastation of hurricanes such as Katrina, Rita, and Gustav. Communities question the safety of their most vulnerable populations and worry about the effects that the Gulf oil disaster will have on their immediate and long-term health. The resulting uncertainty about physical, social, and economic health has profound implications for the psychological well-being of individuals in affected communities.

Despite information available through studies of past oil spills and other disaster responses, uncertainty continues to mount in the absence of reliable and trustworthy information about the hazards posed by the Gulf oil spill and its related clean-up activities. A number of federal, state, academic, private-industry, and community efforts are already under way to help generate data that can answer some of the most pressing questions. However, more information is needed to best protect the health of affected populations in the contexts of the Deepwater Horizon oil spill and future public health disasters.

ASSESSING THE EFFECTS OF THE GULF OF MEXICO OIL SPILL ON HUMAN HEALTH: AN INSTITUTE OF MEDICINE WORKSHOP

To explore the need for appropriate surveillance systems to monitor the spill's potential short- and long-term health effects on affected communities and individuals, Secretary Kathleen Sebelius of the U.S. Department of Health and Human Services (HHS) contracted with the IOM to convene the public workshop Assessing the Human Health Effects of the Gulf of Mexico Oil Spill in the Gulf region. Nancy Adler chaired a six-member planning committee.[2] The workshop explored available scientific evidence about oil spills' effects on human health to guide the development of appropriate surveillance systems and to establish possible directions for additional research. Specifically, HHS asked the IOM to: (1) identify and discuss the populations most vulnerable to or at increased risk for adverse health effects, including worker subpopulations; (2) review current knowledge and identify knowledge gaps regarding the human health effects of exposure to oil, weathered oil products, dispersants, and environmental conditions such as heat; (3) consider effective communication strategies to convey information about health risks to at-risk populations, accounting for cultural, health literacy, linguistic, technological, and geographical barriers; (4) explore research methodologies and appropriate data collection to further our understanding of the risks to human health; and (5) review and assess components of a framework for short-term and long-term surveillance to monitor the spill's potential adverse health effects.

The 2-day workshop included expert presentations, six panel discussions, and an open-microphone dialogue with the audience. Sessions were designed to focus mainly on one of the five charges described above, but some overlap occurred. An additional goal of the workshop was to afford substantial opportunity to hear from members of the public. To accomplish this goal, the planning committee designed four methods for members of the public to submit their questions and comments to the workshop: (1) submitting electronic comments through the IOM website; (2) submitting a written comment sheet during the workshop; (3) completing question cards for individual panels; and (4) speaking during the workshop's public comment session. Appendix D includes a brief

[2]The planning committee's role was limited to planning and preparing the workshop. This document was prepared by rapporteurs as a factual summary of the workshop's presentations and discussions.

summary of the public comments and questions submitted to the IOM through all four methods.

WORKSHOP THEMES

The workshop provided the opportunity for all attendees to hear and to provide a rich array of experiences, diverse perspectives, and fresh ideas. Over the course of the workshop, certain ideas were often repeated in different ways. Box S-1 summarizes the emerging themes. These themes capture some of the overarching ideas and considerations that could inform the development of a successful surveillance and monitoring system.

BOX S-1
Emerging Workshop Themes

Complexity. Assessing the effects on human health of oil spills and response activities is complex.

Multiple dimensions. Human health is multidimensional and includes physical, psychological, and socioeconomic dimensions.

Uncertainty. Information about the specific hazards related to the Gulf oil spill and the range of potential acute and long-term effects of oil spills on human health is incomplete and leads to uncertainty.

Immediacy. Understanding the current state of knowledge can guide immediate actions to mitigate known risks and to fill existing knowledge gaps.

Community engagement. Community involvement and collaboration are essential when designing surveillance systems, related research activities, and effective risk communication strategies.

Coordination. Coordination can strengthen existing and developing surveillance and monitoring systems.

Commitment. Long-term surveillance and related research activities are critical to identifying acute, chronic, and long-term health effects of oil spills.

Complexity

Assessing the effects on human health of oil spills and response activities is complex. Factors such as oil composition and weathering, a diverse range of exposures and potential adverse health effects, the unique characteristics of affected populations, and the ongoing nature of the oil spill, can increase the assessment complexity.

Multiple Dimensions

Human health is multidimensional and includes physical, psychological, and socioeconomic dimensions. These dimensions are not independent and can influence the overall well-being of individuals and communities. A number of workshop participants predicted that the Deepwater Horizon disaster will likely have an even greater effect on the psychological health of affected communities because of serious and prolonged disruptions to the social environment and local economies.

Uncertainty

Information about the specific hazards related to the Gulf oil spill and the range of potential acute and long-term effects of oil spills on human health is incomplete and leads to uncertainty. Only a handful of studies have explored the potential short-term and especially long-term health consequences of oil spills, and the exact nature and extent of hazards, risks, and vulnerable populations contribute to the uncertainty. Some workshop participants suggested that this uncertainty could make effective risk communication with the public and surveillance-strategy development difficult.

Immediacy

Understanding the current state of knowledge can guide immediate actions to mitigate known risks and to fill existing knowledge gaps. Although many aspects of the Deepwater Horizon disaster remain uncertain, information exists that can help prevent and mitigate harm from recognized hazards, as a number of speakers explained. Increasing awareness of hazards and risks associated with adverse health outcomes can help prevent such outcomes, alleviate unnecessary anxieties, and in-

form the policies and procedures that shape responses to the Gulf oil spill and future disasters.

Community Engagement

Community involvement and collaboration are essential when designing surveillance systems, related research activities, and effective risk communication strategies. Local residents and communities have unique experience and expertise that can improve surveillance-related activities, especially if community engagement begins early. A number of participants suggested that community engagement can also strengthen surveillance activities by increasing community participation, encouraging surveillance activities that target "actionable" information, and improving the message and manner of risk communications.

Coordination

Coordination can strengthen existing and developing surveillance and monitoring systems. In light of limited resources and the oil spill's scope and magnitude, many speakers described the need for coordination between and among all interested parties, which may speed surveillance implementation and improve the overall impact of surveillance systems. Additionally, coordination and consultation between interested parties could result in shared platforms and standardization, which could strengthen the system as a whole.

Commitment

Long-term surveillance and related research activities are critical to identifying acute, chronic, and long-term health effects of oil spills. To support ongoing activities, a range of speakers stated that sustained commitments at the federal, state, and local levels are necessary. Investments in public health infrastructures can also play a significant role in the success of long-term surveillance activities. Finally, one speaker noted that if one of the goals of surveillance and related research is to drive action, then long-term strategies are needed to turn surveillance results into practice.

In addition to these recurring themes, participants offered a number of suggestions throughout the workshop on data collection, research methods, and components of an effective surveillance system. For exam-

ple, Nancy Adler proposed six possible dimensions to consider when designing a framework to guide development of a surveillance system and related research activities:

- *Key Characteristics.* A surveillance framework must be long-term, flexible, multilayered, and integrated.
- *Population(s).* A surveillance system needs to monitor all populations in order to establish a baseline for comparison, but must also focus on particularly vulnerable or at-risk populations.
- *Content.* Outcomes and measurement methods should be selected to best capture exposures and the effects of those exposures.
- *Processes.* A successful public health surveillance system will require public input from a wide variety of stakeholders, including communities and government agencies.
- *Use of Existing Data Sources.* A framework for surveillance can build on existing data sets or data-collection activities.
- *Unanswered Questions.* Identifying knowledge gaps and pertinent questions can be as informative to developing a framework for surveillance systems identifying what is known.

WORKSHOP IN BRIEF

Workshop Introduction (Chapter 1)

The oil spill in the Gulf of Mexico and related response activities are unprecedented in the United States. Chapter 1 outlines the events leading up to the IOM's June 22-23 workshop, explains the workshop's overarching goals, and describes themes that emerged during the course of the workshop. Presentations in this chapter focused on the compelling need to understand the potential effects of oil spills on human health and set the stage for later panel discussions. Specifically, expert speakers discussed the current level of scientific understanding about the effects of oil spills on human health and described the chemical composition of oils and oil dispersants, explaining what happens when oil spills into the environment.

At-Risk Populations and Routes of Exposure (Chapter 2)

Effective surveillance systems require a basic understanding of exposure pathways, which includes identifying the contaminant source, available environmental media, exposure points, exposure routes, and the at-risk population. To better identify the most salient hazards when developing a framework for surveillance and monitoring activities, this chapter focuses on different hazards, routes of exposure, and at-risk populations. Panelists discussed not only how different populations (e.g., fishermen and -women, clean-up workers, and residents of the affected communities) are exposed to different hazards related to the oil spill, but also the particular population vulnerabilities and available preventive steps that can affect the likelihood of experiencing adverse health effects.

Short- and Long-Term Effects on Human Health (Chapter 3)

This chapter covers discussions about the current state of knowledge and knowledge gaps regarding a wide range of effects on human health as a result of exposure to oil, weathered-oil products, dispersants, and environmental conditions such as heat. Panelists considered short-term and long-term outcomes; physical and psychological effects of exposure; physical stressors (e.g., heat stress and fatigue) and chemical stressors (e.g., the oil and dispersants); and potential health effects in both the general population and among children and pregnant women, specifically. The panel's goal was to consider which potential adverse effects to include in surveillance and to identify gaps in knowledge that could influence future surveillance programs.

Communicating with the Public (Chapter 4)

One purpose of a surveillance system is to generate information to better protect the health of all affected populations by improving the organization and delivery of health care services (see Chapter 6 for a more detailed discussion of this issue). Timely and reliable data collection and analysis is only one measure of an effective surveillance system. This chapter explores strategies for engaging the public in risk communication, such as identifying the most critical needs of affected populations, engaging the public in surveillance-system and research development,

and establishing mechanisms to communicate credible, reliable, and actionable data. This chapter also includes invited remarks from community representatives and audience members.

Overview of Health-Monitoring Activities: State and Federal Perspectives (Chapter 5)

The state- and federal-level governmental responses to medical and health-related issues around the Deepwater Horizon disaster are dedicated to developing surveillance approaches based on the best available science, to providing needed health services to affected communities as part of surveillance, and to collecting the necessary data to ensure that responses to future disasters are based on an even stronger evidence base. In this chapter, state health officials from Alabama, Florida, Louisiana, Mississippi, and Texas describe the oil spill response from their respective states. Federal representatives from the Office of the U.S. Surgeon General, the Department of Health and Human Services, the Department of Homeland Security, and the Environmental Protection Agency also discuss current response activities.

Data-Collection, Surveillance, and Research Methodologies (Chapter 6)

There is an important distinction but critical connection between the goals of surveillance and the goals of research. This chapter explores research methodologies and available data sources (including ongoing health surveillance and surveys) that could be used to monitor effects of the Gulf oil spill. Panelists discussed characteristics of a surveillance framework that can efficiently and effectively identify and monitor potential short- and long-term health effects and help ensure the establishment of an integrated and coordinated health-monitoring system.

Developing Effective Surveillance and Monitoring Systems: Future Directions and Resource Needs (Chapter 7)

One of the workshop's main objectives was to examine options for a surveillance-system framework to monitor the Gulf oil spill's short- and long-term effects on human health. This final session was designed to integrate the many perspectives and themes that emerged throughout the workshop, including opportunities to build on what is already known and what has yet to be discovered. Considering the broad range of scientific evidence and suggestions presented throughout the course of the workshop, panelists discussed possible components and suggestions to develop a framework for effective surveillance systems and monitoring activities.

1

Introduction

WORKSHOP BACKGROUND

The oil spill in the Gulf of Mexico is unprecedented. From the origin of the leak, to the amount of oil released into the environment, to the spill's duration and ongoing nature, the Gulf oil spill poses unique challenges to human health. On April 20, 2010, the Deepwater Horizon offshore drilling rig exploded in the Gulf of Mexico, killing 11 workers. The explosion led to a sea-floor oil leak 1 mile beneath the ocean's surface. The gusher's depth has made it difficult to accurately measure how much oil is being discharged, with officials estimating 35,000 to 60,000 barrels[1] a day and some scientists estimating 40,000 to 100,000 barrels per day (MacDonald et al., 2010). Located approximately 40 miles off the coast of Venice, Louisiana, but threatening the entire Gulf and Atlantic coastlines, the Deepwater Horizon oil spill, also known as the Gulf of Mexico oil spill or disaster, is the largest offshore oil spill in U.S. history.

The clean-up effort has been the most demanding on-water response in U.S. history, calling for the use of more than 1 million gallons of oil spill dispersants (Judson et al., 2010) and the deployment of more than 2,500 skimming vessels (Deepwater Horizon Response, 2010), including approximately 2,000 "vessels of opportunity" (local boat operators assisting with containment and response activities), by mid-June.[2] The

[1]There are 42 gallons in a typical barrel of crude oil.

[2]This report summarizes a workshop that took place on June 22-23, 2010. All the information presented, including estimated flow rates, is stated as of those approximate dates.

potential physical, psychological, and socioeconomic impacts of the Gulf oil spill and clean-up response on the short- and long-term health of individuals in the affected region—including land- and sea-based clean-up workers, fishermen and -women, other commercial workers, residents, visitors, and communities as a whole—are unknown.

Assessing the Effects of the Gulf of Mexico Oil Spill on Human Health: An Institute of Medicine Workshop

Appropriate monitoring is one key to detecting the spill's short- and long-term physical and psychological health effects on at-risk individuals and to assessing appropriate preventive and health care services. To inform this endeavor's development and implementation, Secretary Kathleen Sebelius of the U.S. Department of Health and Human Services (HHS) asked the Institute of Medicine (IOM) to convene a public workshop to provide expert, scientific input on surveillance needs and directions for future research. (Box 1-1 provides HHS's charge to the IOM.) Nancy Adler chaired the six-member planning committee.[3]

Drawing on the best scientific expertise, the workshop examined a broad range of health issues potentially related to the Deepwater Horizon oil disaster and response with a focus on informing health-monitoring and health care efforts. Workshop presenters and attendees examined a broad range of potential health issues related to the Gulf oil disaster and response. The 2-day workshop comprised four half-day sessions that included expert presentations, six panel discussions, and an open-microphone dialogue with the audience. This report summarizes the panel presentations, discussions, and public comments that occurred during the workshop. (See Appendix C for the workshop agenda.)

Given the gravity of the impact of the Gulf oil spill, it was important to both the IOM and the planning committee members to afford abundant opportunity to hear from members of the public. To accomplish this goal, the planning committee designed four methods for members of the public to submit their questions and comments to the workshop: (1) submitting electronic comments through the IOM website; (2) submitting a written comment sheet during the workshop; (3) completing question cards for

[3]The planning committee's role was limited to planning and preparing the workshop. This document was prepared by rapporteurs as a factual summary of the workshop's presentations and discussions.

BOX 1-1
Charge to the IOM from HHS

- Identify and discuss the populations most vulnerable to or at increased risks for adverse health effects, including worker subpopulations.
- Review current knowledge and identify knowledge gaps regarding the human health effects of exposure to oil, weathered oil products, dispersants, and environmental conditions such as heat.
- Consider effective communication strategies to convey information about health risks to at-risk populations, accounting for culture, health literacy, language, technology, and geographic barriers.
- Explore research methodologies and appropriate data collection to further our understanding of the risks to human health.
- Review and assess components of a framework for short- and long-term surveillance to monitor the spill's potential adverse health effects.

individual panels; and (4) speaking during the workshop's public comment session. Appendix D includes a brief summary of the public comments and questions submitted to the IOM through all four methods.

During the 2-day workshop, several individuals made personal recommendations for moving forward. Importantly, the personal recommendations and the other statements and opinions that were expressed do not reflect group consensus and should not be construed as such. None of the ideas and suggestions published in this report have been endorsed or verified by the National Academies, the Institute of Medicine, or workshop participants as a whole. Furthermore, although the current affiliations of panelists are noted in the report, many speakers qualified their comments as personal opinion that did not necessarily represent the positions of their affiliated organizations (unless specifically noted). Finally, readers should keep in mind that the workshop and writing of this summary report occurred in mid-June through mid-July, 2010, just after British Petroleum installed a temporary cap on the broken wellhead.

The IOM workshop covered a wide range of complex and sometimes sensitive issues. To avoid confusion, it is important to define a few key terms that will be used throughout this summary. First, "health" is a very broad concept. Lynn Goldman reminded the workshop that the World Health Organization defines "health" as a complete state of physical, mental, and social well-being, and not merely the absence of disease or infirmity. Additionally, a number of participants noted the impact that a failing economy can have on health. Although the summary sometimes

categorizes health as physical or psychological for purposes of organization, the subsequent discussions acknowledge the multifaceted nature of health, which is dependent on physical, psychological, social, and economic factors.

Second, because a broad definition of health necessarily implies an even broader range of factors that can affect health status, risks to health include more than simple physical or chemical exposures. In this report, a "hazard" is anything that can cause harm, such as chemical and physical exposures, dangerous working or living conditions, and loss of livelihoods. "Risk" is also used more broadly to mean the chance of a harm occurring. To the extent possible, this summary limits the use of "exposure" to chemical or heat exposures. However, speakers differed in their definitions of "exposed" individuals or populations. Some speakers referred only to individuals who had direct bodily contact with oil spill contaminants whereas others used a broader definition that included individuals affected by the oil spill's socioeconomic impacts.

Finally, a few participants argued that the term "oil spill" did not adequately describe the inception of, or the current situation in, the Gulf of Mexico, arguing that "disaster" may be more appropriately used. For example, Maureen Lichtveld stated that the Gulf oil spill was a disaster "regardless of who declares it, when it is declared, or how it is declared." When referring to the oil in the Gulf of Mexico, this report uses both terms, which may be preceded by "the Gulf of Mexico," "the Gulf," or "the Deepwater Horizon." This decision is not meant to imply that the situation in the Gulf is anything less than disastrous for communities affected by the oil and response activities.

Workshop Themes

The workshop provided the opportunity for attendees to hear and to provide a rich array of experiences, diverse perspectives, and a variety of fresh ideas. Over the course of the workshop, certain refrains were often repeated by individuals. These themes represent some of the characteristics and considerations that workshop participants discussed in the context of developing a surveillance system to monitor the spill's effects on human health. Box 1-2 summarizes the emerging themes.

BOX 1-2
Emerging Workshop Themes

Complexity. Assessing the effects on human health of oil spills and response activities is complex.

Multiple dimensions. Human health is multidimensional and includes physical, psychological, and socioeconomic dimensions.

Uncertainty. Information about the specific hazards related to the Gulf oil spill and the range of potential acute and long-term effects of oil spills on human health is incomplete and leads to uncertainty.

Immediacy. Understanding the current state of knowledge can guide immediate actions to mitigate known risks and to fill existing knowledge gaps.

Community engagement. Community involvement and collaboration are essential when designing surveillance systems, related research activities, and effective risk communication strategies.

Coordination. Coordination can strengthen existing and developing surveillance and monitoring systems.

Commitment. Long-term surveillance and related research activities are critical to identifying acute, chronic, and long-term health effects of oil spills.

Complexity

Assessing the effects on human health of oil spills and response activities is complex. Individual workshop participants identified a number of factors, such as oil composition and weathering, a diverse range of exposures and potential adverse health effects, the unique characteristics of affected populations, and the ongoing nature of the oil spill, that increase the complexity of assessing the effects of the Gulf oil spill on human health.

Multiple Dimensions

Human health is multidimensional and includes physical, psychological, and socioeconomic dimensions. These dimensions are not independent, but interact to influence the overall well-being of individuals

and communities, said Maureen Lichtveld. Describing numerous acute physical symptoms from oil-spill-related exposures and other hazardous conditions, a number of workshop participants, including Howard Osofsky, predicted that the Deepwater Horizon disaster will likely have an even greater effect on the psychological health of affected communities because of serious and prolonged disruptions to the social environment and local economies.

Uncertainty

Information about the specific hazards related to the Gulf oil spill and the range of potential acute and long-term effects of oil spills on human health is incomplete and leads to uncertainty. A number of speakers, such as Nancy Adler, Blanca Laffon, and Nalini Sathiakumar, explained that very little is known about the potential short-term and especially long-term health consequences of the Gulf oil spill, despite lessons learned from past large oil spills, such as the *Exxon Valdez* and *Prestige* spills. Moreover, the exact nature and extent of hazards, risks, and populations vulnerable to adverse health effects are ill-defined, contributing to the uncertainty. As a result, it is difficult to develop and communicate strategies for action, which can contribute to elevated levels of anxiety and fear among affected populations, said Howard Osofsky.

Immediacy

Understanding the current state of knowledge can guide immediate actions to mitigate known risks and to fill existing knowledge gaps. Although many aspects of the Deepwater Horizon disaster remain uncertain, public health officials can draw from what is known to prevent and mitigate harm from identified hazards, said Paul Lioy and other participants. Additionally, there is an urgent need to begin data-collection and surveillance activities immediately, in order to accurately assess the relationships between exposures and conditions related to the Gulf oil spill and adverse health outcomes, argued speakers including John Bailar.

Community Engagement

Community involvement and collaboration are essential when designing surveillance systems, related research activities, and effective risk communication strategies. A number of participants, such as Maureen Lichtveld, noted that local residents and communities have unique experience and expertise that can improve surveillance-related activities, especially if community engagement begins early. A number of participants, including David Abramson, said that community engagement can also strengthen surveillance activities by increasing community participation, encouraging surveillance activities that target "actionable" information, and improving the message and manner of risk communications.

Coordination

Coordination strengthens existing and developing surveillance and monitoring systems. In light of limited resources and the oil spill's scope and magnitude, coordination between and among all interested parties is essential, said Linda Rosenstock and others. Some presenters spoke about the need for centralized oversight to coordinate the activities across sectors. Others, like Lynn Goldman, asserted that coordination could also extend to shared platforms or standards.

Commitment

Long-term surveillance and related research activities are critical to identifying acute, chronic, and long-term health effects of oil spills. Scott Barnhart, among other speakers, emphasized the importance of continuous reassessment based on real-time monitoring of exposure data. A number of participants suggested that long-term investment should focus on public health infrastructure, rather than individual disasters or outbreaks.

In addition to these recurring themes, participants offered throughout the workshop a number of suggestions on data collection, research methods, and components of an effective surveillance system. This summary covers these suggestions in greater detail in later chapters.

Welcome

Harvey V. Fineberg, Institute of Medicine
Nancy E. Adler, University of California, San Francisco

In his opening remarks, Harvey Fineberg, president of the IOM, welcomed workshop participants, expressing a sense of unity with the people in the Gulf region. Observing that many participants were both directly and intimately involved in current response efforts to the Gulf oil spill, he thanked planning committee members, local hosts, and every participant for attending the workshop on such short notice. He also expressed his appreciation to Secretary Sebelius and HHS for sponsoring the workshop.

Describing the Gulf oil catastrophe as being distinctive in its scope, magnitude, and duration, Fineberg said that the workshop's primary purpose was "to join together to share our best thinking, our experience, our ideas, our expertise, our concerns, and our strategies" to develop a clearer, more comprehensive, and more focused sense of how to assist, and monitor the health of, people from affected regions.

Stating what would very quickly emerge as a major overarching theme of the 2-day conference, Fineberg remarked that the complexity of the assessment derives from the reality that it will involve more than scientifically evaluating the medical consequences of exposure to chemical (and physical) substances; it will also require evaluating the social consequences of the Gulf oil catastrophe and developing a better understanding of the culture and needs of the people in the Gulf region.

Nancy Adler, the chair of the workshop planning committee, stated that the amount of uncertainty defines the Deepwater Horizon spill. From oil on the beaches, to oil fumes, to oil dispersants, to controlled burns, to extreme heat, to possible effects within the food chain, to the, perhaps, permanent disruption of people's livelihood, Adler said that this oil spill's effects on human health is uncertain not only because of the lack of evidence from prior oil spills but also because of the unprecedented magnitude and scope of the Deepwater Horizon spill. She said, "For people of this region, which have had more than [their] share of disasters, I wish we could bring more definitive data to say, 'These are the known health effects.' Unfortunately, we are not able to do that right now." Instead of reaching consensus recommendations, Adler emphasized that the workshop is an important step toward identifying the critical questions and laying out a range of options for answering those questions.

Charge to Workshop Participants

Nicole Lurie, U.S. Department of Health and Human Services

Nicole Lurie, Assistant Secretary for Preparedness and Response,[4] summarized the charge to the IOM (see Box 1-1). Differentiating the Gulf oil spill from other environmental disasters, Lurie noted that developing and relying on the best available science was a critical factor to responding to a major environmental catastrophe. "Unfortunately," said Lurie, "we still don't have the kind of evidence base we need." Beyond guiding the HHS response to the oil spill, Lurie stated that the workshop's goal was also to explore "a shared framework for thinking about … the health issues and the work that needs to be done" to prepare the U.S. public health community for this and future disasters, especially those characterized by a high degree of uncertainty.[5] Moreover, said Lurie, the response to this oil spill will be as much a communication issue as it will be a scientific issue.

THE COMPELLING NEED TO UNDERSTAND THE POTENTIAL EFFECTS OF OIL SPILLS ON HUMAN HEALTH

Bernard Goldstein, Blanca Laffon, and Edward Overton set the stage for the workshop by providing scientific overviews of what is known (and not known) about oil, the relationship between oil spill exposures and human health, and lessons learned from previous oil spill surveillance and research activities. Specifically, Goldstein discussed the current level of scientific understanding regarding the effects of oil spills on human health, emphasizing that, while disaster response has improved over the past 20 years (since the *Exxon Valdez* spill), it still "has a long way to go." Laffon summarized results of the handful of previous studies on the human health effects of exposure to oil spills and described in detail the human health biomonitoring activities that occurred (and are still occurring) following another major oil disaster (the *Prestige* spill).

[4]Lurie is responsible for coordinating all spill-related public and mental health activities being conducted by the various HHS agencies.

[5]Although the workshop was not designed to address liability issues, this topic emerged in several discussions later in the workshop, mostly within the context of discussing lessons learned from efforts to conduct long-term research related to the *Exxon Valdez* spill. In fact, some participants remarked that it would have been helpful to have had someone with expertise in the liability arena attending the workshop.

Finally, Overton described the chemical makeup of oils and oil dispersants and explained what happens when oil spills into the environment; he emphasized the dynamic nature of the composition of oil spilled into the environment and how exposure varies across time and space.

Understanding the Effects of Oil Spills on Human Health

Bernard D. Goldstein, Pittsburgh Graduate School of Public Health

In discussing the current level of scientific understanding regarding the effects of oil spills on human health, Goldstein stated that, while disaster response has improved over the past 20 years (since the *Exxon Valdez* spill), it still "has a long way to go." He described the complex cause-and-effect relationship between oil spill exposures and human health and the lack of evidence around how best to respond to a disaster of this magnitude. Goldstein used three themes to organize his remarks.

The first theme was the unity of human health and the environment. When oil spills into the physical environment, it also spills into the social environment, creating a very complex situation with many unanswered questions about the impact of oil and oil dispersants on human health. Goldstein stated that a growing body of knowledge has been building around the inextricable link between health and the environment. The Gulf oil spill is not just an environmental disaster—it is also a human health disaster. Access is needed to data on the toxicological effects of oils and dispersants, but data may qualify as proprietary information, which may prevent individuals or companies from releasing the data to the public. Goldstein called for legislative reform to limit litigation secrecy and to increase accessibility to proprietary toxicology data.[6] The situation is even more complex because of the possibility that oil or dispersants might contribute to the hypoxic "dead zone" in the Gulf, resulting in human health effects from algal blooms, such as red tides.

Goldstein's second theme stated that, although our capacity to respond to the public health consequences of disasters is greater than it has been in the past, there is still "a long way to go." Citing several *Exxon Valdez* studies by Lawrence Palinkas and colleagues (see e.g., Palinkas et al., 1992) and referring to the more than 100 additional studies on the

[6]Corexit manufactures a dispersant used in the Gulf oil spill cleanup. Goldstein noted that, although Corexit is providing all legally required information to the public, additional data could provide helpful information about the potential toxicological effects of the dispersant.

health effects of exposure to the World Trade Center attack in 2001, Goldstein stated that there is a growing body of knowledge on ways to improve disaster response and to prevent adverse human health effects. Much of this past research—and, therefore, the knowledge gained—is in the area of mental health. (Palinkas spoke about some of this research in a later session; see Chapter 2 for a summary of his remarks.) Additionally, there are several new federal programs relevant to the clean-up response that were not in place 20 years ago. For example, the National Institute of Environmental Health Sciences (NIEHS), an organization typically associated with basic research, has a very effective hazardous waste training program that has trained more than 1 million workers since its inception, many of whom were involved in the 9/11 clean-up response. Other programs that did not exist 20 years ago include the Centers for Public Health Preparedness (funded by the Centers for Disease Control and Prevention [CDC]) and Preparedness and Emergency Response Research Centers programs.

The third theme was that the majority of the expertise needed for disaster response, just as the majority of the impact, will always be local. Goldstein described the importance of involving affected communities and engaging local authorities in the Deepwater Horizon response. He discussed the concept of environmental justice and its three "indisputable truisms": (1) there are more environmental hazards in disadvantaged communities; (2) there are more individuals with poor health in disadvantaged communities; and (3) individuals with poor health tend to be more susceptible to environmental pollutants.

Recognizing these truisms, Goldstein suggested three levels of community participation. First, environmental health research should focus on disadvantaged communities. Second, to be successful, environmental health research requires the cooperation of disadvantaged communities. Too often in academia, community participation involves either communicating the results of a study after the study has been completed or allowing community members to participate in the study. The current situation, Goldstein said, calls for a third level of participation: working with the community and together deciding what research should be done and how to do it. This will involve going beyond studying the effects of exposure to one or more specific chemicals and will require considering how to assess objective and subjective outcomes, such as job loss or disruptions to a quality and way of life—things that matter to the population or culture being affected by the Gulf oil spill.

Research on the Human Health Effects of Exposure After Oil Spills: The *Prestige* Experience

Blanca Laffon, University of A Coruña, Spain

The human health effects of exposures during oil spills have been studied following only 7 of the 38 major oil spills over the past half century, said Blanca Laffon. These studies have examined various acute symptoms (e.g., eye and throat irritation, respiratory symptoms, dermatological symptoms), physiological functions (e.g., renal function, liver function), and psychological symptoms (e.g., depression, anxiety, post-traumatic stress). Generally, the results have shown evidence of effects, but those effects diminish with time and are largely reversible.

Laffon discussed the *Prestige* accident, which occurred 130 miles off the coast of France and Spain. The *Prestige* spill involved about 44,000 tons initially and 22,000 tons over the course of the next few weeks (125 tons/day) and attracted a total of 327,476 volunteers from throughout Europe to help clean the sea, beaches, rocks, and oil-contaminated birds and other fauna. The oil was a complex mixture of compounds, including three groups of compounds with known human health consequences of exposure (e.g., genotoxicity, carcinogenicity, endocrine disrupting): (1) volatile organic compounds (VOCs); (2) polyacylic aromatic hydrocarbons (PAHs); and (3) heavy metals.

Before the 2002 *Prestige* spill off the Galician coast of Spain, there was no evidence on the potential chronic human health effects of exposure to spilled oils. Because of the large number of people involved in the *Prestige* clean-up effort, Laffon and colleagues saw an opportunity to fill some gaps in knowledge around the potential adverse, long-term health effects of exposure, especially genotoxicity. They designed a study with two key objectives: (1) to evaluate the genotoxic effects of oil exposure during the handling of oil-contaminated birds and the cleaning of beaches and rocks; and (2) to determine the influence of physiological factors, consumption habits, and the use of protective devices on genotoxicity. Laffon described the study in detail.

The first part of the study involved examining genotoxicity in individuals who had performed autopsies and cleaned oil-contaminated birds (34 exposed individuals, 35 controls). Briefly, according to the results of one type of genotoxicity test (the "comet assay," which measures DNA damage at the cellular level), the first part of the study demonstrated significant genotoxic damage in the exposed individuals, with genotoxicity being greater among individuals exposed for longer periods of time.

However, according to a second type of genotoxicity test (the "micronuclei assay," which measures permanent structural chromosomal alterations), there was no significant genotoxicity effect among the exposed individuals. Laffon and her team concluded that, because the results of the first test were positive, there was significant DNA damage, but the negative results of the second test suggest that whatever damage occurred initially did not persist.

Additionally, because not all of the individuals in the first part of the study wore protective masks, the researchers were also able to assess whether the effects of exposure on genotoxicity are the same or different between clean-up workers who wear masks and those who do not. Again, although there appeared to be more damage among individuals who did not wear the protective masks, the damage subsided over time.

The second part of the study involved examining genotoxicity in individuals who had participated in the beach and rock clean-up effort. According to the results of the comet assay, all three exposed groups demonstrated significant DNA damage, with the most damage occurring in volunteers. Laffon and colleagues surmised that, because the clean-up workers had been exposed for several months before testing, they may have developed an adaptive response over time. According to results of the micronuclei assay, both the manual workers and workers using high-pressure water machines experienced significant DNA damage, suggesting that a long period of exposure was necessary to induce significant genotoxic damage. According to results of a third genotoxicity assay (the "sister chromatid exchange [SCE] assay"), only workers using high-pressure machines showed significant DNA damage. Based on results of the three assays, the researchers concluded that the genotoxic effects of exposure change over time and vary depending on the type of clean-up work being done.

Also in the second part of the study, the researchers examined levels of exposure to VOCs and heavy metals and found that, with respect to VOCs, volunteers were the most exposed and workers using high-pressure water machines were the least exposed. With respect to heavy metals, all the different types of workers showed significant exposure to aluminum compared to the controls, but only some of the different types of workers showed significant exposure to nickel and zinc (volunteers and workers who used high-pressure water machines) and lead (clean-up workers who worked manually). None of the workers showed significant exposure to cadmium.

Additionally, the researchers evaluated the value of wearing protective devices, given that most bodily contact with oil is with the hands, followed by the head, neck, arms, legs, and feet. The researchers found that neither clothes nor masks correlated with significant reductions in symptoms, which could suggest that the protective devices may not have been suitable or that workers may not have been using the protective devices correctly. Laffon and colleagues are still studying the chronic genotoxic effects of the spill.

What Exactly Are People Being Exposed to During the Deepwater Horizon Oil Disaster Cleanup?

Edward Overton, Louisiana State University

The sparse data on exposure to oil spills and the human health effects of such exposure, coupled with the reality that not all oil spills are the same (e.g., oil acts differently in different circumstances—the *Exxon Valdez* oil was a heavy, thick, "gunky" material, compared to the Deepwater Horizon oil, which is already emulsified by the time it reaches the ocean surface), has led to a great deal of uncertainty around exactly what it is that workers and other populations have been and continue to be exposed to during the Deepwater Horizon oil disaster and response. Edward Overton explored some of this uncertainty.

What Is Oil?

Oil acts differently in different environments, but there are some "rules of thumb" when you are designing surveillance frameworks to evaluate exposures to oil, Overton explained. First, oil contains many thousands of compounds. Moreover, all oils contain the same compounds and molecular structures, regardless of their source. Differences among oils (e.g., between the *Exxon Valdez* oil, and the Deepwater Horizon oil) are caused by differences in quantities of those compounds in the oils. Overton and his colleagues analyzed the content of the Deepwater Horizon oil and detected nearly 2,000 identifiable compounds.

Second, the quantity of different hydrocarbons determines an oil's chemical and physical properties. For example, an oil that contains lighter, smaller molecules is less viscous. The Deepwater Horizon oil is an extremely light oil, which affects evaporation at the ocean's surface.

The structure of the hydrocarbon (e.g., straight-chain, branched, and nonaromatic and aromatic cyclical) also affects how an oil interacts with its environment. Aromatic compounds include benzene and PAHs or PAH homologs, and may include sulfur or heavy metals within the chain. Finally, oil contains a class of residue, asphaltenes, which together form what we call road tar.

Third, most aromatic hydrocarbons in oils are alkyl homologs of "parent" polycyclic compounds, and most studies on the human health effects of oil exposure have involved parent polycyclic compounds (the Environmental Protection Agency's [EPA's] standard oil analytic test, the 8270 GCMS method, detects only the parent compounds). The Deepwater Horizon oil has almost no parent polycyclic compounds, which means that the standard 8270 GCMS method would not be useful.

Lastly, because there are so many compounds present in oil, it is difficult to evaluate toxicity. While the aromatic hydrocarbons are responsible for much of the toxicity, Overton cautioned that they are not the only compounds in oil with potentially toxic effects on human health. Oil also contains a series of saturated compounds, including hydrocarbons, that are called biomarkers. Because biomarkers do not degrade quickly, they can be used to trace oil as it moves through the environment.

What Happens to Oil in the Environment?

It is extremely difficult to quantitatively analyze oil in the environment—both fresh oil in the water and weathered oil on the beach—because of oil's heterogeneous distribution. Oil starts changing immediately after it leaves the wellhead. Overton explained how, at the time of the workshop, the Gulf Oil disaster involved two main types of oil: a very light, floating oil (source oil) and a very heavy, sinking oil (weathered oil). Initially, the more toxic, lighter compounds (e.g., benzene and other aliphatic hydrocarbons) break off and enter the water column. As oil continues to weather, it becomes heavy and sticky, which Overton stated is likely a high-asphaltenic oil. The weathered oil is neutrally buoyant and can easily wash down into the water column and settle on the bottom of the ocean floor. He listed several weathering steps that oils can undergo and commented on their relevance to the Gulf oil spill:

- Adsorption (sedimentation). The process by which one substance is attracted to and adheres to the surface of another substance without actually penetrating its internal structure. This is not a significant problem in the Gulf.
- Biodegradation. The degradation of substances resulting from their use as food energy sources by certain microorganisms. The Deepwater Horizon oil is an "imminently degradable" oil, Overton said, and the bacteria "love it." He stated that biodegradation and evaporation together led to about 30-50 percent of the Deepwater Horizon oil weathering away within the first week.
- Dispersion (either naturally or through chemicals). The distribution of spilled oil into the upper layers of the water column by natural wave action or application of chemical dispersants. Corexit 9500, the dispersant being used at the time of the workshop, is composed of six components. Information about the components is available on the Nalco Company website (Nalco, 2010).
- Dissolution (or subsurface weathering). The act or process of dissolving one substance in another. In the Gulf oil spill, many of the small molecules dissolve within the water column as it rises to the surface. This creates oil plumes. Although the concentration of dissolved chemicals within an oil plume is relatively low when compared to freshly released oil, toxicity of certain dissolved chemicals may still be a concern.
- Emulsification. The process whereby one liquid is dispersed into another liquid (emulsifies) in the form of small droplets. Because this is a deep spill, the oil has plenty of time to emulsify within the water column, turning the oil into what looks like a "red mousse" (see cover photograph).
- Evaporation. The process whereby any substance is converted from a liquid state to become part of the surrounding atmosphere in the form of a vapor. Again, biodegradation and evaporation together led to about 30-50 percent of the Deepwater Horizon oil disappearing within the first week.[7]

[7]Given that roughly 50 percent of the oil may evaporate when it reaches the ocean surface, it is logical that clean-up workers and volunteers may be at the greatest risk of exposure to these evaporated chemicals. However, as Overton stated, most health studies have focused on the heavier PAH compounds, which tend to remain in the water.

- Photo-oxidation. In the context of the Gulf oil spill, photo-oxidation occurs when sunlight facilitates a chemical reaction between the air and oil. As Overton explained, photo-oxidation basically takes a nonpolar molecule and makes it polar, which enhances the production of stable emulsions. Additionally, photo-oxidation can enhance phototoxicity. Although photo-oxidation has not been shown to have much of a direct effect on the human population, it does affect the ecology of our environment, which can indirectly impact human health.

Overton concluded by summarizing the types of issues that need to be considered when evaluating the complexity of exposure analysis. In addition to the effects that weathering has on the large number of existing chemicals and chemical structures within oil, the ongoing nature of the Gulf oil spill further complicates monitoring activities because not all the oil within the environment is at the same stage of the weathering process. Therefore, the exposure risks are constantly changing as the oil itself evolves within the environment.

2

At-Risk Populations and Routes of Exposure

Effective surveillance systems require a basic understanding of exposure pathways, which includes identifying the contaminant source, available environmental media, exposure points, exposure routes, and the at-risk population, said Maureen Lichtveld. When developing a framework for surveillance, it is also important to understand why certain populations are at risk for developing particular short- and long-term adverse health effects.

Hazard assessment, including assessing chemical exposures and psychological impacts, is complex. The at-risk populations are defined by a wide range of characteristics that affect the types of hazards and the routes of exposure of greatest concern to different populations. As Edward Overton noted (see Chapter 1), oil comprises more than 2,000 chemicals that vary in amount and structure as oil weathers, and oil dispersants may expose individuals to additional chemicals. In addition to chemical exposures, occupational hazards related to clean-up activities may also pose significant risks of harm due to injury, intense heat and fatigue, and particulate matter from controlled burns. In the general population, the socioeconomic impacts stemming from the Gulf oil spill have psychological and physical ramifications that continue to affect a growing number of individuals.

To better identify the most salient hazards when developing a framework for surveillance and monitoring activities, this panel explored different exposures and conditions, routes of exposure, and at-risk populations. Panelists discussed not only how different populations (e.g., fishermen and -women, clean-up workers, and residents of the affected communities) are exposed to different hazards related to the oil spill, but also the particular population vulnerabilities and available preventive

steps that can affect the likelihood of experiencing adverse health effects. Linda Rosenstock moderated the panel discussion.

John Howard proposed a framework that used proximity to the oil spill source to define the risks of exposure and anxiety or concern for specific categories of at-risk populations. He stated that different subpopulations may be more likely to encounter specific hazards, which may affect overall risk calculations and public health responses aimed at injury, illness, and disability prevention. By tracking possible links between measured hazards and adverse health outcomes, a surveillance system may be able to predict future exposures, to mitigate the damage from past and ongoing exposures, and to ensure care for those affected.

Scott Barnhart discussed specific occupational hazards and risks to workers and volunteers, noting that certain other physical and psychological hazards may pose greater risk of harm than more distinct chemical exposures, especially if workers and volunteers are trained properly to use personal protective equipment. Paul Lioy described elements of an effective disaster response, including problem identification, strategic planning, and recognition of opportunities to minimize and prevent exposure.

Maureen Lichtveld explored the various characteristics of the populations in the Gulf States that may inform and improve surveillance system design and implementation. She recommended involving local experts and communities in the development of surveillance and communication activities to ensure that these activities are participatory in nature, include a holistic approach to individual and community health, and provide cultural competence and transparency. This chapter summarizes the workshop presentations and discussions on at-risk populations and routes of exposure.

POPULATIONS OF CONCERN: DIFFERENT EXPOSURES, DIFFERENT RISKS[1]

John Howard, National Institute for Occupational Safety and Health

Different subpopulations experience different types and levels of exposure, which affects risk calculations and preparations for public health responses aimed at preventing injury, illness, and disability. By develop-

[1]This section summarizes the panel remarks of John Howard that pertained to at-risk populations. See Chapter 5 for a summary of Howard's remarks on the federal response to the Gulf oil disaster.

ing a system to monitor the oil spill's effects, the federal government anticipates that it will be better able to predict future exposures, to mitigate the damage from past and ongoing exposures, and to ensure care for those affected, said John Howard. Using a proposed "bull's-eye" model (see Figure 2-1), Howard categorized the types and levels of exposure by proximity to the oil source. The different subpopulations include workers at or near the plume, clean-up workers on the water, clean-up workers on the beach, affected communities, and the general public.

Exposure to oil freshly released into the environment poses more risks than exposure to oil closer to shore. Referencing Overton's remarks (see Chapter 1), Howard explained that oil moving from the wellhead to the surface contains compounds such as volatile organic compounds (VOCs), explosive vapors, and methane. Dispersants are also more concentrated in the area where oil moves from the wellhead to the surface. As a result, workers nearer the point of origination are more likely to be exposed to higher levels of VOCs. For instance, clean-up workers on vessels drilling relief wells may be at higher risk for inhaling VOCs than workers on vessels laying boom or skimming oil-contaminated waters nearer to shore. And workers directly involved with burning oil will be exposed to higher concentrations of combustion products, heat, and rare flash fires.

Clean-up efforts on land are as varied as those on the water, leading to a wide variety of exposures, stated Howard. Workers charged with shoreline cleanup are exposed to weathered oil, contaminated beaches, and prolonged exposure to heat. Workers and volunteers involved with removing oil from contaminated vessels and personal protective equipment and cleaning and caring for oil-soiled birds, turtles, and other wildlife before relocation could also be exposed to weathered oil. Finally, response and remediation workers involved in the disposal and recycling of hazardous solid and liquid wastes could be exposed to the wastes that the other workers are managing.

Residents in the affected communities are also at risk for dermal exposure to either crude oil in the water or weathered oil on the beach; inhalational exposure to chemicals or compounds, such as those carried ashore by prevailing winds; or ingestion by eating potentially contaminated seafood, drinking contaminated water, or other forms of ingestion. Although oil and other related chemicals may be less concentrated in residential areas, affected communities are already wrestling with

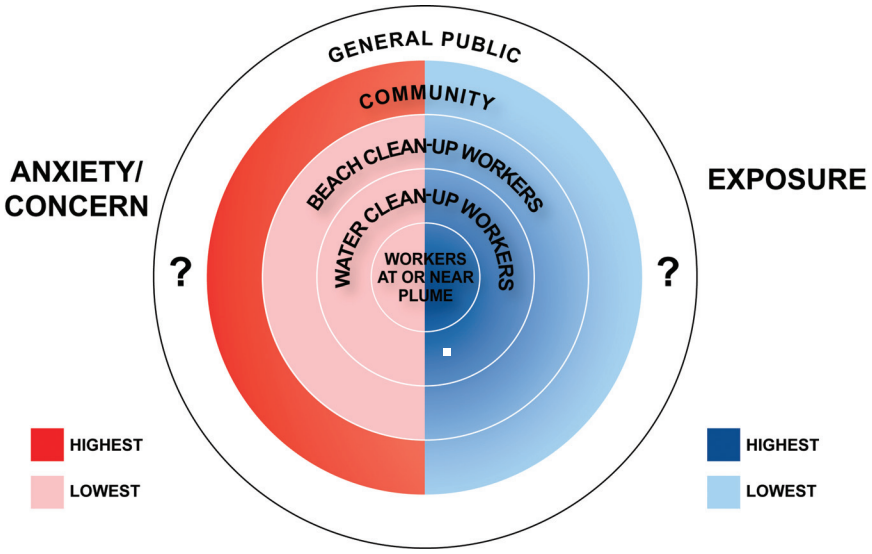

FIGURE 2-1 Levels of population exposures and anxiety or concern as defined by proximity to the oil leak.

uncertainties about their social and economic futures as a result of the Gulf oil spill, putting them at an elevated risk for poorer psychological health outcomes, stated Howard.

OCCUPATIONAL RISKS AND HEALTH HAZARDS: WORKERS AND VOLUNTEERS

Scott Barnhart, University of Washington

Accurate measures of occupational and environmental health exposures can help public health officials manage and mitigate the varied risks posed to workers and volunteers. These measures include making an accurate exposure assessment across a variety of exposures that are not limited to chemical toxins. According to Scott Barnhart, studies of previous oil spills indicate that response workers and volunteers are exposed to chemicals or conditions during response activities that cause adverse health effects (see Chapter 3). Thus, it is important to identify exactly what exposures led to which adverse health outcomes.

In addition to the oil itself, workers and volunteers responding to the Gulf oil spill may be exposed to a number of potentially hazardous substances or situations, stated Barnhart. Box 2-1 lists categories of hazards that could be considered when developing surveillance or monitoring systems that include clean-up workers or volunteers.

Beyond the type of exposure, the dose or duration of exposure is important when monitoring for possible adverse health effects, said Barnhart. Individuals exposed to higher concentrations of harmful chemicals may be more likely to suffer adverse health effects. For example, exposures to high levels of hydrocarbon solvents have been linked to adverse neurologic, renal, hepatic, dermatological, and hematopoietic effects. However, Barnhart opined that these health effects are unlikely to result from the current, lower levels of exposure that workers and volunteers are experiencing, especially when individuals comply with proper safety and hygiene guidelines.

Because response efforts to the Gulf oil spill bring diverse groups in direct contact with a variety of chemicals and conditions, workers and volunteers are uniquely vulnerable to certain adverse health effects. According to Barnhart, inhalation and dermal contact are the most likely routes of exposure to oil and other chemical substances because workers are exposed to VOCs evaporating from crude oil on the water and to substances carried on protective clothing.

Some notable differences between workers and volunteers will also complicate hazard assessment, including chemical exposures. Statutory

BOX 2-1
Potential Categories of Hazards Related to the Gulf Oil Spill and Its Response Efforts

- Chemical (e.g., oil, dispersants, degreasers, soaps)
- Biological (e.g., plants, animals, insects, remediation materials)
- Biohazardous debris (e.g., syringes on shoreline)
- Workplace injuries (e.g., slips, trips, falls, cuts)
- Ergonomic stresses (e.g., repetitive stress, low back pain)
- Heat stress, sunburn, and fatigue
- Fires (including exposure to particulate matter) and explosions
- Psychological stress
- Drowning and injuries from underwater diving
- Noise
- Electricity

requirements provide an additional level of protection for workers who are fully trained, monitored, and equipped with personal protective equipment. Volunteers do not necessarily have the same protections as official workers, which may increase volunteers' likelihood of injury or chemical exposure, stated Barnhart. Additionally, much less is known about volunteers' actual risks of exposure.

The Gulf of Mexico oil spill is different from previous oil spills, which adds a layer of uncertainty that must be explored. In addition to the ongoing nature of the oil spill, Barnhart explained that the underwater oil source; the use of dispersants, pressure washing, and controlled burns; and the sheer volume of the spill distinguishes the Gulf oil spill from other oil spills. Despite these differences, data from previous oil spills, coupled with a wealth of other occupational and environmental health data, can inform decisions related to the Gulf oil spill. For example, available evidence from past oil spills suggests that safety-related risks are generally of greater concern than chemical risks. Safety-related risks may include the removal of personal protective equipment in response to extreme heat. Additionally, past studies indicate that workers and volunteers are likely to suffer from post-traumatic stress disorder, anxiety, and depression as a result of exposures experienced during response activities.

To capitalize on what is known, it is important to collect data immediately, to account for confounding factors, and to reduce anticipated exposures, said Barnhart. Causation is multifactorial, and there is often a latent period between the time of exposure and the presentation of a disease or condition. To link possible exposures to adverse health effects, Barnhart proposed gathering data, maintaining registries, and banking samples to better determine causation. This would include continuous reassessment based on real-time monitoring of exposure data, particularly among volunteers. As part of the health monitoring, workers and volunteers should also receive psychological risk assessments that are culturally sensitive and accurately communicate the risks associated with specific behaviors and activities. To prevent injuries and adverse physical and psychological effects, Barnhart also suggested requiring adequate training, especially for volunteers.

ASSESSING AND PREVENTING EXPOSURE ACROSS POPULATIONS

Paul J. Lioy, Robert Wood Johnson Medical School, University of Medicine & Dentistry of New Jersey

The Gulf oil spill affects not only those in the Gulf region, but also people across the United States. In addition to the workers and volunteers, Paul Lioy described how the oil spill has also affected a number of commercial and industrial activities (including fishing), military personnel, visitors, and residents living near or along the Gulf Coast region. As the oil continues to rise from the seabed, Lioy suggested using a "64-back-64-forward approach"[2] to assess past exposures with an eye to preventing future exposures. For "64 forward," preventing exposure should be the primary goal. This requires a rapid response through coordinated data collection about exposures to determine whether different types of at-risk populations are appropriately protected. Furthermore, long-term surveillance activities could be designed to minimize known exposure and to prevent unnecessary illness.

To best avoid mistakes that may limit effectiveness in preventing and treating exposures that lead to adverse health outcomes, Lioy stated that effective disaster response required problem identification, strategic planning, and recognition of opportunities to minimize and prevent exposure. In this case, the problem was an ongoing oil leak, which made each day the first day of the disaster response. Based on his experience with the response to the 2001 World Trade Center disaster, Lioy stated that strategic planning for disasters should be divided into the "5 Rs": rescue, reentry, recovery, restoration, and rehabilitation (Lioy, 2010). Each phase provides opportunities to minimize the impact of the disaster if each phase is strategically timed.

According to Lioy, at the time of the workshop, there had been some rescue, reentry, and recovery activities with the Gulf oil disaster, but restoration and rehabilitation were "years away." As part of the recovery stage, 17,000 National Guardsmen were expected (at the time of the workshop) to assist with the clean-up effort. Lioy expressed concern that none of the guardsmen had professional training to handle hazardous waste.

Lioy stated that, during recovery, the public can be an important source of information about possible exposures. For example, affected

[2]At the time of the June 22 workshop, 64 days had passed since the oil rig explosion on April 20, 2010.

regions could report the smell or presence of oil-contaminated water at their homes. Additionally, affected communities may choose to use passive air monitors to measure VOCs in the air. Contaminated air, water, and food may also be a concern during the restoration and reconstruction phases of the Gulf oil disaster recovery. Long-term surveillance will be necessary to ensure that the most effective policies are selected to best protect the public as the Gulf region struggles to rebuild.

OF PEOPLE AND PELICANS: A LOCAL PERSPECTIVE ON THE GULF OF MEXICO OIL SPILL

Maureen Y. Lichtveld, Tulane School of Public Health and Tropical Medicine

The first step to developing an effective surveillance system requires a basic understanding of exposure pathways. This analysis, explained Maureen Lichtveld, includes identifying the contaminant source, contaminated environmental media, exposure points and routes, and the at-risk population. Although some agreement exists surrounding contaminated environmental media and the potential sources of contamination (as described earlier in this chapter and in Chapter 1), there is a great deal of uncertainty about the exposure point (where individuals are exposed) and exposure routes (how individuals are exposed). Compounding these uncertainties is the critical need to assess cumulative risk in the absence of data characterizing changes in the composition of the contaminant mixtures over time, said Lichtveld. Additionally, there are a number of at-risk populations in the affected regions that may be particularly vulnerable to adverse health effects. The lack of definitive answers to growing community concerns has created a sense of urgency that reverberates throughout the Gulf region.

The characteristics of an at-risk population can help define exposure points and routes. Like most areas across the United States, there are certain populations within the Gulf region that are considered at-risk groups because of well established vulnerabilities. Children may be more at risk due to their developmental stage. The oil spill may also disproportionately affect pregnant women, the elderly, and individuals with preexisting health conditions.

Gulf Coast residents also have unique characteristics that make their population more susceptible to adverse health effects than the general population, said Lichtveld. For example, fishermen and -women who

now serve as temporary clean-up workers are an integral part of their community, resulting in complex exposure scenarios. The Gulf Coast population also experiences high rates of health disparities exacerbated by poverty, access to culturally competent care, inadequate quality education, and self-perceived discrimination. Moreover, the health of the Gulf ecosystem and the survival of the community are inextricably linked. As a number of presenters explained throughout the workshop, Gulf residents boast an intimate relationship with the water as a source of their livelihood, culture, and history. At the core, the spill is threatening Gulf communities' ways of life, including individual families and states' economies.

The impact of frequent natural and human-caused disasters, such as Hurricane Katrina and now the oil spill, further strains populations that are already experiencing a great deal of stress. Gulf residents are still recovering from the aftermath of Hurricane Katrina.[3] Coupled with community concerns about the lack of transparency and paucity of information from various sources, the vulnerabilities described above suggest that long-term psychological and social impacts may be as significant as the Gulf oil spill's physical impacts, Lichtveld stated.

When formulating an action plan to help identify the greatest areas of concern for a surveillance system, there is no substitute for local knowledge and expertise, said Lichtveld. In a community that has been hit hard by a number of disasters within the past decade, numerous questions arise, including what role historic health disparities play. To answer these questions effectively, researchers must work hand in hand with the communities to develop, implement, and evaluate any action plan that attempts to link health outcomes and oil spill exposures. She then discussed components of a multipronged action plan, which is presented in Chapter 7 (see Box 7-1).

Lichtveld concluded by remarking that these actions should be carried out in a participatory way (with the affected communities), holistically (by, for instance, taking into account existing health disparities), with cultural competence and transparency. Stating that "the spill is a disaster experienced by the community," she emphasized the importance of involving local communities in any planned or future surveillance and communication activities.

[3]Other presenters, including John Hosey and Thomas Guidry, described the impacts that other hurricanes and recent floods have had on the Gulf region.

QUESTIONS AND COMMENTS FROM THE AUDIENCE

Data Collection

How do you differentiate between occupational exposures that occurred before the disaster and exposures that occurred after the onset of the disaster?

Barnhart replied, "Baseline exams." Lioy remarked that one of the challenges during a disaster is that it may be difficult to obtain baseline information for many affected individuals. While some organizations already have worker baseline information on record, he stressed the importance of collecting new baseline information for new workers and other newly exposed individuals as soon as possible. Lichtveld noted the importance of collecting psycho-social baseline data in addition to physical health data.

Is biospecimen banking being done adequately?

While the panelists agreed that biospecimen banking is important, none of them had enough information to know if it was being done adequately at the time of the workshop.

What barriers exist to collecting good exposure data (e.g., legal, political, cultural, economic), and how can those barriers can be overcome?

The panelists identified the need for two-way dialogue rather than one-way communication, the need for better individual exposure data, and the need to consider whether an expanded legal authority could improve real-time access to data so that data can be used to mitigate some of the disaster's impact. Specifically, Lichtveld replied that many barriers revolve around the need to be sensitive about how to communicate information.

Lioy stated that the barriers extend well beyond communicating good information and identified the need to collect information in the first place as a major barrier. Data collection is cumbersome and difficult. He explained that although there are rules and regulations for collecting occupational data, environmental data in particular is tough because it involves monitoring the personal environments of individuals. An air or

water monitoring system may be suitable for monitoring the general air or water quality of an area. However, there is a difference between general air or water quality and the exposure that individuals are actually experiencing. Monitoring individual environmental exposure involves a different sampling methodology. It is important to recognize that time changes the character of oil, and clearly there are chemicals that should or should not be measured in certain circumstances.

Finally, Barnhart raised the question: When considering a disaster like this in the context of public health law, what is the role for more expanded authority in terms of access to data and use of those data to manage the situation and to mitigate some of the impact? Rosenstock agreed that this was an excellent question and one that would hopefully be addressed later during the workshop.

The Need for Central Coordination

Given that multiple agencies are involved in worker retraining, how can injury risk be mitigated as workers are retrained to do new tasks?

Barnhart replied that injury is the one area of risk that ought to be mitigated because so much is known about it and because there are effective measures that can readily be implemented to mitigate injury risk. These include adequate training; use of the right equipment; and use of real-time feedback loops to detect injuries, characterize the nature of those injuries, and identify what needs to be done to prevent those injuries. The challenge with the Deepwater Horizon response is the need for some form of central coordination. Lioy stressed the importance of constant reinforcement and monitoring of the volunteers and workers being retrained to participate in clean-up activities (e.g., National Guardsmen).

Who is going to take responsibility for coordinating local studies to avoid redundancy and confusion?

Lichtveld replied that it is critical that a local coordinating center be in place so that investigators, affected communities, and workers can engage in dialogue with each other. She also suggested that the center should be clearly linked to a national advisory board to ensure that the science is high quality. She said, “What we don’t need, frankly, is a repeat after Hurricane Katrina, where everybody descended down on New

Orleans, did all sorts of studies, and the community was left without the very answers that we need." She emphasized that, in addition to coordination, collecting meaningful data that will allow communities to take the actions that they need to take is very important. Lioy agreed that local control is very important. He stated, however, that it is also important to ensure that outside resources, including academic researchers and government agencies, are not construed as barriers. Otherwise, there will be duplication of efforts and confusion. He emphasized the importance of collaboration between local and federal/other efforts.

Communicating with At-Risk Populations

A separate session summarized in Chapter 3 focused in more detail on communication issues. Nonetheless, the panelists were asked: Based on lessons learned from past disasters, when is there enough certainty to begin communicating to the public about exposure?

Barnhart replied that enough has been learned from past oil spills that there is enough certainty now to provide information. Finding a balance between providing information and communicating uncertainties about that information requires engaging the community early on during the communication process, for example, through focus groups or advisory boards.

Lichtveld agreed that there is enough information available now to communicate and reminded the workshop of the many assets that communities have to deploy. She urged that communication not be delayed until "we have all the t's crossed and i's dotted." Additionally, she remarked that a critical lesson learned after Katrina was that, although the message is critical, the messenger is even more critical. She stated that the use of faith-based organizations as messengers was critically important after Katrina. The channel of communication is also important. For example, during Katrina, the Internet provided a very good resource.

Another challenge is making information, particularly numerical information, understandable to the general public. Lioy agreed with both Barnhart and Lichtveld about the urgency of providing available information now. He referred to the bull's-eye figure that Howard showed, with environmental concentrations of toxins decreasing as one moves away from the source, and commented on the importance of communicating that reality to the general public in order to alleviate fears. Com-

municating that level of understanding about exposure is crucial to moving forward. However, Lioy cautioned that numerical information posted on the Internet is often not very meaningful to the general public. For example, he pointed to posted occupational and environmental toxin levels being in parts per million versus parts per billion, respectively, and how that difference is meaningless to many people. For many people, he said, "a number is a number." The problem is not just with numeracy. Rosenstock pointed to confusion around the use of terms such as "barrels" and "gallons." While the public understands the massive scope of what is happening, variable use of terms can be very confusing.

Who is going to help communicate and navigate the information that already exists, and how will organizations be held responsible for presenting clear and concise risk-mitigating information in a health-literate way? Many other disasters have point persons assigned to deliver information (e.g., the 2001 anthrax episode). Does the ongoing and complex nature of the Deepwater Horizon oil disaster necessitate a point person, or are there other ways to coordinate and communicate useful information?

Lioy replied that a coordinated approach does not necessarily imply one voice. Rather, it means selecting people with the most knowledge about individual components of what needs to be communicated and using those people to determine if what is being communicated is going to be effective. He stated that the information that needs to be communicated is not just health information. It also includes engineering and mitigation information, such as information about how to prevent oil from reaching shore. Therefore, a variety of expertise is needed to help with the communications strategy. While health officers are very important, this is a very complex problem with multiple components. He opined that a coordinated group of people with expertise in a variety of areas would be a more effective tool for providing good information to the people than a single voice. Moreover, because there will likely be discontinuities in the information, a group may be able to express uncertainties more clearly and may be able to say "I don't know" more effectively.

Lichtveld agreed that having a single point person is not the best approach to take at this time. She observed that there are existing state-level health systems already responsible for communication and emphasized early collaboration with the health officers of the affected states

(Alabama, Florida, Louisiana, Mississippi, Texas) and other, trusted local authorities.

Barnhart stated the importance of staying away from *managing* information. Although a time comes when it is necessary to synthesize the data, transparency and having lines of data available from multiple sources is important.

3

Short- and Long-Term Effects on Human Health

The Gulf of Mexico oil spill's impacts are wide-reaching and will likely have long-lasting effects on the physical, psychological, social, and economic health of populations in the affected regions. The second component of the Department of Health and Human Services' (HHS') charge to the Institute of Medicine (IOM) was to review current knowledge and identify knowledge gaps regarding the wide range of effects on human health as a result of exposure to oil, weathered oil products, dispersants, and environmental conditions such as heat. Panelists considered both short-term (e.g., respiratory) and long-term (e.g., neurological) outcomes; both physical and psychological effects of exposure; both physical stressors (e.g., heat stress and fatigue) and chemical stressors (e.g., the oil and dispersants); and potential health effects in both the general population and among children and pregnant women specifically. The goal was not to examine comprehensively all that is known about the spill's potential effects on human health. Instead, its goal was to consider which potential adverse effects to include in surveillance and to identify gaps in knowledge that could inform future surveillance programs.

This chapter summarizes the panel discussions and question-and-answer periods that occurred during this session. Two separate panels discussed the risks that the oil spill poses to the short- and long-term physical and psychological health of individuals within the Gulf region as a result of the oil spill. Although this section divides speaker presentations into the general categories of physical and psychological health effects, many speakers over the course of the workshop recognized that the health of an individual and population is multidimensional and that physical, psychological, social, and economic factors interact to create an overarching state of health.

POTENTIAL SHORT- AND LONG-TERM PHYSICAL EFFECTS

Oil spills and related clean-up efforts can pose numerous hazards to the physical health of individuals and communities. Nalini Sathiakumar quickly recapped some of the potentially hazardous chemicals and conditions associated with oil spills and provided a broad overview of the types of physical health outcomes that have been linked to specific hazards. Citing previous oil spill studies, she argued that currently available data can provide important information on risks of acute toxicity symptoms, genotoxicity, endocrine toxicity, and injuries, as well as the impact that proper use of personal protective equipment can have on reducing specific symptoms. Peter Spencer expanded on Sathiakumar's overview by focusing on how exposures to select hydrocarbons in crude oil, including aromatic but also other types of hydrocarbons, can have chronic, neurotoxic effects on human health. He emphasized the transient nature of these effects in humans based on data from occupational exposure concentrations.

In addition to chemical toxins, another major hazard (and, in some places, the hazard of greatest concern) is heat. Turning his attention to workers and volunteers, Thomas Bernard described the well-known effects of heat stress and fatigue, but stated that additional information was needed on the cumulative effect of prolonged, daily exposures. He noted that the effects of heat stress and fatigue were easy to identify and manage.

In discussing the effects that certain chemicals can have on human reproduction and child development, Brenda Eskenazi described mechanisms by which chemical exposures can affect a child before conception, during gestation, and after birth. Drawing from non-oil-spill studies, she explored the types of health outcomes that could be monitored in a surveillance system, identified various sources for immediate biomonitoring activities, and explained the importance of adhering to the precautionary principle when working with pregnant women and children.

Finally, Irwin Redlener focused on child physical and psychological development and health, describing the crucial characteristics that make children uniquely vulnerable to short- and long-term adverse health effects stemming from the Gulf oil spill. He identified several activities that he thought would be important to include in a child health surveil-

lance system (e.g., biospecimen banking and monitoring the onset of new emotional or behavior symptoms).

Short-Term Physical Effects

Nalini Sathiakumar, University of Alabama, Birmingham

The Gulf oil spill and its related response efforts pose various hazards to individuals, which can increase the risk of adverse health outcomes, including acute toxicity and physical injuries. Although data are limited, there is consistent evidence that exposure to oil and related response activities are associated with short-term health effects. Nalini Sathiakumar began with an overview of potentially hazardous chemicals and conditions related to the Gulf oil spill. Among these are exposures to volatile organic compounds (VOCs), polyacylic aromatic hydrocarbons (PAHs), heavy metals, and dispersants. In addition, there are physical hazards associated with noise levels, sun exposure, heat stress, injuries, and ergonomic stressors.

Studies of the Effects of Previous Oil Spills on Physical Health

Much of the information about the short-term physical effects of exposure comes from studies of seven supertanker oil spills since the 1960s (Aguilera et al., 2010). Sathiakumar summarized the results of studies for each of the oil spills, except the *Exxon Valdez* studies (which are covered later in the chapter in relation to Lawrence Palinkas's presentation). Most of these studies were cross-sectional and investigated the short-term, physical effects of hazards stemming from the oil spills. The majority of these studies used standardized questionnaires to measure acute toxic symptoms and general health.

MV Braer (United Kingdom, 1993). Campbell and colleagues (1993) studied community residents using general health questionnaires to identify major, acute toxicity symptoms within the first 2 days of exposure following the oil spill. The researchers found evidence of neurological, ocular, and respiratory symptoms but no significant differences in lung, liver, or renal function between exposed and unexposed populations. In a follow-up study, Campbell and colleagues (1994) found that the general health questionnaire symptom score of exposed individuals was signifi-

cantly higher than that reported by unexposed individuals after 6 months, although there was still no evidence of adverse effects on lung, liver, or renal function. In a separate study by Crum (1993) investigating lung function in children, results showed no deterioration in lung function at either 3 or 9 to 12 days following exposure. Finally, Cole and colleagues (1997) found no evidence of genotoxicity after a 1-year followup of participants from the community.

Sea Empress (United Kingdom, 1996). In a study of 18- to 65-year-olds in affected communities, Lyons and colleagues (1999) found that exposed residents were more likely to report symptoms of acute toxicity, including neurological, ocular, and respiratory symptoms, than unexposed residents. An additional study by Gallacher and colleagues (2007) found an association between oil exposures and raised perceptions of risk.

Nakhodka (Japan, 1997). Morita and colleagues (1999) found that clean-up workers reported increased acute toxic symptoms (primarily neurological, ocular, and upper respiratory symptoms) and physical injuries (lower back pain) compared to the control group. The researchers also reported that, although 100 percent of clean-up workers used gloves, only 87 percent of the women and 35 percent of the men used masks, and less than 30 percent used protective eyewear.

Erika (France, 1999). In a cross-sectional study of clean-up workers and volunteers, Schvoerer and colleagues (2000) identified neurological, dermal, ocular, and respiratory symptoms, as well as lumbar pain, in individuals involved in clean-up activities. The study identified duration of cleaning as a significant risk factor for an increase in lumbar pain.

Prestige (Spain, 2002). Suarez and colleagues (2005) and Carrasco and colleagues (2006) investigated differences in reported toxicity symptoms between seamen and other types of workers, including bird cleaners, volunteers, and paid workers. Both studies found that toxic symptoms were higher among seamen than other types of workers, but Carrasco and colleagues also found that training about personal protective equipment (PPE) reduced the risk of toxic symptoms. Additionally, both studies found that injuries (e.g., bruises, deep wounds, sprains, fractures) were greatest among bird cleaners. The 2005 study also found a significant increase in the risk of injury for individuals that worked 20 or

more days. A separate study by Zock and colleagues (2007) recorded that the duration of clean-up activities was positively correlated with the risk of lower respiratory tract symptoms. These same studies also found increased levels of aluminum, nickel, and lead but decreased levels of zinc in blood samples from exposed individuals.

In studies that focused on genotoxicity,[1] Laffon and colleagues (2006) found that clean-up workers had greater DNA damage, but not cytogenetic damage, related to time of exposure. Pérez-Cadahía and colleagues (2006) also found a significant increase in comet assay in clean-up workers, indicating genotoxic damage, which was not affected by PPE use.

Tasman Spirit (Pakistan, 2003). In a cross-sectional study of exposed residents, Janjua and colleagues (2006) found moderate to strong associations between proximity to the spill site and toxic symptoms. In a 2008 study of community residents and vendors, Khursid and colleagues found slightly elevated levels of lymphocyte and eosinophil levels among exposed populations. In a questionnaire about general health symptoms among clean-up workers, Meo and colleagues (2008) found a higher prevalence of ocular and respiratory symptoms compared to individuals not exposed to clean-up activities. In 2009, Meo and colleagues used a spirometer to identify a significant reduction in lung function among clean-up workers, but found that lung function improved when workers were removed from the polluted environment.

Summary of Results

Previous studies provide important lessons about acute toxicity symptoms, genotoxicity, endocrine toxicity, injuries, and PPE usage. Tables 3-1 and 3-2 describe categories of acute toxic effects associated with exposure to crude oil and to oil dispersants, as presented by Sathiakumar.

Sathiakumar stated that acute toxic effects are associated with exposure to VOCs and oil dispersants, which can enter the body through the lungs, skin, or other membranes.[2] The fumes are absorbed by the

[1]Blanca Laffon described studies of genotoxicity and endocrine toxicity related to the *Prestige* oil spill (see Chapter 1).

[2]As Edward Overton and John Howard explained (see Chapters 1 and 2, respectively), these VOCs are most heavily concentrated in areas near the spill site and can increase the risk of acute toxic effects.

skin or external membranes or inhaled through the mouth and nose and have been associated with disorders of the skin and mucus membranes. Additionally, ingestion of benzene and toluene is associated with neurological symptoms, nausea, vomiting, and diarrhea, stated Sathiakumar. Although not all studies measured particular exposure levels, among those that did, hydrocarbons were below occupational safety levels, levels of benzene did not exceed threshold limit values, and VOCs were within the range observed in urban environments, according to Sathiakumar.

In communities living in the vicinity of the oil spills, even after controlling for preexisting allergies and medical conditions, there was consistent evidence of acute toxic effects (mainly neurological, ocular, and respiratory but not dermal) among exposed residents. However, these effects appear to be transient, said Sathiakumar. Biochemical tests for lung, kidney, and liver function were within normal levels both immediately and 6 months after the spill, and children's respiratory function was within the normal range. In the context of genetic and endocrine toxicity, Sathiakumar referenced an earlier presentation by Blanca Laffon (see Chapter 1), which indicated some genotoxic damage in workers involved with oil spill clean-up activities.

TABLE 3-1 Categories of Acute Toxic Effects Associated with Human Exposure to Crude Oil

Chemical	Route of Exposure	Symptoms*
VOCs (ethylbenzene xylene) PAH	Dermal (contact)	**Skin/mucous membranes:** erythema (redness), edema (swelling), irritation, dermatitis (rash, blisters)
VOCs (benzene, ethylbenzene, xylene)	Inhalation (air) Dermal (contact)	**Ocular (eyes):** redness, soreness, watering, itching
VOCs (benzene, ethylbenzene)	Inhalation (air)	**Respiratory:** cough, throat irritation (dry, scratchy, sore), shortness of breath, wheezing
VOCs (benzene, toluene)	Inhalation (air)	**Neurological:** nausea/vomiting, headache, dizziness, irritability, confusion, weakness of extremities

*Symptoms more pronounced in sensitive individuals.

TABLE 3-2 Categories of Acute Toxic Effects Associated with Human Exposure to Oil Dispersants

Chemical	Route of Exposure	Symptoms*
VOCs	Ingestion (food, water)	**Gastrointestinal tract disturbances:** transient nausea, possible vomiting, and self-limiting diarrhea
2-butoxyethanol, Petroleum Distillate (oil mist)	Dermal (contact)	**Skin/mucous membranes:** irritation of skin
2-butoxyethanol, Petroleum Distillate (oil mist, aromatic hydrocarbons)	Inhalation (air) Dermal (contact)	**Ocular (eyes):** watering, itching
2-butoxyethanol Petroleum Distillate (oil mist, aromatic hydrocarbons)	Inhalation (air)	**Respiratory:** cough and throat irritation

*Symptoms more pronounced in sensitive individuals.

Among clean-up workers, the studies found consistent evidence of acute neurological, ocular, respiratory, and dermal symptoms. Seamen showed more toxic symptoms than other types of exposed workers, such as paid workers and volunteers. However, in studies that measured VOC levels, VOC concentrations were highest in the volunteer environments. In the studies that found an association between reduced lung function and proximity to oil spill sites, the reduction was transient and improved in workers who were removed from the polluted environments.

A few studies also analyzed the effect that use of PPE had on the reporting of acute toxicity symptoms. Results indicate that PPE usage (especially protective eyewear) was less than optimal. However, proper education about PPE was associated with increased PPE usage and workers reporting fewer symptoms. Unfortunately, PPE usage did not affect genotoxicity.

In addition to risk of harm from chemical exposures, there are physical hazards such as noise levels, sun exposure, heat stress, injuries, and ergonomic stressors. Table 3-3 lists possible risk factors and potential adverse outcomes that oil spill response workers could experience.

In the studies that Sathiakumar described, researchers found significant differences in toxicity symptoms reported by seamen and other workers, including bird cleaners, volunteers, and paid workers. Bird cleaners were at greatest risk of injuries such as bruises, deep wounds, sprains, and fractures. Clean-up workers and volunteers were also at risk for developing back pain. One study identified working 20 or more days as a risk factor for worker injury.

Although these studies provide valuable information about the types of health outcomes that may be appropriate for surveillance activities related to the Gulf oil spill, Sathiakumar described some methodological limitations that should also be considered. First, in addition to relatively small sample sizes and low rates of participation within affected populations, most of the past studies on short-term effects of oil spill exposures were cross-sectional. Because cross-sectional studies compare participant groups at only a single point in time, it is difficult to establish a temporal relationship between exposure and outcome.

Second, with few exceptions, studies did not systematically monitor for exposures to specific chemicals. Instead, researchers established surrogate measures of exposure, such as an individual's proximity to the spill site, location of residence, and the type and duration of operation for clean-up workers. Finally, there was no long-term follow-up of high-risk groups for either exposure or outcome assessment.

TABLE 3-3 Potential Physical Injuries Related to Oil-Spill Response Efforts

Possible Risk Factors	Potential Adverse Outcomes
Slippery or uneven working surfaces	Slips, trips, and falls
Use of tools, equipment, and machinery, working with wild animal (birds, fish)	Injuries
Strenuous work schedules, heavy physical workload, long duration of work	Fatigue and lumbar pain
Exertion, hot environment	Heat-related health conditions

Heat Stress and Fatigue

Thomas E. Bernard, University of South Florida

The acute health effects of heat stress and fatigue are well known, stated Thomas Bernard. Unlike chemical stressors, there is no uncertainty about the effects of heat exposure—at least on a daily scale. Exertional heat stroke is the primary health concern for individuals exposed to intense heat because it can lead to fatalities. More common types of adverse health effects include heat exhaustion, which is less critical. Other acute heat effects include fainting and cramping. Exposure to intense heat can also affect individual behaviors. In fact, heat stress near occupational exposure limits is associated with a 50-75 percent increase in the frequency of unsafe behaviors when compared to a "thermally comfortable environment," said Bernard. In unacclimatized individuals, the risk is even greater. As one would expect, increases in risky behaviors are associated with increases in acute injuries and musculoskeletal disorders.

Despite a strong understanding of how limited exposure to heat stress can affect the health of individuals, said Bernard, more information is needed on the cumulative effects of exposure to extreme heat or "heat fatigue." Understanding heat fatigue is especially important in the context of the Gulf oil spill where people are working 12 hours a day each day of the week. Borrowing from work-physiology models and studies of military recruits and the general population during documented heat waves, Bernard stated that repeated exposures to heat stress also increase the occurrence of injuries and place more strenuous demands on the cardiovascular system. Studies of the general population during documented heat waves may also provide additional endpoints to measure heat fatigue.

Fortunately, the adverse effects of heat are quickly observable and readily reversible, which makes the Gulf oil spill a good opportunity to improve our understanding of the cumulative effects of heat stress and heat fatigue, Bernard remarked. It is important to carefully classify heat disorders through the use of a diagnostic protocol. Personal physiological monitors can capture information about the physical strain on workers. Additionally, to establish a causal linkage between health outcomes and heat, records logging the exact hours worked, including rest cycles, should be gathered, said Bernard.

Certain policies and procedures exist to limit substantially the risks for occupational heat stroke in workers, and the Gulf oil spill management and supervision systems are highly adaptive, changing work practices daily in reaction to the heat stress, observed Bernard. However, the assumptions underlying these policies and procedures may not adequately account for conditions in the Gulf of Mexico, Bernard asserted. When discussing heat stress, experts tend to assume that the worker population is healthy, acclimated, stable, and experienced with heat stress. In the affected Gulf regions, oil spill response workers are not being introduced slowly into a stable workforce, but are instead recruited all at once. Consequently, there are not enough experienced workers to teach newer workers about heat stress, putting new workers at greater risk of heat stress.

Experts also tend to assume that the heat-exposure control measures that have evolved over time are generally effective, said Bernard. However, certain barriers may prevent workers from taking adequate precautions to protect themselves from the adverse effects of heat stress and fatigue. Possible communication or language barriers can prevent adequate and timely explanation of risks. Workers may also underestimate the risk associated with their jobs—believing that, because they work in familiar heat environments, occupational exposure limits are too conservative. Although Bernard observed that the Gulf oil spill management and supervision system appears "highly adaptive," he also suggested that bottom-up communications, such as social marketing, could improve risk communication, better ensuring the recognition and treatment of serious adverse health outcomes, such as heat stroke.

Exposure to Hydrocarbons in Oil and the Potential for Chronic Neurotoxic Effects

Peter S. Spencer, Oregon Health & Science University, School of Medicine

The potential of any given chemical to produce chronic or long-latency toxic effects on health varies by chemical structure, which can change over time, and by dose and duration of the exposure. Peter Spencer began by observing that, of the thousands of chemical structures in crude oil described by Edward Overton, only a very few of these structures have been tested individually for their toxic potential. The ability to study the biological effects of chemical mixtures is limited.

After mentioning the acute, reversible effects on brain function of volatile petroleum chemicals, Spencer focused on the molecular mechanisms leading to chronic neurotoxicity and carcinogenesis resulting from exposure to certain hydrocarbons in crude oil. Importantly, the ability of petroleum chemicals to affect brain function in the short term does not necessarily translate to long-term adverse health effects involving the nervous system.

Much of what is known about the neurotoxic potential of chemicals in crude oil has been obtained largely from the administration of large chemical doses to laboratory animals in experimental settings. Additionally, because the underlying mechanisms for short- and long-term effects may be entirely different, the presence of acute health effects, such as headaches and dizziness, may or may not accurately predict the development of long-term effects. Moreover, scientists are just beginning to understand how certain genetic predispositions may affect the likelihood of adverse health effects as a result of specific chemical exposures.

Of what is known about chemicals in crude oil, remarked Spencer, most of the data concern hydrocarbons, particularly the straight-chain, low-molecular compounds that evaporate very quickly (the alkanes). Noting the reversible short-term effects of alkane exposure (e.g., dizziness and headache), also described by Sathiakumar, Spencer stated that prolonged exposure to certain alkanes (e.g., n-hexane) also had the potential to produce long-term neurotoxic effects associated with nerve fiber degeneration. For example, some workers in industrial settings who were exposed for very long durations to significant concentrations of certain alkanes have developed peripheral neuropathy, which involves an insidious, gradual onset of changes in sensation and muscle weakness in the feet and hands that ascends the legs and arms. Fortunately, once the exposure ceases, the disease may advance to some degree but then slowly regresses to almost complete recovery with a few persistent effects, stated Spencer. However, recent laboratory rodent studies[3] found that damage to the central nervous system was only very poorly repaired and that new types of neurological deficits may appear even after recovery of peripheral nerve fiber function. One laboratory proposed that exposure to particular alkanes may cause late-onset Parkinsonism in rats, but those results have not been replicated.

[3]Spencer noted that laboratory experiments involving model organisms usually involve high levels of exposure (i.e., not human exposure levels in real-world settings).

In addition to straight-chain compounds in oil, specific benzene derivatives may also produce peripheral neuropathy symptoms. Spencer and his colleagues demonstrated that compounds such as 1,2-diethylbenzene (1,2-DEB) and its metabolite 1,2-diacetylbenzene (1,2-DAB) are substantially more potent than specific straight-chain compounds in laboratory rats. In addition to being neurotoxic, 1,2-DEB and 1,2-DAB in high concentrations can produce a bluish discoloration in amino acids that can spread throughout the body. As the toxin travels throughout the body, the toxin reacts with the particular architecture of the nervous system, resulting in the degeneration of long, large nerve fibers. Although 1,2-DEB can exist in small concentrations in petroleum, no adverse effects have been documented in humans due to minimal exposure.

Spencer concluded by noting that a third class of hydrocarbons, the cycloalkanes (e.g., naphthenes), has attracted much less attention with respect to its potential human health effects. Certain polyaromatic forms have been associated with DNA damage and carcinogenicity, but these chemicals have not yet been identified in the Deepwater Horizon oil.

Human Reproduction and Child Development

Brenda Eskenazi, University of California, Berkeley

Chemical exposures before conception, during gestation, and after birth can affect a child's health. Direct chemical exposures can occur to a fetus or a child across the placenta or by ingestion, inhalation, or dermal absorption. Overall, very little information is available for most of the chemical compounds in oil and for the chemical dispersants being used in the clean-up, said Brenda Eskenazi. This is especially true of chemical mixtures.

Children and fetuses are more vulnerable to adverse effects from chemical exposures because developing organs are more sensitive and less efficient at detoxifying and metabolizing chemicals, said Eskenazi. One study involving hundreds of children found that children under the age of 7 have insufficient enzyme levels to detoxify a particular pesticide (Holland et al., 2006; Huen et al., 2010), suggesting that the period of vulnerability for different chemical compounds could be lengthy. At least five studies investigating the effects of benzene exposure on children's health identified association between residential proximity to gas stations (or repair garages using benzene) and childhood leukemia (Shu et al.,

1988; Steffen et al., 2004; Whitworth et al., 2008; Brosselin et al., 2009; Weng et al., 2010). Eskenazi also described studies of children in the United Kingdom, which found that exposures to chemicals from the *MV Braer* oil spill did not cause any deterioration in lung function at either 3 or 9 to 12 days following exposure (Crum, 1993).

A number of studies have also documented a broad range of potential effects on children as a result of in-utero exposures. In terms of exposure to benzene itself, some studies have shown associations with spontaneous abortion (Xu et al., 1998), neural-crest birth defects (Wennborg et al., 2005), decreased birth weight (Aguilera et al., 2009), and decreased head circumference (Slama et al., 2009). Another study found that exposure to benzene alone was not associated with lower birth weights, but rather that the interaction between benzene exposure and high stress that increased the likelihood of decreased birth weight (Chen et al., 2000). Eskenazi also described four studies that showed associations between PAH exposure and decreased birth length, birth weight, head circumference, and body weight of toddlers (Perera et al., 1998; Choi et al., 2006; Tang et al., 2006; Choi et al., 2008). Two studies revealed associations between airborne PAHs and DNA adducts (Perera et al., 2004; Wu et al., 2010). When present in maternal blood, such adducts have been linked to spontaneous abortions. However, Eskenazi repeated that PAH exposures may not be of greatest importance, citing previous speakers who stated that high concentrations of PAHs had not been found in Deepwater Horizon oil.

Chemical exposures in general can also have epigenetic transgenerational effects on future children. Eskenazi also described one scientific paper that explored the effect of oil spills on the health of pregnant women, finding only short-term eye irritation, headaches, and abdominal pain in pregnant women (Kim et al., 2009). However, maternal exposures to certain fungicides have been shown to cause low sperm counts in rats four generations removed (Anway et al., 2005). Paternal exposures to certain chemicals can also affect offspring, which is important because many of the Gulf oil disaster clean-up workers are fathers or future fathers, said Eskenazi. A growing body of evidence finds that paternal exposure to specific toxins can increase the risk of spontaneous abortion, birth defects, and aneuploidy syndromes (such as Down syndrome) in children. A 2010 study showed that fathers who had been exposed to workplace benzene had an increased risk of sperm hyperploidy, which could result in aneuploidy in offspring (Xing et al., 2010). Another study using a job-exposure matrix found that specific paternal exposures to

PAHs increased the likelihood of brain tumors in offspring (Cordier et al., 2004).

Drawing from What We Already Know and Have

Clearly, there is a great deal that we don't know about the short- and long-term impacts of oil-spill-related exposures on single and multi-generational development, said Eskenazi. However, opportunities exist to learn from past disasters and to capitalize on specimens already available, especially if future research is community based. Eskenazi suggested that data from birth certificates can quickly provide useful information related to the effects of tracked exposures on newborn health. Researchers can also petition local health departments to add questions to birth certificates to help fill existing data gaps. For example, one study of pregnant women after the 2001 World Trade Center disaster found a much higher proportion of lower birth weight children and more females than expected (Eskenazi et al., 2007).

Eskenazi emphasized the importance of collecting biomonitoring data immediately. She reported that, immediately following a 1976 dioxin explosion in Italy, blood samples were collected. Although it was not clear at the time which chemical to measure, researchers were able to examine associations between exposure to that dioxin and adverse health outcomes a decade later. Eskenazi said that there are several "easy" ways to collect blood specimens for biomonitoring data. For example, health care providers collect blood samples as part of routine prenatal alpha-fetoprotein screening and as part of the newborn heel-prick test for phenylketonuria. In addition to blood, other biological materials could be used for biomonitoring, including urine, breast milk, amniotic fluid, and meconium (the first stools of the infant).

Finally, in discussing risk communication strategies that target pregnant women, Eskenazi stated that the precautionary principle should guide actions in the absence of complete information. Currently, pregnant women are referred to information posted on the Centers for Disease Control and Prevention (CDC) website, which advises pregnant women to "avoid areas where there are reports of oil reaching the shore" and other, specified activities (CDC, no date). Although the website states that "seafood that is unsafe will not be allowed in stores," Eskenazi questioned whether additional precautions should be taken to protect

pregnant women and children from potential adverse health effects from yet-unidentified exposures stemming from the Gulf oil spill.

Impact of the Gulf Oil Spill Disaster on Children

Irwin Redlener, Columbia University

Children represent about 25 percent of the U.S. population, but they are an under-resourced and under-served population with respect to their special needs during and following disasters. It is not enough to simply extrapolate from research among adults. As Irwin Redlener said, children are not just "little adults." Several unique anatomical, physiological, and behavioral characteristics make children a very different and special population to consider when evaluating the health effects of hazards related to the Gulf oil spill. Redlener described seven characteristics that make children uniquely susceptible to a wide range of adverse health effects:

- Children live and breathe more closely to the ground. Consequently children may inhale greater concentrations of "heavier" toxic elements in the environment than do adults.
- Children's respiratory rates are more rapid than those of adults. Thus, children may have unique problems related to inhalation exposures.
- Children have a large permeable skin-to-body mass ratio, which has implications for absorption of toxic materials through the skin.
- Children routinely place hands and objects in their mouths, increasing the risks associated with ingestion of toxic materials.
- Children take risks, so they are less likely to follow public health guidelines or act in a safe manner.
- Children are dependent. Due to stages of physical and psychological development, children cannot always identify or choose when to avoid something harmful in their environment.
- Children are highly susceptible to short- and long-term stress.

As a result of their unique characteristics, children are more susceptible to adverse outcomes related to the Gulf oil spill and its response activities. Children in particular high-risk groups, including low-income, disadvantaged, and asthmatic children, are at increased risk for exacer-

bating respiratory symptoms common in the general pediatric population. Inhalation-related symptoms, such as narcosis, tachypnea (rapid breathing), pneumonia, headaches, and other mild neurological symptoms, have already been documented. Redlener suggested that surveillance activities should also track dermatological conditions, aspiration syndromes, and a range of long-term, central nervous system consequences or malignancies that may result from exposure to crude oil products.

Psychological "toxic stress" is arguably the most significant health issue for children, according to Redlener. Children who are exposed to long-term, persistent stress without a strong mitigating parental figure can suffer a range of irreversible effects, including chronic medical conditions in adulthood. In fact, the well-being of children is directly related to the resiliency and stability of their parents, said Redlener. Hurricane Katrina is a recent memory and trauma for many children, and the Gulf oil spill is likely to increase the risks associated with stress and anxiety in children's environments. When asked which was worse, Hurricane Katrina or the oil spill, one 15-year-old boy said:

> This is way worse than Katrina. That was just a hurricane; that destroyed a lot, but we could rebuild and eventually come back to our homes. With the oil spill, we live with uncertainty, and most of us are afraid that this place we love will not come back. It will mean the end of our way of life. I don't know what we'll do—or how we'll survive.

There are significant psychological and academic consequences associated with toxic stress in children. In fact, researchers documented elevated levels of anxiety and post-traumatic stress following the 2001 World Trade Center attack. Redlener also described unpublished studies (at the time of the IOM workshop) that found severe consequences related to persistent uncertainty, parental dysfunction, and severe economic stress following Hurricane Katrina. Seventy-five percent of children affected by Hurricane Katrina exhibited serious psychological issues. These children were four times more likely than children in the general population to have serious emotional disorders and two times more likely than children in the general population to be too old for their grade.

Relevant Gaps in Scientific Knowledge

Redlener stated that significant gaps exist in our knowledge of potential adverse health effects of large-scale disasters in children. Insufficient evidence exists to indicate whether there will be long-term pathology related to persistent, high-level toxin exposures or psychological consequences stemming from prolonged periods of uncertainty or economic loss. Questions remain about the effects of multiple exposures to large-scale disasters, such as Hurricane Katrina, the recession, the Gulf oil crisis, and the possibility of another hurricane. Accordingly, there is a need to identify effective interventions for prevention and mitigation of trauma across populations, as well as identifying best practices for bolstering family resiliency, ensuring stability and access to health care and other essential services, and maintaining academic continuity in the face of large-scale disasters like the Gulf oil catastrophe.

Suggested Monitoring

Redlener recommended a particular approach to monitoring potential adverse health impacts of exposure to toxins and toxic stress. As part of surveillance activities, public health authorities should: (1) collect baseline clinical and laboratory assessments; (2) bank biospecimens; (3) monitor new onset of specific health concerns (e.g., breathing issues, headaches, abdominal symptoms); (4) monitor new onset of emotional or behavioral symptoms; (5) monitor cognitive, developmental, and academic status; and (6) monitor family and child "well-being" indexes.

Redlener concluded by emphasizing the critical importance of providing reliable information from trusted sources by engaging local authorities in risk communications strategies. Redlener said that he has observed a significant and widespread lack of trust in the federal or state governments or outside agencies. Citizens wanted to hear from their local authorities about whether or not parents should allow their children to swim, to play in the yard, and the like. A dearth of such information only adds to the anxiety.

POTENTIAL SHORT- AND LONG-TERM PSYCHOLOGICAL EFFECTS

As with the acute health effects of exposure, potential acute, chronic, and delayed mental health problems are just as important to consider as potential chronic physical health problems. Howard Osofsky described the immediate effects that the social, economic, and psychological stressors had on communities in the Gulf region following Hurricanes Katrina and Rita and noted that local residents and parishes were already reporting similar symptoms, such as depression, anxiety, and suicidal thoughts. Osofksy described some of the mental health data that he and colleagues collected after Hurricane Katrina and explained that they would continue to collect modified forms of these same data in the wake of the Deepwater Horizon disaster.

Sheldon Cohen described the different ways that the Gulf oil disaster may be producing the same type of psychological stress that other, more common events (e.g., job loss) cause; how psychological stress varies depending on how threatening an event is perceived to be and how well a person is able to cope with the perceived threat; and the behavioral and physiological changes that can occur as a result of stress. He also listed stress-related endpoints for use in future health surveillance efforts.

In conclusion, Lawrence Palinkas described in detail what he and other researchers learned about the psychological impact of the *Exxon Valdez* spill. Based on these results, Palinkas identified populations in the Gulf region that he suspects may be especially vulnerable to psychological stress (e.g., previously traumatized populations) and recommended certain types of data to include in surveillance.

Assessing the Early Mental Health Effects of the Gulf Oil Spill

Howard J. Osofsky, Louisiana State University Health Sciences Center

Disasters increase the prevalence of adverse mental health outcomes, but research focused on these outcomes and application of knowledge generated by such research is somewhat limited, especially where it concerns the well-being of children and families, said Howard Osofsky. Assessment can be difficult because of the interactions between psychological, physical, and neuropsychiatric health. Moreover, developmental considerations are of particular importance given that Louisiana's state-level crisis and response program (Louisiana Spirit) is already receiving

from schools calls related to the potential for learning-cognitive difficulties, impulse-control issues, and risk-taking behavior as a result of the oil spill disaster.

While there are studies of natural and technological disasters that have investigated early mental health effects related to substantial changes in way of life, employment, and income, the Gulf oil disaster is unique for several reasons:

- **Retraumatization:** The Gulf oil disaster follows closely on the heels of Hurricanes Katrina, Rita, and Gustav and an economic recession. For individuals that survived the hurricane traumas, the cumulative effects of multiple traumas may increase susceptibility to psychological conditions or disorders.
- **Population diversity:** The Gulf community is large and ethnographically and culturally diverse, even within the affected parishes. Particular aversions to participation, such as "avoidance" or a desire not to talk about problems, is an expected part of the culture in affected communities.
- **History:** Other unique aspects of the Gulf region's history may affect surveillance and monitoring activities. For instance, multiple generations of fishermen and -women may lose their livelihoods. Gulf residents also exhibit an ambivalent relationship with the oil companies, leading residents to be suspicious of safeguards, even while the residents depend on oil companies for their livelihoods.

Retraumatization may increase the risk of developing adverse psychological-health effects. Following Hurricane Katrina, Osofsky and his colleagues collected 5 years of pre-oil spill data on children, adolescents, and some first responders. These data will continue to be collected, and researchers will continue to measure the cumulative effects of multiple traumas. (A summary of Osofsky's presentation in Chapter 6 provides additional information about these studies.) These data can provide a baseline from which to assess the cumulative effects of multiple traumas, to track trends, and to predict the need for health care services. For instance, 40 percent of the first responders surveyed after Katrina requested help for themselves or their families.

A number of data-collection activities are currently under way. Osofsky stated that he was already receiving reports from domestic-violence shelters and drug courts. Focus groups have revealed increases

in suspiciousness, arguing, domestic violence, depressive symptoms, suicidal thoughts, consumption of alcohol, acute anxiety, and fear. On the other hand, some people have expressed relief that family members are not employed as responders in relief efforts because it means less exposure to toxins. Osofsky ultimately predicted that mental health problems would likely become much worse over time as a result of the Gulf oil spill.

Finally, Osofsky described the importance of establishing a long-term working relationship with local communities and organizations. Osofsky explained that individuals in the affected communities do not want handouts, but do want "hand-ups"—meaning that those individuals want information and assistance to help guide their approaches in the future. In addition to earning the trust of local community members, working with communities can also provide information about how best to link people with available services or about the need for additional resources.

Long-Term Psychological Stress and Disease: Implications for the Gulf Oil Spill

Sheldon Cohen, Carnegie Mellon University

Drawing on scientific literature that addresses a wide range of stressful events that have been associated with adverse health effects (such as job loss and personal stressors such as divorce), Sheldon Cohen explained how the existing literature on the connection between psychological stress and disease can provide information about the long-term effects that could be expected as a result of the Gulf oil spill. Many of the stressful events that have been associated with disease risk are fundamentally similar to events that currently affect people in the Gulf region. For example, individuals are reporting lower self-esteem, sometimes resulting from job loss; loss of purpose or meaning in life, such as a loss of career aspirations or family businesses; and loss of feelings of control over important outcomes, resulting from the inability to support a family or protect the environment. Other common psychological symptoms associated with poorer health include perceptions of unfair treatment, stemming from causes such as problems with reimbursement for loss, and damage to social networks, often resulting from conflict or loss of close friends.

Cohen further explained that the stress associated with any given event, such as job loss, could be very different for different individuals, depending on how those individuals perceive the event. For example, the perceived stress for someone who is about to retire would be very different than the perceived stress for someone who needs a job to support his or her family. Additionally, the stress of a threatening event could be very different for different people, depending on available coping mechanisms. For example, someone who has supportive friends and family or access to another source of income would experience a different level of stress in response to a threatening event than someone without a support system or alternate source of income.

Psychological stress is known to be associated with many mental health outcomes in adults, including depression, post-traumatic stress disorder, and anxiety disorder, said Cohen. Stress has also been associated with emotional and social conflicts in children. These negative emotional responses can lead to intermittent physiological and other health effects, such as activation of the sympathetic nervous system. Moreover, individuals who have negative emotional responses tend to adhere poorly to medical regimens and to have poor health practices, such as poor sleep quality, poor diets, lack of physical activity, and increased alcohol and drug use. Together, these physiological changes and poor health practices can lead to an increased risk of physical disease.

Cohen stated that psychological stress is also known to be associated with several physical health outcomes in both adults and children, including total mortality and increased risks of coronary heart disease, hypertension, and upper respiratory infections. Stress is also known to exacerbate several chronic diseases, including HIV/AIDS progression, oral and genital herpes, rheumatoid arthritis, and asthma. Indeed, studies demonstrated an increased risk for coronary heart disease (including myocardial infarction, cardiac arrhythmia, and sudden death) within 30 days after the World Trade Center attack and within 60 days of SCUD-missile attacks in Israel. But not all such risks manifest immediately. Risk for coronary heart disease has also been shown to increase 6 months to several years after work-related stressful events when those events involve a perceived lack of control over work or a perceived lack of institutional fairness.

Populations most vulnerable to stress-associated risk include children, individuals with chronic illnesses, histories of poor coping, a lack of close social ties, and lower levels of income and education (because they have fewer resources to help them cope with stressful events).

Cohen ultimately suggested several endpoints and a research design that could be incorporated into a surveillance or monitoring system to monitor psychological stress related to the Gulf oil catastrophe. Cohen suggested measuring perception of stress and/or threat, along with feelings of depression, anxiety, and anger; health practices that are also good indicators of stress, including sleep quality, diet, physical activity, height and weight, smoking, alcohol and drug use; and adherence to medical regimens. Cohen also suggested some endpoints related to disease outcomes, such as the presence of depression, anxiety, and post-traumatic stress disorder; the incidence of cardiovascular disease; markers of disease progression among the chronically ill; and the use of health care. As part of the research design, Cohen proposed longitudinal, long-term, and individual follow-up studies to assess the progression and exacerbation of chronic diseases, with a special emphasis on mental health.

Psychological Impacts of Oil Spills: The *Exxon Valdez* Disaster

Lawrence Palinkas, University of Southern California

A number of studies have been conducted on the social and psychological consequences of the *Exxon Valdez* spill. Lawrence Palinkas was involved with one of the largest of those studies, the "Oiled Mayors" study. The study was conducted 1 year after the spill and combined ethnographic fieldwork in 22 communities with a quantitative survey of about 600 households. The researchers measured exposure based on responses to a series of questions about whether the household had used an area affected by the spill, participated in clean-up activities, and the like.

Lessons of the Exxon Valdez *Studies*

Palinkas's studies found a number of psychological outcomes that were associated with the degree of exposure (Palinkas et al., 1993a). A 1993 study by Palinkas and colleagues examined the relationship between certain psychiatric disorders and exposure to the *Exxon Valdez* oil spill and its response activities. In this study, exposure was widely defined to include direct contact with oil, damage or property loss, and disruptions to social and economic activities. Figure 3-1 depicts a significant association between exposure and generalized anxiety disorder,

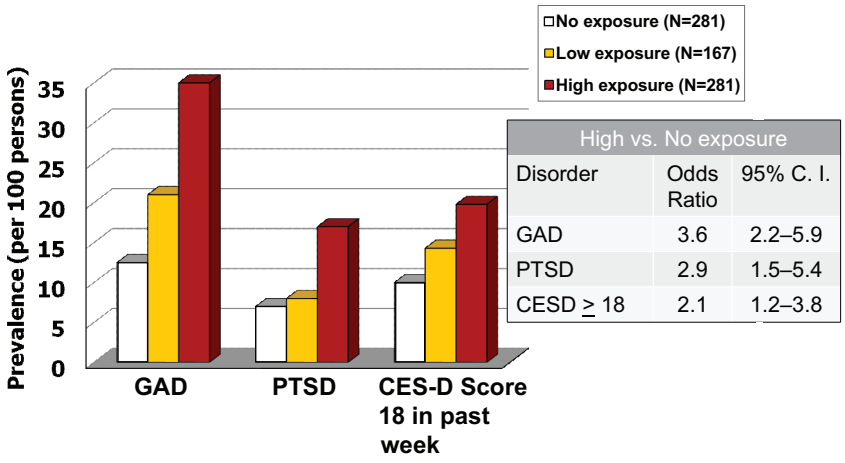

FIGURE 3-1 Prevalence of generalized anxiety disorder (GAD), post-traumatic stress disorder (PTSD), and levels of depressive symptoms (assessed using the Center for Epidemiologic Studies Depression [CES-D] Scale) in *Exxon Valdez* study respondents.
NOTE: In this figure, comparison groups are defined by exposure levels and include varying numbers of participants (N). The figure lists the odds ratios and confidence intervals (C.I.) for high- versus no-exposure groups.
SOURCE: Palinkas et al., 1993a.

post-traumatic stress disorder, and depressive symptoms as reported by study participants.

Widely defined exposures to oil spills and clean-up activities were also associated with increased use of mental health services, as indicated by an increase in the number of mental health visits to the Seward Life Action Council in Seward, Alaska, between July and December 1989 (compared to July-December 1988) (Impact Assessment, Inc., 1990). In addition to the psychological outcomes, Palinkas and colleagues detected significant associations between exposure and problems with alcohol and drug abuse and domestic violence (Palinkas et al., 1993b; Russell et al., 1996) (see Table 3-4), as well as declines in traditional social relations (Palinkas et al., 1993b; Russel et al., 1996; Palinkas, 2009).

TABLE 3-4 Impact of Exposure to *Exxon Valdez* Oil Spill on Domestic Violence and Alcohol and Drug Abuse

Social Unit and Problem	% High Exposed	% Low Exposed	% Not Exposed
Community			
More Drinking*	56.8	4.4	5.0
More Drinking Problems*	45.3	32.5	6.9
More Drug Use*	50.4	43.2	6.8
More Drug Use Problems*	39.5	30.8	9.4
More Fighting*	40.5	32.3	3.5
More Fighting Problems*	33.9	27.7	4.8
Family and Friends			
More Drinking*	29.3	15.3	2.8
More Drinking Problems*	26.0	13.3	5.4
More Drug Use*	21.2	10.8	1.7
More Drug Use Problems*	19.4	9.1	1.5
More Fighting*	19.7	3.8	0.9

*Chi-square test for trend $P < .0001$.
SOURCES: Palinkas et al., 1993b; Russell et al., 1996.

Palinkas explained that the studies following the *Exxon Valdez* disaster were noteworthy because they were the first to document post-traumatic stress disorder without any loss of human life. As Redlener had described earlier with respect to what is happening now with the Gulf of Mexico oil disaster, it was the loss of a way of life and not necessarily the loss of life itself that is profoundly affecting individuals. Palinkas described several results of the research, as outlined in the following sections.

The researchers found that not all individuals were equally vulnerable. The Alaskan Native population was one of the groups most vulnerable to the disaster's traumatic consequences, as the native population not only relied on the affected areas for subsistence activities but also participated heavily in the clean-up activities (Palinkas et al., 2004). Other vulnerable populations included clean-up workers, women, and families and children.

The researchers also examined the impact of exposure on children and found that increased exposure was associated with a decline in relations with other children in the community, difficulties sleeping, poor

school performance, anxiety upon hearing someone talk about the spill, bedwetting, problems with being left alone, fighting with other children, and difficulties getting along with parents and siblings (McLees-Palinkas, 1994). In some cases, these findings were similar to those in adults. One of the most interesting findings, Palinkas said, was the association between difficulty finding child care and post-traumatic stress disorder, anxiety, and depression in parents.

Because psychological stress can lead to physiological changes and increased risks for chronic diseases, Palinkas and colleagues examined the impact of the *Exxon Valdez* spill on physical health. As with the psychological outcomes, researchers found that more-exposed individuals reported more heart disease, high blood pressure, diabetes, thyroid problems, cancer, asthma, ulcers, bronchitis, chronic coughs, and skin rashes (Impact Assessment, Inc., 1990).

Applying Lessons Learned from the Exxon Valdez *Studies to the Gulf Oil Spill*

Palinkas echoed other panelists' recommendations to monitor populations particularly vulnerable to psychological stress. He mentioned previously traumatized populations, such as Hurricane Katrina victims, Vietnamese refugees, children and families, and under-served populations. Palinkas also singled out the need to monitor participants in clean-up activities, whose vulnerability stems from prolonged separation from their families, conflicts between those who did and did not accept clean-up jobs, and witnessing firsthand the ecosystem's destruction.

Palinkas also recommended the collection of particular types of data necessary to measure long-term mental health effects. Suggested measures included measures of mental health indicators, such as indicators for anxiety, depression, and post-traumatic stress disorder; social disruption; drug and alcohol use; child behavior; and qualitative data on individual- and community-level responses to the oil spill.

Finally, as other panelists had done, Palinkas highlighted the possible influence of litigation on long-term data collection.[4] Although the *Exxon Valdez* oil reached its maximum size within 56 days, the *Exxon Valdez* story did not end after 56 days. In fact, it continued for about 20 years,

[4]Although HHS did not charge the IOM with investigating the effect of litigation on possible surveillance systems, the issue continued to emerge as an important research limitation.

until late 2009, when the U.S. Supreme Court ruled on compensation for damages. For many of the residents of the affected communities, the story continues even today. Ironically, the litigation itself has been a form of stress-inducing exposure that caused community conflict and prolonged uncertainty.

QUESTIONS AND COMMENTS FROM THE AUDIENCE

Is there a need for diagnostic protocols or clinical guidelines for mental health symptoms that front-line providers can use?

Osofsky replied that such protocols and guidelines would be useful. Even well-trained volunteers and workers will experience medical or psychological problems. Individuals present in emergency rooms for respiratory, dermatological, cardiovascular, or other physical problems, and it can be difficult for professionals treating them to realize that such individuals may also have acute stress, depression, or other psychological problems that are compounding the expression of physical symptoms. The physical and psychological symptoms need to be treated together. There also needs to be some recognition that medical personnel may be experiencing secondary traumatic stress themselves.

Later during the workshop, there will be discussions around ways to monitor populations and collect research data while moving forward. But what about providing care to the people who are being monitored or are participating in the research studies? For example, have there been efforts in the mental health field to ramp up services as data are collected?

Osofsky replied that, while the Deepwater Horizon disaster has not interrupted services like Hurricane Katrina did, resources are nonetheless very limited and are only just being re-established.

Is there reason to be concerned about a potential synergistic effect of heat and chemical exposure?

Bernard replied such a concern is appropriate to the extent that anything that affects the central nervous system is probably going to affect the thermal regulatory center. And anything that affects the renal system

or other factors that affect fluids and electrolyte balance will likely influence the effect of heat exposure. Sathiakumar identified the relationship between chemical exposure, heat exposure, and behavior as being very important (e.g., if it is too hot to wear PPE, the risk of chemical exposure will increase). Osofsky added that individuals taking medications for mental health conditions will be much more vulnerable to heat exposure.

Given that heat stress increases risky behaviors, is having well-motivated workers (workers who want to work quickly in the heat for a longer period of time to stop the oil from coming to shore) a problem?

Bernard replied that particular attitudes can be a problem. It is important to have an effective heat stress management program in place to contain that enthusiasm so that workers protect themselves.

Many clean-up workers have preexisting medical conditions that may put them at increased risk for heat stress. What guidelines or recommendations exist for screening these workers?

Bernard replied that there are some risk factors related to impaired water balance, decreased cardiovascular capacity, or impaired thermal regulation (e.g., many drugs used to treat chronic disease affect thermal regulation). The problem with pre-screening is that there is no good test to identify who is going to be able to work in the heat, other than a history of having successfully worked in the heat. One approach is to review known risk factors with workers and submit letters with information on heat exposure to workers' personal care physicians so that the workers can be properly guided.

Do break periods need to vary by age?

Bernard replied that heat stress is less age-related than it is fitness-related. In addition to previous heat exposure experiences, aerobic capacity is a good indicator of how well one will do in the heat. In any event, right now, breaks are extensive. For example, offshore workers receive 2-hour breaks for lunch in an air-conditioned facility.

Are biomarkers of exposure relevant to the general population, or are they relevant only for heavily exposed populations?

The relevance of biomarkers appears to depend on which chemical compound is being monitored. Spencer replied that many biomarkers of exposure are developed as a consequence of experimental studies that involve studying high doses of exposure in laboratory animals; this is because limits in the duration of exposure possible in experimental settings requires that researchers increase the doses so that they can detect effects. The biomarkers that are identified in those circumstances have limited use in situations where the levels of exposure are low (i.e., most real-world human situations). On the other hand, Eskenazi stated that there are some sensitive biomarkers, such as those for benzene, that can be used to detect fairly low exposure levels. In fact, she and her colleagues have used biomarkers (in sperm) to measure changes in benzene exposure even within the U.S. permissible exposure limit.

What are the neurotoxic effects of exposures to heavy metals (e.g., lead, mercury, cadmium)?

As is the case with so many exposure pathways, there are many uncertainties (e.g., whether thresholds for effects are reached in real-world settings and whether other factors could be responsible for the observed effects). Spencer stated that many heavy metals can adversely affect neurologic function. As an example, he pointed to Minamata Bay, Japan, where industrial effluent containing mercury that had been released into the bay was converted into an organic mercury that then entered the marine food chain and caused profound neurologic damage in humans. For instance, children born to pregnant women who had consumed mercury-contaminated fish were born with abnormal brain structures and permanent brain dysfunction. But in order to answer the question in the context of the Deepwater Horizon disaster, he said that he would need to know the likely levels of exposure, as there are thresholds for the effects, and it is not clear whether they will be reached. Eskenazi stated that she was very concerned about heavy metals, noting that recent evidence indicates that even low levels of manganese may affect neurobehavioral development in children. She suggested that lead levels in children in the Gulf region be screened to see whether there are any "pockets of elevation."

Spencer also reminded the audience of the Gulf of Mexico "dead zone," which Goldstein had mentioned, and the brevetoxins that naturally exist in the bivalve and molluscan shellfish inhabitants of the dead zone, which are responsible for the region's "red tides." He noted that brevetoxins can enter the food chain and cause both acute and chronic significant neurologic dysfunction.

What are your recommendations for long-term monitoring of mental health?

Most of the panelists agreed that relying on biomarkers to monitor mental health is not an effective strategy and that clinical monitoring of symptoms and the use of standardized mental health assessment tools would be much more useful. Specifically, Cohen replied that the use of biomarkers to measure stress (e.g., epinephrine or cortisol) are not useful in this situation, as the quality of available biomarkers is extremely variable and biomarker measures are sometimes not comparable across environments. He emphasized the importance of long-term monitoring for symptoms of anxiety and depression. He stated that Redlener agreed that biomarkers are not a practical means of monitoring changes to inform care, particularly in children, and emphasized instead the importance of clinical "psychomarker" monitoring—the monitoring of sleep difficulties, changes in behavior, difficulties interacting with siblings or peers, etc. Palinkas mentioned the Millennium Cohort Study, a large population-based study that emerged after the first Gulf War in response to concerns about Gulf War syndrome, as a good example of how standardized mental health assessment protocols and tools can be incorporated into the surveillance process in a timely manner and in such a way that the data can be used to inform policy and mitigate adverse health outcomes. The study was designed to identify both the long-term physical and mental health effects of deployment of military personnel, and it is beginning to generate substantive knowledge. Study participants respond annually either through mailed questionnaires or via a website to standardized instruments that assess health outcomes.

If you or your family were living in the Gulf Coast area, what concerns would you have and what precautions would you take?

Most of the panelists identified the need for mental health services and a trusted source of information as the most pressing concerns.

Redlener replied that his principal concern would be to find out where he could get information that would help him understand the consequences of the disaster for his family. Residents want to know what the risks are with the food supply, the water supply, etc. He said, "There are many, many details of normal, day-to-day living for which people want answers." Eskenazi agreed with Redlener that she would want a trusted source of accurate information. She described how several studies have shown that often one of the largest outcomes following disasters is distrust of authority. Palinkas agreed. He said that trusted local authorities serve not only as sources of accurate information but also as mechanisms for maintaining a sense of stability in the affected communities. Having faith that local governments are managing certain components of the response (e.g., employment issues) could alleviate some of the residents' concerns that are causing stress. However, he said that one of his biggest concerns would be the adequacy of services. Following Hurricane Katrina, the health care and social-services sector was among the hardest hit sectors. That sector is only just beginning to recover, and now there are increased demands for psychologists, psychiatrists, and other mental health and social-services professionals. Cohen expressed concern about the potential loss of the very strong sense of community and culture that exists in the Gulf region and the psychological stress caused by that loss.

Eskenazi also said that, if she were a parent of a young child, she would carefully watch the Environmental Protection Agency (EPA) air-monitoring website. She would also be concerned about feeding her children local fish, although she acknowledged that her concern was a gut-level response and was not based on evidence. Spencer replied that he would primarily be concerned about the quality of food.

What can be done today with the information already available to mitigate the adverse health consequences of exposure?

Based on lessons learned from the *Exxon Valdez* spill and Hurricane Katrina, Palinkas and Redlener both identified the need to establish a way for the community to feel in control of the situation. Palinkas replied that, based on the *Exxon Valdez* experience, the manner in which the cleanup was conducted was one of the biggest sources of stress. Many people in the communities felt a loss of control, in much the same way that Cohen said happens during stressful situations, because the *Exxon Valdez* contractor approached communities from the outside and offered

wages that exceeded what was otherwise available to workers in those communities, which caused some community conflict. For example, citizens who would otherwise generate income through child daycare made much more money cleaning oil off the rocks, which led to very limited child daycare services for the community.

Cohen said that one way to mitigate adverse effects is through local control—not only with respect to compensating local residents but also with respect to including residents in clean-up activities without overwhelming community resources and the physical and mental capabilities of the residents. Redlener reflected further, but from a different perspective, on the need for an immediate sense of control. He replied that it is essential that residents immediately know who is in control and where they can access information on a daily basis to help them make decisions (e.g., about whether it is safe to let their children play outside). Many of the most affected families were medically under-served and disadvantaged before the oil disaster, and their access to the usual forms of health care information is extremely limited. Affected families need to be provided a sense of structure and cohesion, as well-trusted messengers, to help them get through what is a very stressful time. The failure to provide these services will exacerbate problems that already exist.

Other panelists identified the need to develop effective communication strategies for vulnerable populations. Specifically, Eskenazi emphasized the importance of focusing on pregnant women. Some studies have shown that some of the mental health consequences are greater in women than in men, and pregnant women are particularly vulnerable because they are not just protecting themselves but also their developing fetuses. She asked how pregnant women can obtain accurate information from a trusted source about the risks (e.g., of eating seafood)? Spencer agreed with Eskenazi and remarked that chemical exposure during development can potentially cause permanent changes to the brain and other parts of the body. He emphasized the importance of considering the other end of the aging spectrum as well. Older adults are uniquely vulnerable to chemical exposure because of weight loss, loss of liver metabolism and renal excretion functions, etc.

Spencer also discussed variation in susceptibility to the adverse effects of exposure. Specifically, he reminded the workshop that the federal threshold levels that have been established to protect health are based on "protection of the majority but not the totality of the population." Scientists are increasingly recognizing that there are individual genetic susceptibilities to certain exposures, one example being heat

stress; there is a genetically based loss of muscle function that has been shown to be associated with increased susceptibility to heat stress. Spencer emphasized the need to determine whether people involved with clean-up are more susceptible to heat stress or other risks because of their genetic make-up or other factors.

4

Communicating with the Public

One purpose of a surveillance system is to generate information to better protect the health of all affected populations by improving the organization and delivery of health care services (see Chapter 6 for a more detailed discussion of this issue). However, timely and reliable data collection and analysis is only one measure of an effective surveillance system. According to David Abramson, the success of surveillance and monitoring activities is also dependent on how results are communicated to the affected populations and incorporated into public health practice. This chapter explores strategies for engaging the public in risk communication. These strategies include identifying the most critical needs of affected populations, involving the public in surveillance-system and research development, and communicating to a vast array of stakeholders credible, reliable, and actionable data that account for cultural, language, technological, and geographic barriers, as well as varying levels of health literacy.

Focusing on the topics listed above, Abramson delivered a presentation on strategies and considerations to engage the public and protect the health of affected communities. He also provided personal recommendations for moving forward. Following his presentation, Mike Magee moderated a discussion with the audience, designed to generate feedback about the types of exposures and uncertainties of greatest concern to the public. The discussion also focused on current research and surveillance activities that could inform the design of a larger surveillance system. At the planning committee's request, four representatives from local communities provided remarks during an open-dialogue session. Members of the audience were also invited to comment on any aspect of the Gulf oil disaster.

ENGAGING THE PUBLIC, PROTECTING THE HEALTH

David Abramson, Columbia University

Decision making is the ultimate ambition of risk and health communications, according to David Abramson, and can be described in terms of information push and pull. From the policy maker's or public health practitioner's perspective, risk communication is designed to "push" information that encourages behavioral change or action that reduces known risks. From the public's perspective, risk communication activities allow communities and individuals to "pull" information that influences short- and long-term decision making. Abramson explained that town hall meetings provide opportunities for the public to request information that guides specific actions. For example, one individual at a recent town meeting asked whether to conduct baseline soil testing on personal property to document potential damage if an insurance claim should be filed.

Abramson stated that his presentation's three goals were to consider: (1) what influences perceptions, dissemination, and comprehension of health and risk communication by a variety of populations; (2) what vulnerability means to risk communication and how it influences what threats are perceived as most prominent; and (3) options for communication strategies that account for variations in culture, literacy, and other factors that define high-risk populations.

Influencing Health and Risk Communication

Health communication is not risk communication. Health information, which includes economic information, is geared toward social marketing and long-term behavior change, whereas risk communication draws on "emergency broadcasting" methods to elicit an immediate response, stated Abramson. Thus, variations in risk and health communication effectiveness may depend on different factors. For example, lack of attention or awareness may weaken the impact of health communication messages. On the other hand, risk communication messages are more vulnerable to fatigue, which can result from conflicting messages or dismissal if people do not perceive themselves as being part of the at-risk group.

Abramson cited a long line of science and scholarship on risk communication that can be used to inform communication strategies. For

example, one study investigating how attention to risk and health communications vary by population found pronounced differences between Pakistani, Orthodox Jewish, Chinese, Jamaican, and Caribbean populations even within the same region. Table 4-1 lists key findings of several recent National Center for Disaster Preparedness communications projects.

A number of general factors can influence perceptions of health and risk messages. First, the public must trust both the message and the messenger. In the aftermath of Hurricane Katrina, Abramson explained, many residents developed a significant mistrust of authority and the insurance industry. As a result, it is important to carefully select messengers that the target population recognizes as trusted organizations or figures. Additionally, the message must be understandable. Currently, the majority of graphics and data used by the media or policy makers for public communications only use one or two variables. In the context of the oil spill, information may include multiple variables, such as race, occupation, exposure, socioeconomic status, or language. Abramson described some recent projects that have trained practitioners and policy makers to use complex data to target interventions (e.g., "radar charts") and suggested that the same strategies be used to communicate to the public about disaster preparedness and response. However, said Abramson, communicating with the public also should account for levels of overall health literacy in addition to ease of data interpretation and comprehension.

There is also a question of whether it is productive to include a sense of immediacy in the message. Abramson explained that, in recent focus groups, approximately one-half of individuals interviewed did not want a message to scare them, but the other half felt that alarm was necessary to trigger action. However, Abramson questioned the wisdom of using fear to motivate populations that are ill equipped to adequately respond to the message due to circumstances such as limited economic resources.

TABLE 4-1 Results of Recent Communications Studies

Study Description	Applicable Findings or Activities
The American Preparedness Project examined attitudes, behaviors, and health practices in the U.S. population.	Eighty to 85 percent of the population sampled considers the U.S. Centers for Disease Control and Prevention to be a highly trusted health authority.
The Elusive Communities Project explored how undocumented Mexican immigrants respond to health communication strategies post-H1N1.	Community-based organizations play an important filtering role in risk communications.
The Ready New York Campaign focused on evaluating the attentiveness of communities to risk and health communication.	Different ethnic populations respond differently to risk communication messages.
Community Cells and Circles studied mechanisms for allowing rapid two-way communication with high-risk or at-risk populations (i.e., HIV/AIDS, Harlem teenagers, homebound, and undocumented immigrants).	Preliminary results demonstrate how a range of both old and new technologies can be used effectively to communicate information.
The Gulf Coast Child & Family Health Study is a longitudinal cohort study involving more than 1,000 families in Louisiana and Mississippi.	Recovery has occurred at a variable rate in the Gulf, often contingent on access to resources and restoration of social systems.
The American Hotspots Project uses geospatial intelligence and social data to measure public health preparedness.	Data-driven decision making can be enhanced by graphical tolls that allow for the display of complex social and geographic data.

Vulnerability and Evolving Threat Saliency

The unique vulnerability of a population also can affect how communities interpret messages about health or risks. Abramson defined vulnerability as a "predisposition to higher risk," which may include physical, psychological, social, or economic vulnerabilities. As discussed

by Maureen Lichtveld (see Chapter 2), the Gulf population is uniquely vulnerable to adverse health effects from the oil spill and its related activities for a variety of reasons, including high rates of poverty, poor education, and exposure to multiple disasters. As noted above, vulnerable populations, such as those with physical disabilities or limited economic resources, may be more likely to view informational messages as frightening if they are unable to respond to the information provided. Additionally, concern over disclosures of personal information (such as HIV status or immigration status) may prevent some individuals from acting on information included in the messages. Abramson also noted that families often make decisions based on the most vulnerable person in the household. Thus, even if the majority of household members are capable of taking recommended action, they may be constrained by the capabilities of the most vulnerable member of the family.

Finally, retraumatization may affect how communities respond to risk and health messages. Because of recent exposures to situations stemming from disasters such as Hurricanes Katrina and Rita and recent floods, populations may experience increased susceptibility and decreased resiliency in response to the Gulf of Mexico oil spill. Moreover, Abramson explained that Gulf residents were tiring of having the Gulf oil spill compared to Hurricane Katrina because it forced them to relive traumatizing experiences that had been left in the past.

Health and Risk Communication Strategies

Certain principles should guide strategies for effective health and risk communications. First, one-way communication has limits. Abramson stated that communities want their voices heard. If the message incorporates input from local residents, then communities will be far more receptive to messages from trusted sources. As such, communication strategies should include mechanisms for generating two-way communication. Second, Abramson continued, citizen action often requires interpretation and deliberation. Thus, strategies need to allow these processes to occur and efforts should be made to provide communities with accurate and reliable information, as well as tools to help them interpret complex or unfamiliar information. Local political and community leaders are often regarded as trusted sources, and can be instrumental in helping communities interpret such complex information.

Incorporating the topics covered during the course of his presentation, Abramson recommended five immediate actions to develop effective risk strategies:

1. Identify populations at risk and what makes them vulnerable. As explained above, vulnerabilities come in many forms. Predefined categories of vulnerability are not always useful.
2. Understand and address at-risk populations' concerns.
3. Know which messengers and media the local communities trust.
4. Create communications platforms for disseminating and interpreting complex data and for enabling two-way communication.
5. Develop key roles for local leaders.

Abramson noted that a number of community-based platforms already exist to disseminate and interpret complex data. In Europe, for example, "science shops" assign a scientist to community groups, and they work together to interpret and understand the data. In closing, Abramson underscored the importance of developing capacity and responsibility among local leaders. Although local representatives may not have the scientific expertise to interpret all the data and information made available to the public, communities in the affected Gulf regions trust their parish presidents, mayors, and local health officials to represent their best interests.

COMMUNITY PERSPECTIVES

Mike Magee, Positive Medicine, Inc.

Good instructional design and graphic displays can improve communication of complex topics to the general public. According to Mike Magee, by focusing on the quality and not the quantity of the message, graphic displays force the messengers to develop succinct messages, which generate behavioral change. Following a short presentation illustrating the power of graphics to improve communication, Magee initiated dialogue with the audience. To gain a better understanding of the issues about the Gulf oil spill that most concern different at-risk populations, four community representatives were invited to comment on the Deepwater Horizon disaster before the floor was opened to the audience.

Myra Lewis
On Behalf of Dillard University's Deep South Center for Environmental Justice

Myra Lewis drew on her 20 years of experience in outreach and communication. Lewis expressed gratitude that the workshop discussed so many of the factors that put Gulf Coast communities at risk, such as economic challenges, language barriers, and previous trauma. Because of past trauma, Lewis explained that many communities had lost some of their resiliency, felt powerless in the face of this current disaster, and no longer trusted governmental authorities at any level. Consequently, identifying trusted authorities to disseminate information would be essential for communication activities.

Adequate worker training also was a concern. Lewis emphasized the need for rigorous 40-hour training for the "individuals that are answering the call to go out and clean up this oil spill." She observed that the Deep South Center for Environmental Justice had received hundreds of calls in the weeks prior to the workshop, from local fishermen and -women and people who requested more in-depth training, as opposed to the 4-hour training that is being offered elsewhere. Volunteers are concerned about protecting themselves from unwarranted exposures, said Lewis.

Diem Nguyen
On Behalf of the Gulf Region Vietnamese-American Fishermen Population

Diem Nguyen remarked that financial ruin caused by the Gulf oil disaster was the greatest concern among the Vietnamese-American fishermen. Having come from Vietnam and not knowing any other livelihood, many fishermen question whether they still will be able to take provide for themselves and their families and how long the uncertainty will persist. Moreover, language barriers make it very difficult to tell a 50-year-old man, who has been fishing all his life, that he must learn English and find a new livelihood. Nguyen described the threat to mental health as a "domino effect," which began in the water and followed a path that ended with the loss of employment and financial security. In turn, this will negatively affect the mental and physical health of an already vulnerable population. However, Nguyen expressed hope that

collaborative efforts would soon begin to find strategies for protecting those individuals most vulnerable in the Gulf region.

Wilma Subra
On Behalf of Subra Company and
Louisiana Environmental Action Network

During her comments, Wilma Subra focused on two populations at risk: the Gulf residents and the Gulf fishermen and -women (some of whom are now employed as clean-up workers). At the time of the workshop, "when the winds blow from the south," these populations already were experiencing headaches, nausea, dizziness, respiratory problems, and burning eyes. Additionally, despite assurances to the contrary, many workers reported exposure to dispersants.

Subra also described growing animosity toward current authorities handling the oil spill response. Many fishermen and -women who had lost their livelihoods applied for and received clean-up work, but then became ill after beginning the clean-up work. Subra explained that some of these workers and their families felt that they could not complain about their illnesses for fear of losing their jobs. Additionally, these same workers were not seeking medical care, nor were they participating in health impact surveys, as this was equated to admitting sickness and could lead to termination. She concluded by saying that in 2010, workplace environments should not be exposing workers to conditions that threaten their health.

John Hosey
On Behalf of the Mississippi Interfaith Disaster Task Force

John Hosey stated that the Mississippi Interfaith Disaster Task Force was putting together a summit to begin working on some of the emotional, behavioral, economic, and spiritual issues resulting from the Gulf of Mexico oil spill. Over the past few months, many of the questions raised during the workshop also were being raised among the faith-based communities. But, like the oil floating in the water, the answers that people were currently receiving were not "worth very much," said Hosey.

This is not just a Gulf Coast problem—this is a national problem, which may become a global problem over time, Hosey said. He

described a regional summit that would bring together communities, businesses, and others impacted by the oil spill to develop a policy statement that would address emotional, spiritual, behavioral, and economic issues. Communities were frustrated due to job loss, conflicting messages, and uncertainties in how to respond to a disaster of this nature and magnitude. Given the history of the region, there is a distrust of research that does not lead to actionable outcomes. Hosey expressed a need to develop strategies for long-term response and encouraged researchers coming to the area to collaborate with the people in the region who know the affected communities.

OPEN DIALOGUE WITH THE AUDIENCE

To continue the dialogue with affected communities and to gain a better understanding of the issues of greatest concern to the Gulf population, audience members were invited to comment on any issues related to the Gulf oil spill. The discussion covered a wide range of topics, including barriers to research, community engagement, short- and long-term health consequences from exposures, advanced information technologies, converting data into action, and accuracy of terms.

Semantics: The Gulf Oil "Spill" Is Not Just a Spill

There was a comment about use of the word *spill* and that the Gulf oil disaster was not a spill—it was a "drilling disaster." Indeed, throughout the workshop, various other terms were used at different times and by different speakers, including *disaster*, *leak*, *blowout*, and *catastrophe*.

Other Vulnerable Populations

Audience members identified two additional vulnerable populations: pregnant adolescents (because the Gulf region has residents who are among the "youngest mothers in the nation," and pregnant adolescents often do not even know they are pregnant) and Latinos (who are uniquely vulnerable because many Latinos are assumed to speak English but do not).

Local Communities Are Not Just Risk Weary—They Are Also "Lab Rat Weary"

Adding to what several panelists said about the lack of trust in authority that exists in the Gulf region, there were several comments about local populations being "lab rat weary" from having been studied for so long. One audience member urged that any researchers considering studying the health impact of the Gulf oil disaster engage neighborhood groups and local community agencies in their research efforts. He stated that local community members are willing to contribute to research efforts but only if the research will have "meaningful and long-standing impact" for the community. Another audience member urged development of a "unified plan" for a coordinated research effort among universities and other research agencies to avoid unnecessary and duplicative research efforts. A few individuals commented about the need to unify efforts not only among institutions but also across sectors (e.g., environmental scientists and animal and human health researchers and practitioners).

Unanswered Questions About the Health Consequences of Gulf Oil Disaster-Related Exposures

There were several comments about hazards posed to human health and the environment related to the oil spill and its various clean-up activities. One comment discussed the lack of scientific evidence on the health consequences of exposure to combinations of chemicals. Other comments focused on the importance of considering not just long-term health effects of short-term exposure but also the long-term health effects of long-term exposure. Concern was raised about the long-term impacts of the oil-contaminated protective equipment and other supplies being disposed of in municipal waste sites.

One participant pointed out that oil contains many class I carcinogens and that crude oil itself is classified as a class III carcinogen. However, although exposures to some of the chemicals that exist in oil have been associated with lung cancer, multiple myeloma, acute lymphocytic leukemia, and chronic myeloid leukemia, it is not clear whether exposure to oil produces these same effects. Most of the studies have been only short-term, cross-sectional studies. It is very difficult to tease apart the effects of exposure to oil from other events in a person's

life that also may increase the risk of cancer. This type of analysis requires a long-term commitment.

Addressing the direct effects of the oil spill on the environment, an audience member suggested that although naturally existing bacteria ingest and break down some of the chemical compounds in oil, these oil-metabolizing bacteria require oxygen. An increase in their numbers caused by a large food source could result in an even larger dead zone (which could cause indirect, adverse effects on human health, as Goldstein pointed out during his presentation).

Use Electronic Health Records for Surveillance and Research

A few audience members suggested that U.S. Department of Health and Human Services (HHS) technology funds be leveraged. Funding could be redirected to improve electronic health record keeping in the affected areas, and electronic health records could be used for surveillance. Some of the new information technologies could also be used to increase local participation in health research. As an example of how helpful new information technology can be, another workshop participant identified something called the Oil Spill Crisis Map (Louisiana Bucket Brigade, 2010) as a good example of a participatory research tool, which at the time of the workshop had already received 900 hits since May 1, 2010. Citizens can add information to the map through e-mail, Twitter, and other means, reporting on experiences related to the Deepwater Horizon disaster, such as reports of sores or blisters as a result of wading in oil-contaminated water. Something like the Oil Spill Crisis Map could be a valuable tool for tracking long-term health impacts or for identifying "hotspots."

One participant remarked that "technology alone is not going to solve the whole issue" and that new technologies need a dedicated workforce behind them. Another participant expressed concern that, in areas where the average annual income approaches "Third World country status," relying on Internet surveys may not be practical. However, in areas with reliable Internet access, one person suggested that cell phones may be an underutilized tool.

Combining Surveillance with Mental Health and Other Services

Hitting on what would eventually emerge as a major overarching workshop theme, one audience member emphasized the importance of balancing the need for good surveillance data with the need to generate data that are immediately useful to the people affected by the Deepwater Horizon disaster (i.e., people who "need help with very difficult and very personal decisions" about their circumstances). This led to discussion about the types of services needed and the challenges in providing those services, particularly mental health services. There was a comment about the lack of mental health services infrastructure in the region, which had not recovered from Hurricane Katrina. This was echoed by other remarks about the "overwhelming" mental health consequences of this disaster and the lack of sufficient community-based mental health services, particularly substance abuse services and services for children with developmental disabilities.

5

Overview of Health-Monitoring Activities: State and Federal Perspectives

In the context of human health, the state- and federal-level government responses to the Deepwater Horizon disaster include developing surveillance approaches based on the best available science, providing needed health services to affected communities as part of surveillance, and collecting the necessary data to ensure that responses to future disasters are based on an even stronger evidence base.

State agencies across the Gulf Coast and many federal agencies have been actively conducting environmental and public health monitoring in an effort to track the oil spill's public health impact and to ensure that workers, residents, and other persons whose health could be affected by the spill are receiving the appropriate medical care. During this session, state health officials from Alabama, Florida, Louisiana, Mississippi, and Texas described the oil spill response from their respective states. Additionally, federal representatives from the Office of the U.S. Surgeon General, the Department of Health and Human Services (HHS), the Department of Homeland Security, and the Environmental Protection Agency (EPA) participated in this workshop session. This chapter summarizes their presentations and comments.

STATE RESPONSES

All five states reported two types of active public health surveillance: syndromic surveillance and reporting surveillance. Syndromic surveillance involves collecting data on sets of symptoms that may be exposure related (e.g., respiratory symptoms) and investigating case clusters. Data for syndromic surveillance come from the Department of Defense (DoD)

and Veterans Affairs (VA) treatment facilities as part of the Centers for Disease Control and Prevention's (CDC's) BioSense Program[1] and from hospital emergency rooms and urgent care centers participating in other surveillance programs (e.g., Florida's ESSENCE program [defined later in this chapter]). Reporting surveillance involves collecting data from poison control centers, physician clinics, and other sources, and investigating unusual clusters of symptoms that could be exposure related.

At the time of the workshop, only Alabama had detected an increase in illness through syndromic surveillance (29 exposure-related emergency room visits, mostly inhalation related). Additionally, Alabama had detected 66 exposure-related illnesses through reporting surveillance, with most being inhalation related. Louisiana had detected a total of 143 exposure-related illnesses through reporting surveillance. Most illnesses were inhalation-related illnesses among rig workers or clean-up workers, with the most commonly reported symptoms being headache, nausea, and throat irritation.

Alabama

Donald E. Williamson, State Health Officer

The entire Alabama coastline has been impacted by the Deepwater Horizon disaster, with all oyster reefs and coastal water closed for fishing at the time of the workshop, reported Donald Williamson. Although large amounts of oil were still rolling onshore, the swimming advisory that was at one point issued for all coastal waters has been lifted for some, but not all, beaches. As with the other states, Alabama has been conducting both syndromic and reporting surveillance.

Alabama's hospital syndromic surveillance includes tracking visits to 8 hospital emergency rooms and 20 high-volume urgent care centers and Federally Qualified Health Centers in two spill-affected counties. Exposure-related data are collected daily and collated weekly. Of a total of 19,429 complaints between the middle of May and the time of the workshop, 29 were related to oil exposure (18 via inhalation, 8 via dermal contact, and 3 via ingestion). Syndromic surveillance of DoD and VA treatment facilities through the BioSense program had not detected any anomalies at the time of the workshop.

[1]BioSense receives and displays clinical care data in real-time from more than 1,730 DoD, VA, and other hospitals nationwide. The data are used to detect and monitor disease trends at the national, state, and local levels.

There were 66 oil-spill-related exposure calls to the Alabama Poison Center at the time of the workshop, including 57 describing minor symptoms (e.g., nausea, vomiting, diarrhea, skin rash) and 9 describing moderate symptoms. As with the syndromic surveillance data, most symptoms were inhalation related (50), followed by dermal contact (12) and ingestion (4).

Improving Surveillance

Alabama is continually refining its surveillance activities. Williamson identified several areas of surveillance that need improvement. Many of the areas identified were also mentioned by representatives from the other Gulf States:

- Surveillance is voluntary with no validation of exposure reports. Williamson said that he suspected that most exposures are not from the oil itself, but from the oil spill response efforts (e.g., 10 days before the workshop, 17 people on a barge fell ill, not from exposure to oil, but from carbon monoxide that the generator had been pumping into the air intake).
- Monitoring systems that capture relevant data for examining long-term health effects need to be developed (e.g., population-monitoring systems that can capture increases in hypertension, cardiovascular disease, and other chronic diseases).
- Mental health surveillance needs improvement so that the necessary interventions are available.
- The current syndromic surveillance system has yet to differentiate between resident and worker status, although efforts are under way.
- Worker health surveillance also needs improvement, with more information being communicated from BP to the state health departments.
- Messages to the public need to clearly communicate uncertainty around potential adverse long-term health effects. For instance, noted Williamson, a lack of evidence for acute health effects does not mean that there are no adverse effects.

Florida

Ana M. Viamonte Ros, State Surgeon General

Although early indications suggest that the Gulf oil spill's acute physical health effects may be minimal, Ana Viamonte Ros agreed with other panelists about the importance of monitoring behavioral health complications that may arise as a result of environmental devastation and growing economic losses stemming from the Gulf oil disaster. This is especially true of Florida, said Viamonte Ros, where both the tourism and seafood industries are experiencing severe economic downturns as a result of the Deepwater Horizon disaster. Tourism comprises a large sector of Florida's economy. In 2008, tourism spending totaled more than $65 billion and brought in another $4 billion in sales-tax revenue, and more than 1 million people were employed in the tourism industry. Florida's finfish and shellfish industry comprises another significant portion of the state economy, with a dockside value of more than $200 million.

Syndromic and Real-Time Reporting Surveillance

The Florida Department of Health has been collaborating with both the CDC and the National Institute for Occupational Safety and Health (NIOSH) to monitor potential adverse health effects in both the general public and clean-up workers. As in Louisiana and Alabama, the state has been conducting both syndromic and reporting surveillance, using similar data sources.

Hospital syndromic surveillance includes tracking visits to participating emergency rooms for illnesses that may be related to oil or smoke exposure. Tracking is done through a program called ESSENCE (Electronic Surveillance System for the Early Notification of Community-based Epidemics). Syndromic surveillance of DoD and VA treatment facilities is being carried out through the BioSense program. Additionally, real-time monitoring of electronic reports from the Florida Poison Information Center Network is ongoing.

At the time of the workshop, none of the surveillance activities had detected any oil-related clusters of illness, although there had been some reports of heat exhaustion and dehydration.

Environmental Monitoring

In addition to public health monitoring, Florida has initiated baseline environmental testing (e.g., water, sediment, and seafood-tissue sampling) and contingency planning for other future monitoring needs. For example, an air quality monitoring protocol is being developed in the event that near-shore oil burning becomes necessary, and a fisheries reopening protocol (e.g., seafood-tissue testing) is being developed for those fisheries that have been closed due to the presence of oil in the water.

Risk and Health Communication

Florida has also initiated a robust effort to manage public information, with health information being communicated to the public at the regional, county, and local levels in English, Spanish, and Creole. Additionally, the state government has enacted a rumor-control program to respond to health-related rumors; established an integrated Deepwater Horizon response website to serve as a single access point for information, with a real-time map showing places where oil-related health advisories have been issued; launched a toll-free, spill-related information hotline; and briefed the personnel at Florida's four poison control centers about potential exposures and potential adverse health effects of exposure. The hotline and poison control center scripts are updated frequently as new health and safety information emerges.

Louisiana

Jimmy Guidry, State Health Officer

Louisiana has been conducting both syndromic and reporting surveillance of sickness complaints and exposure claims, as well as monitoring the environment (air, water, and seafood) with the goals of mitigating adverse effects related to exposure and ensuring that people do not become sick unnecessarily. As Jimmy Guidry explained, the state is also monitoring the health care provided to those who are potentially affected by exposure in order to ensure that people are receiving the right care.

Syndromic Surveillance

The state has been conducting syndromic surveillance among seven hospitals in impacted areas for increases in respiratory illness or asthma. At the time of the workshop, in comparison to trends over the past 3 years, there was no indication of spill-related increases in either outcome.

Reporting Surveillance

At the time of the workshop, Louisiana was in its third week of reporting surveillance. The state health department has been monitoring complaint data from the public and from health care providers about potential exposures (e.g., through odors, fumes, or dermal contact) and data on all illnesses and injuries potentially related to exposure (including heat stress). The health data include both objective (e.g., vomiting) and subjective (e.g., nausea) measures. Although not mandatory, Guidry said that the response has been robust and that people are often willing to share what is happening in their lives during tumultuous events or experiences. Details of the reported exposures and health effects are issued in weekly surveillance reports, and the state health department is using these reports to identify trends and to ensure that the necessary medical resources are available where needed. Additionally, the Occupational Safety and Health Administration (OSHA) is using the data to enhance worker surveillance, and the media are using the data to monitor health complaints.

At the time of the workshop, there had been a total of 143 reported exposure-related illnesses (108 workers, 35 general public), including 20 hospitalizations (17 workers, 3 general public). Poison control centers reported most of the data (73 reports), followed by physician clinics (33 reports), and the hotline (3 reports). The most commonly reported route of exposure was odor or inhalation, followed by skin contact. Again, most of the illnesses were among rig workers or clean-up workers, with the most commonly reported symptoms being headache, nausea, and throat irritation.

Improving Surveillance

An important limitation of the surveillance data being collected (at the time of the workshop) is that no attempts were made to confirm exact exposure. Confirming self-reported exposures is challenging. People's perception of reality is often very different from reality, and people may perceive that they are exposed to things when they are not, said Guidry. For example, after receiving multiple reports of nausea, which many of the affected people attributed to oil-dispersant exposure, the state conducted air sampling in the cluster areas and concluded that the symptoms were more likely related to hydrogen sulfide coming from the swamps (and not to the oil spill). Additionally, given that many of the workers are working in 100°F conditions or hotter, it can be difficult to identify whether weakness, nausea, headache, or other illnesses due to chemical exposures or to heat.

In addition to the difficulties associated with validating exposure claims, another major surveillance challenge—not just for Louisiana but for all the Gulf states—is uncertainty around the oil spill's long-term effects. Surveillance must separate oil spill related exposures from other factors that could adversely affect an individual's health (e.g., genetics, lifestyle choices).

Mississippi

Mary Currier, State Health Officer

Although the oil spill has not hit Mississippi nearly as hard as it has hit Alabama, Florida, and Louisiana (at the time of the workshop), there is considerable monitoring already under way or planned, including of both the environment (e.g., air, water, fish) and of human health. The monitoring under way is very similar to what the other Gulf States are doing with respect to acute health effect surveillance, with both syndromic and reporting surveillance systems in operation. At the time of the workshop, none of the surveillance data indicated any increases in human illness related to the Deepwater Horizon oil spill.

Syndromic Surveillance

Mississippi has been conducting syndromic surveillance in five coastal and four inland hospital emergency rooms for four symptoms: (1) respiratory illness with fever, (2) respiratory illness without fever,

(3) rash, and (4) "other" (nausea, vomiting, headache). The inland hospitals serve as controls. The data are reported on a daily basis as a percentage of all non-trauma patients seen in a 24-hour period. Mary Currier emphasized the importance of gathering baseline data to get a sense of "normal" and "routine," so that spikes can be readily identified and investigated. She showed a few examples of the types of spikes in data that prompted further investigation (see Figure 5-1).

In addition to hospital emergency department data, the state has also been using BioSense data from VA and DoD facilities to examine the same four syndromes.

Reporting Surveillance

The state has been collecting data from the Mississippi Poison Control Center on the number of calls related to the oil spill, differentiating between exposure and informational calls. At the time of the workshop, the poison control center had received a total of 13 calls on the oil spill, including 8 informational and 5 exposure-related calls. The Rocky Mountain Poison Control Center in Colorado was contracted to receive some of Mississippi's calls, and those data had not been collected yet.

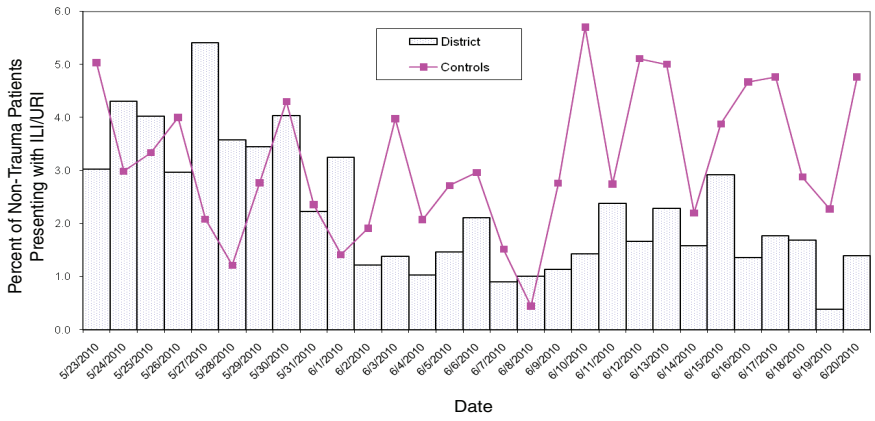

FIGURE 5-1 A comparison of coastal and inland (control) syndromic surveillance data for influenza-like illness (ILI) and upper respiratory infection (URI).

Improving Surveillance

In addition to determining how to transfer Rocky Mountain Poison Control Central calls to the Mississippi center, other immediate needs include improving mental health surveillance and care and monitoring long-term health effects. Currier remarked that the Department of Mental Health had already seen approximately a 10 to 15 percent increase in calls to its emergency phone lines and referrals to psychiatrists and psychologists.

Texas

Bruce Clements, Director of the Community Preparedness Section, Texas Department of State Health Services

At the time of the workshop, Bruce Clements reported that Texas had been spared direct damage from the Gulf oil spill. Nonetheless, the state had been preparing itself in the event that a response to direct impact would become necessary. Specifically, Texas has been conducting potential exposure-related syndromic surveillance among 28 hospitals (14 nonfederal and 14 military or VA treatment facilities). No anomalies in either mental or physical health had been detected.

Improving Surveillance

One of the challenges with surveillance is the large number of Texas residents who have left Texas to work on the oil spill response and the lack of clarity about how data on those workers will be tracked. As reported by other states, mental health surveillance poses yet another challenge. However, the greatest challenge, Clements said, is the reactionary nature of the political agenda. He observed that federal funding for public health preparedness has decreased every year since 2001 (i.e., after 9/11 and the anthrax mailings). As just one example, 2006 saw a 13 percent decrease in funding for public health preparedness; yet that same year, there was an infusion of targeted federal funding for avian influenza preparedness and response. Clements described the 8-year research and development process for developing a new grenade or other weapon as "very thoughtful" and "very strategic." By contrast, he said, "We don't put that kind of thought into our surveillance systems in public

health." The way that funds are redirected from one topic to another, year by year, means that "we can't be strategic in our approach. We are truly not building the infrastructure that we need to carry out the surveillance that is being described here." Rather than focusing on individual events or outbreaks, efforts need to be directed toward putting systems in place that can address all public health threats.

PANEL DISCUSSION

The Need for a Sustained Federal Commitment to Building Surveillance Capacity

Although mental health and chronic health surveillance were both identified as major areas for improvement, Clements' remark about the challenge posed by the reactionary nature of the political agenda prompted some heated discussion. Some panelists agreed that directing federal funds toward specific public health threats weakens the overall public health preparedness infrastructure, which affects all disaster response efforts. The surveillance systems needed for the Gulf oil spill are no different than the surveillance systems needed for other public health emergencies. As Currier said, "Surveillance for oil spill illness is surveillance for everything." Viamonte Ros echoed Clements' call for more sustained federal funding so that state-level efforts can be directed toward developing long-term surveillance systems. Williamson agreed that state-level capacity to build the necessary surveillance systems will be uncertain without sustained support. Additionally, Williamson pointed to the lack of surge capacity for "unusual" laboratory testing (e.g., polyaromatic hydrocarbon testing) as another example of activities needing sustained federal commitment.

The Need for Answers: The Importance of Collaboration in Research

There was some discussion about the importance of research collaboration among states, federal agencies, private industry, and the affected communities. Guidry pointed out that, even though a great deal of money was put into health research following the *Exxon Valdez* spill, "We still don't have the answers." He emphasized the importance of collective

thinking around how best to design a strategic research program so that the affected communities do not feel like "guinea pigs." Guidry also commented on the added challenge created when messages are sent to the public about the potential chronic health consequences of exposure, such as cancer, despite insufficient scientific evidence to support those claims. He opined that sharing conjecture with the public may add to emerging mental health problems. Those messages can be difficult to hear when people are already worried about what they should and should not do in the face of a disaster. Williamson agreed with Guidry about the need to not let "half-science create unnecessary fear." He said that part of the problem is that the longitudinal follow-up studies necessary to address some of the remaining questions about the potential long-term, human health consequences of exposure to oil spills were not conducted after the *Exxon Valdez* spill. He cautioned that the Deepwater Horizon disaster "won't be the last spill" and said he hoped that the public health community is not faced with the same unanswered questions in the future.

FEDERAL RESPONSE

The Specific Goals and Activities of the U.S. Federal Government Health Response[2]

John Howard, National Institute for Occupational Safety and Health

As John Howard explained, the Department of Homeland Security is in charge of the overall Deepwater Horizon response (under Homeland Security Presidential Directive 5). At the operational level, the federal response to the Gulf oil spill is under the direction of Coast Guard Admiral Thad Allen, with the White House Domestic Policy Council coordinating the federal-level, human health response (i.e., health-related activities of all federal agencies and cabinet-level departments). Within

[2]This section summarizes panel remarks that pertained to the federal response. See Chapter 1 for a summary of Howard's remarks on populations of concern.

HHS,[3] the various spill-related public and mental health activities are coordinated by the Assistant Secretary for Preparedness and Response, Nicole Lurie, who spoke during the opening session of the workshop (see Chapter 1 for a summary of her comments). The EPA is in charge of most environmental monitoring of the Deepwater Horizon disaster, with some assistance from the National Oceanic and Atmospheric Administration (NOAA), with real-time monitoring data being posted on the EPA website.

According to Howard, the federal government health response to the Deepwater Horizon disaster has four primary goals:

1. Prevent injury, illness, and disability as a result of the spill and its consequences.
2. Monitor short- and long-term health consequences within affected populations.
3. Ensure care for those who need it, including behavioral health care, for spill-related problems.
4. Anticipate and mitigate problems that could arise.

To achieve these goals, federal agencies have been actively involved in a number of activities.

Disseminating Information on Health Risks

All federal agencies participating in the human health response have been disseminating information on the potential health risks associated with exposures to the oil spill.

Protecting Workers, Volunteers, and Residents

Several federal agencies are involved with worker, volunteer, and resident safety and protection, including the Coast Guard, OSHA, the

[3]The Department of Health and Human Services includes Administration for Children and Families (ACF), Administration on Aging (AoA), Agency for Healthcare Research and Quality (AHRQ), Agency for Toxic Substance and Disease Registry (ATSDR), Centers for Disease Control and Prevention (CDC), Centers for Medicare and Medicaid Services (CMS), Food and Drug Administration (FDA), Health Resources and Services Administration (HRSA), Indian Health Service (IHS), National Institutes of Health (NIH), Office of Inspector General (OIG), Office of the Secretary (OS), and Substance Abuse and Mental Health Services Administration (SAMHSA).

FDA, NOAA, NIOSH, and the Substance Abuse and Mental Health Services Administration (SAMHSA). For example, the Coast Guard is responsible for protecting Coast Guard personnel by monitoring exposures through established occupational safety and health programs; providing senior safety officials to assist other local, state, and federal clean-up efforts; ensuring port and tanker safety; monitoring the safe operation of all U.S. flag vessels and offshore facilities; and other activities. NIOSH has been providing interim guidance for protecting workers and volunteers. Additionally, the FDA and NOAA have been working together to test fish caught outside the closed fishing areas to ensure that the closed areas are sufficiently broad. The FDA also has increased its testing and inspection activities to ensure the safety of seafood harvested from the area.

Training Workers to Maximize Their Safety During Response Activities

Both the National Institutes of Health (NIH)'s National Institute of Environmental Health Sciences (NIEHS) and OSHA have been training workers. NIEHS has been providing recommendations on worker education and developing and translating training materials into relevant languages (e.g., Spanish and Vietnamese). OSHA has been distributing worker safety materials in multiple languages and auditing training sessions, as well as working with safety officials to protect workers from hazards such as chemical exposures, heat stress, and injuries.

Monitoring Exposures of Workers and the Public

In addition to exposure monitoring that the Coast Guard conducts as a regular part of its occupational health and safety program (see above), the EPA, OSHA, CDC's National Center for Environmental Health (NCEH), and NIOSH have all been monitoring exposures. Most ongoing, federal-level environmental monitoring has been conducted through the EPA, with some assistance from NOAA. This includes monitoring air, water, sediment, and waste-streams samples along the shoreline and beyond for chemicals related to oil and dispersants in the air, water, and sediment (e.g., NOAA has been conducting aerial monitoring with NOAA P-3 aircraft), and monitoring the effects of dispersants in the subsurface environment. The EPA regularly posts these data on its website. Additionally, OSHA has been monitoring worker exposures and posting

worker monitoring data on its website. NCEH has been working with the EPA to review air-monitoring data and identify potential health impacts on residents. NIOSH has been conducting health-hazard evaluations (worker health assessments and exposure characterizations).

Monitoring Public Health

The NIOSH, NCEH, the FDA, and SAMHSA are all involved with public health monitoring. NIOSH has been compiling worker rosters (i.e., administering surveys to 15,000 workers involved in the response); monitoring worker illness and injury (capturing all health symptoms that could be related to oil response work and ensuring that those reports are being evaluated by safety and health professionals); and collaborating with states, OSHA, and BP to identify acute and potential chronic health effects. NCEH has been helping the Gulf States collect surveillance data from health facilities and poison control centers (see the earlier summaries in this chapter of state-level surveillance activities). In the context of behavioral health-monitoring activities, SAMHSA is collecting baseline health data from impacted states, consulting nongovernmental partners about mental health and cultural issues, working with other federal agencies to ensure that behavioral needs are considered, and collaborating with states to facilitate access to behavioral health services.

Providing Medical Care

At the request of states, the Assistant Secretary for Preparedness and Response (ASPR)'s National Disaster Medical System (NDMS) has been providing medical care in needed areas. For example, at the time of the workshop, ASPR was providing sick-call/primary care support to responders and the local community in Venice, Louisiana.

Preparing for Long-Term Follow-Up

The NIH and the CDC are helping states prepare for long-term follow-up. For example, on June 15, 2010, NIH Director Francis Collins announced plans for a long-term cohort study of exposed workers and residents.

Department of Homeland Security

Alexander G. Garza, Office of Health Affairs

One of the main missions of the Office of Health Affairs is to work across federal agencies to ensure that Secretary of Homeland Security Janet Napolitano is aware of all health issues that affect national security. The Office of Health Affairs is also involved with workforce health protection and has been working closely with Rear Admiral Mark Tedesco.[4] As Alexander Garza explained, Secretary Napolitano recently convened a meeting with all the various federal agency stakeholders (e.g., the CDC, OSHA, the EPA) to ensure that she understood how the Gulf oil spill's potential effects on human health could impact national security. However, the Office of Health Affairs "owns" neither the medical response nor environmental monitoring. Rather, it views itself as a facilitator and a collaborator for the multiple agencies working on medical and health issues—an umbrella agency to bring all information together.

Environmental Protection Agency

Mathy V. Stanislaus, Office of Solid Waste and Emergency Response

As Mathy Stanislaus explained, the EPA has an extensive air-monitoring system in place, including mobile monitors circulating around the Gulf, to measure levels of various oil products (e.g., hydrocarbons) and dispersant constituents, (e.g., airplane monitors). Within a few days of the initial Deepwater Horizon explosion, the agency had gathered baseline data and has been conducting ongoing monitoring since then. At the time of the workshop, the EPA had no evidence of inhalational hazards either on the shore or at sea. The EPA has also been monitoring waste disposal. None of the waste being disposed in landfills had been identified as hazardous, although oil products were being sent to separate facilities. Additionally, the agency has been conducting dispersant toxicity tests to identify whether equally effective but less toxic dispersants could be used. The results of those tests were not available at the time of the workshop.

Finally, the EPA has been in regular communication with state and local governments, as well as nongovernmental organizations involved in the response, to ensure that the information gathered—including not just

[4]Rear Admiral Mark Tedesco is the Coast Guard's Chief Medical Officer and Director of Health, Safety, and Work-Life.

what is known but also what is *not* known—is effectively communicated. Indeed, several times during the course of the workshop, participants commented on the usefulness of the EPA's real-time air-monitoring information (www.epa.gov/BPSpill). The agency also worked with HHS to develop a fact sheet about odors that is also available on the EPA website.

Seeking a Public Health Approach Based on the Best Available Science: Remarks from the Surgeon General

Regina M. Benjamin, Surgeon General of the U.S. Public Health Service

Regina Benjamin elaborated on how the federal government is taking a public health approach toward the Deepwater Horizon disaster. By identifying the issues, the federal government can better treat and mitigate existing health problems and prevent similar conditions in the future. In addition to a multitude of public health experts, veterinarians, engineers, and other professionals working throughout other government agencies (e.g., the CDC, the FDA, the Health Resources and Services Administration [HRSA], the NIH, and SAMSHA) to address the public health problems at hand, U.S. Public Health Service Commission Corps officers were deployed to the Gulf region on May 27, 2010. Local Medical Research Corps volunteers also are working with the affected communities and achieving a comfort level that would take outside groups months to achieve.

Like many other participants, Benjamin recognized the needs of people who are not only just losing their jobs, but also their livelihoods and ways of life that have been part of the Gulf region for generations. She referred to the central role that the seafood industry, water sports industry, and subsistence fishing play in Gulf residents' lives. Having grown up in the Gulf region, Benjamin stated, "The water is really a part of our lives ... it's really in our blood." She described her personal connection to the Gulf region, including her childhood in Daphne Bay, Alabama, where her family's homestead has been since the early 1800s; her education at Xavier and Tulane Universities; and her 23-year private family practice in Bayou La Batre, Alabama. She echoed other participants' comments about how the Gulf oil disaster is delivering a "new blow" to Bayou La Batre, which is only just recovering from Hurricane Katrina.

Finally, Benjamin remarked that her job as U.S. Surgeon General is to provide trustworthy information that is based on the best available science and to clearly communicate how the disaster is going to affect both short- and long-term health. However, the current scientific literature is inconclusive with regard to the potential hazards resulting from the oil spill, with some scientists predicting little to no toxic effect and others expressing serious concerns about the potential short- and long-term effects on responders' and residents' health. She ended with a quote from President Barack Obama: "Science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been before."

6

Data-Collection, Surveillance, and Research Methodologies

Two of the workshop's primary goals were: (1) to review and assess components of a framework for short- and long-term surveillance to monitor the spill's potential adverse health effects; and (2) to explore research methodologies and appropriate data collection to further scientific understanding of the risks of exposure to human health.

As a few expert panelists pointed out, there is an important distinction but critical connection between the goals of surveillance and research. As Thomas Matte defined it, surveillance entails collecting "actionable information to make things better now." Research, on the other hand, involves collecting information or data to expand the knowledge base and, in doing so, strengthen future surveillance efforts.

There is, however, considerable overlap between the two activities. Each informs the other. By expanding the knowledge base, noted Matte, research strengthens future surveillance efforts. Moreover, these efforts help identify at-risk individuals and preventive actions that may better protect individuals in the event that a disaster of this magnitude occurs again in the future, said Lynn Goldman.

Panelists considered methodologies and available data sources (including ongoing health surveillance and surveys) that could be used to monitor the oil spill's effects. Panelists also identified characteristics of a surveillance framework that can efficiently and effectively identify and monitor potential short- and long-term health effects and help ensure the establishment of an integrated and coordinated health-monitoring system. This chapter summarizes the panel presentations and discussion addressing these issues.

Matte discussed the difference between surveillance and research and gave some examples of the type of data that surveillance entails.

Matte also made some personal recommendations for developing a public health surveillance system to measure and to mitigate the oil spill's impact. However, in light of very limited resources for building surveillance capacity, he also emphasized balancing the value of any particular tool or approach with its cost.

Throughout the course of the workshop, several participants emphasized the need for immediate data collection and sample archiving. Lynn Goldman elaborated on the need for immediate health and environmental data collection and analysis, as well as the need for clear communication with members of the public about the what data means to their health and safety and about the uncertainties and limits of what can be learned from those data.

William Farland commented that the Gulf oil disaster provides an opportunity to gain a better understanding of exposure profiles (i.e., who is being exposed) and exposure routes. However, because of the disaster's complexity, data collection will require comprehensive, long-term, and coordinated efforts between environmental health professionals in the public (i.e., local, state, and federal government levels), academia, and private sectors.

Moreover, there is a critical need to collect mental health data as soon as possible and to use those data to steer at-risk populations toward available mental health services, said Howard Oskofsky. When assessing the disaster's mental health impact, he emphasized the need for collaboration with local communities, the importance of generating both qualitative and quantitative data, and the importance of considering the special needs of children and adolescents.

Daniel Masys described the Veteran Administration's (VA's) computerized patient records in Hurricane Katrina's aftermath and the value of electronic health records (EHRs) in assessing the health impacts of disasters in general. He also recommended creating a Gulf Region Health Information Exchange to pool health data from practice-based EHRs across the region so that health effects can be more effectively monitored.

Finally, John Bailar reflected on many of the issues around surveillance that had been addressed up until that point. He elaborated on Matte's distinction between surveillance and research; emphasized, as so many other expert panelists did, the urgency of collecting data as soon as possible; and discussed the nature, scope, and cost of the type of surveillance system needed.

The session ended with a question-and-answer period. The discussion covered immediate steps to initiate surveillance, the types of data to monitor, and strategies to communicate results of surveillance to the public.

PUBLIC HEALTH SURVEILLANCE IN EMERGENCY RESPONSE SETTINGS: LESSONS LEARNED FROM 9/11 AND OTHER DISASTERS

Thomas Matte, Hunter College and City University of New York School of Public Health

Drawing on his experiences in New York City, Thomas Matte addressed the different goals and methods of public health surveillance and research in the context of emergency-response settings. Using 9/11, the H1N1 outbreak, and blackouts as examples, Matte addressed the concepts of *surveillance* and *research*, noting that surveillance and research have different goals but overlap and must necessarily inform one another. He ultimately identified several types of surveillance-generated and research-generated information and data that could be used to assess and reduce the oil disaster's overall health impact.

Surveillance Generally

Matte focused his remarks on four types of data sources and methods relevant to disaster settings: (1) syndromic surveillance; (2) surveys; (3) other surveillance activities, including registries, cohorts, and panels; and (4) worker medical surveillance.

Syndromic Surveillance

Matte stated that *syndromic surveillance* involves tracking nondiagnostic health indicators. (See Chapter 4 for descriptions of state-level syndromic surveillance systems that are already in place for monitoring the potential health outcomes of the Gulf oil disaster.) Syndromic surveillance systems among New York City emergency departments have evolved since their establishment 2 days after the 2001 World Trade Center attack. Those same systems played a major role in tracking

H1N1. While syndromic surveillance is useful, it may also suffer from particular limitations, including its lack of exposure information, lack of clinical detail, and limited geographic coverage, depending on which providers participate in the surveillance network.

Surveys

Matte stated that surveys can provide outcome estimates for either the general population or targeted populations, and simplified and focused surveys can be rapidly implemented. Surveys were helpful in tracking the 9/11 attack's effects on victims' mental health and the use of mental health services following the attack. Online surveys provided by schools following the H1N1 outbreak were also particularly useful. Surveys are useful, in part, because researchers can rapidly implement them and clearly focus the surveys on particular issues and population targets. Surveys are, however, limited by self-reporting biases and the cross-sectional nature of the data. As a result, the data's value for etiological research is limited, unless researchers can recruit individuals for follow-up.

Registries, Cohorts, and Panels

Matte discussed the World Trade Center Health Registry, which allowed for longitudinal follow-up of populations impacted by the World Trade Center attack. The registry included more than 70,000 of an estimated 400,000 eligible residents, employees, students, passers-by, and others enrolled between 2003 and 2004. Through periodic follow-ups, linkages with health records, and nested studies by outside researchers, the registry has been used to document persistent respiratory illness and mental health problems. In addition to providing information, the registry also provides links to services. Unfortunately, the registries were limited by available exposure and baseline-health measures. Additionally, the data and findings may not be representative of all eligible individuals.

Surveillance of Disaster Responders

Matte discussed surveillance of disaster responders. One example is the National Institute for Occupational Safety and Health (NIOSH)-funded World Trade Center Medical Monitoring and Treatment Program. From 2002 to 2007, more then 20,000 responders received standardized initial exams. The program has documented high rates of persistent respiratory, mental health, and other conditions, and it offers treatment for specified conditions. Programs meant to monitor disaster responders, however, suffer from some of the same deficiencies as registries. These deficiencies include limited availability of exposure data and difficulty generalizing results about workers who seek care to other eligible worker populations. Nevertheless, a follow-up program involving the New York City Fire Department's 9/11 responders benefited from a well-defined cohort, had access to pre-9/11 baseline health data, and used standardized post-9/11 follow-up.

Application of Surveillance Methods to the Oil Spill Disaster

To monitor and mitigate the adverse health effects of exposure to the Deepwater Horizon disaster, Matte suggested that developing an effective public health surveillance system would require a flexible, multilayered, and coordinated approach. He observed that some aspects appeared to be coming together at the time of the workshop. Emphasizing that there is no single, "right" approach, Matte made several suggestions for developing a public health surveillance system to measure and mitigate the oil disaster's impact. He then described how different forms of surveillance could be useful, if modified, for the oil spill disaster.

- Syndromic surveillance systems should be improved and enhanced by, for example, expanding data sources.
- Baseline measurements (e.g., lung function tests) should be obtained, if possible, before responders deploy. Responder health surveillance should also be implemented independently, so that workers will not worry that they will lose their jobs if they report symptoms.
- Surveys should be considered as a way to identify and quantify exposed populations, track population impacts, and inform recruitment for registries.

- Registries should be established and could benefit from longitudinal studies. Registries should include objective baseline measures of exposures and should also identify possible relevant covariates.

Matte stated that, although it has become much easier to develop and analyze data, surveillance has costs. It is always important to ask whether a particular approach is likely to produce benefits in proportion to the cost and effort. Finally, Matte emphasized that follow-up surveillance efforts need to be coordinated and adequately resourced, with linkages in place to ensure that individuals involved in the follow-ups have access to needed services.

AN OVERVIEW OF METHODOLOGIES AND DATA SOURCES FOR USE IN HEALTH SURVEILLANCE AND ENVIRONMENTAL MONITORING ACTIVITIES

Lynn R. Goldman, Johns Hopkins University

According to Lynn Goldman, the reality that unknown numbers of individuals are being exposed to unknown hazards poses a major challenge to developing health surveillance and environmental monitoring systems for the Gulf oil disaster. Even identifying such individuals is in some cases difficult; beyond the organized responders and clean-up workers, many other people—including volunteers and residents—could be exposed to chemical and physical hazards. And that counts only physical exposure to oil. Many more suffer from diminished livelihood and exposure to substances other than oil. As a result, opined Goldman, "We are never prepared on a day-to-day basis for being able to ramp up the kind of surveillance and monitoring that we need for a disaster like this."

Goldman stated that past experiences have nonetheless taught some important lessons about health and environmental data collection and surveillance and research methodologies. First, early collection of exposure information is critically important. Too often in disaster situations, there are gaps in knowledge about exposure during the most important time period—during and immediately after an event. Second, an effective assessment of a disaster's health impact relies on rapid identification and collection of baseline health status data for both individuals and communities—information that is too often lacking. Because the local,

state, and federal governments are not funded to establish the type of surveillance and monitoring systems that a disaster of this magnitude and scope demands, a rapid infusion of resources is needed. This includes engaging help from the academic community and tapping into resources that already exist in the region.

Third, researchers should use all available data. For instance, air samples should be archived so that they can later be analyzed. The same is true of biological samples. Information that indirectly suggests exposure, like reports of odors received by the Environmental Protection Agency (EPA), should be catalogued, as well.

Fourth, Goldman said that researchers should enlist the aid of citizens and communities to design and analyze studies, all the while clearly communicating to those populations the limits of current knowledge and the ability ultimately to show cause and effect. This may involve addressing cultural and legal barriers to data collection. Researchers must be sensitive to privacy issues, the potential for the misuse of data, and the ever-looming threat of private litigation. There is also a process of give and take; affected communities want to know, "Are we safe right now?", whereas scientists may be interested in learning about longer term health outcomes. The more that health departments communicate information about syndromic surveillance and other data in ways that are sensitive to local cultures and values, the more useful the information.

Finally, Goldman emphasized the importance of environmental public health monitoring and listed the various types of data that should be collected, including both health surveillance and environmental monitoring data:

- Health surveillance data
  - Baseline health status
  - Change in health, both in the immediate aftermath of the disaster and over time
  - Biomonitoring-based changes that are indicative of exposures or increased risks of adverse health outcomes
- Environmental monitoring data
  - Immediate environmental monitoring
  - Collection and archiving of samples for later, more sophisticated analyses
  - Use of all possible sources of data

ASSESSING THE HEALTH EFFECTS OF THE GULF OIL SPILL: DATA SOURCES

William H. Farland, Colorado State University

William Farland addressed the need to examine complex chemical exposures in terms of a combination of exposures, rather than one chemical at a time. Exposure stressors can alter biology, leading to adverse effects. As exposures impinge on normal biology, there is a continuum from exposure to disease that occurs against a backdrop of variability in terms of both the exposure and a particular population's susceptibility to disease. Depending on those two variables, exposure may ultimately overcome the body's natural coping mechanisms, leading to adverse effects. According to Farland, although a primary goal of the public health response to the Gulf oil spill should be to prevent exposure, it may nonetheless be possible to manage and mitigate adverse effects when exposures do occur by gaining a better understanding of "source-to-receptor" pathways (i.e., the multiple pathways and environmental fates of potential toxins).

Farland indicated that the pathways to human exposure are complex, and multiple sources of exposure are possible in the context of the oil spill. But the potential for toxins to enter the food supply is a particularly important issue to consider in the Gulf. Understanding the source-to-receptor pathways in the Gulf, including toxicity in the food supply, will require gathering several types of data through various types of monitoring activities, including food, air, and water sampling.

Farland addressed some of the complexities of monitoring. For instance, effective air sampling must account for the differences between crude oil, weathered oil, and products of incomplete combustion. In this regard, air sampling conducted by both the EPA and local agencies (see Chapter 4) should be a rich source of air-sampling data on which to draw. Because there are local populations of subsistence hunters and fishermen and -women, food sampling should involve not just seafood testing but also creel surveys and game monitoring. With respect to water sampling, while it is unlikely that contamination will move far enough inland to affect underground water systems, it is important to ensure that disposal plans for various items (e.g., used personal protective equipment) do not contaminate local wells.

Farland summarized what he thought were the key challenges to assessing the Deepwater Horizon exposure situation, such as the need to consider aggregate and cumulative exposures, including previous expo-

sures; the need for a robust data set to manage the uncertainty and variability around source-to-receptor exposure pathways; and the need to consider focusing on different life stages (e.g., children) and special populations that may be more vulnerable to exposure (e.g., subsistence fishermen and -women).

Farland said that there are opportunities to understand the routes of exposure and to mitigate future exposures based on that understanding. However, because the current situation is so complex, exploiting those opportunities will require a comprehensive, long-term effort.

MENTAL HEALTH RESEARCH AND SCREENING METHODOLOGIES

Howard J. Osofsky, Louisiana State University Health Sciences Center

Howard Osofsky addressed several key issues to consider when evaluating mental health surveillance and research methodologies. Disasters have typically limited the ability to conduct longitudinal and cross-sectional research. The reasons for these limitations are obvious: The unpredictability of a disaster makes it difficult to conduct either qualitative or quantitative research on health impacts. During the first days following a disaster, the focus is on control rather than research—in this case, the need to control the oil spill and respond to the basic needs of individuals and families. Disasters also lead to tremendous displacement because, for example, individuals cannot return to their jobs and need to move elsewhere. These realities hamper research, as they make it difficult to follow individuals and families over time.

According to Osofsky, other challenges further limit the ability to conduct valuable research. Researchers must confront difficulties with formulating samples, including differences in age and cultures that researchers will encounter. Cultural sensitivity is important in the Gulf region, where differences in population are pronounced. Researchers will encounter cultural differences, including differences in religion and approaches to well-being and health that must be incorporated into research.

In this region in particular, researchers will also encounter cumulative trauma, meaning trauma that this population has encountered both before and after the oil spill. Osofsky reiterated what early panelists had said about the very strong multigenerational relationship that many of the

affected communities have with their natural environment and the way the disaster is impacting not only their physical health but also "the entirety of their being." Osofsky indicated that adults process cumulative trauma in different ways. For instance, some adults may have come to feel that they can "master" disasters. But others will feel an increased sense of vulnerability. Osofsky particularly emphasized the importance of paying attention to the needs of children of different age groups and backgrounds. Children deal with trauma in different ways, most showing normal patterns of resilience; some experiencing breakdowns that may also be related to a child's existing mental difficulties, home difficulties, and issues relating to peer relations and other losses; and still others appearing to have coped with a disaster, only to have a decline in resilience over time.

In light of these challenges, collaboration with local communities is important. Osofsky opined that individuals have been willing to help researchers in situations where the individuals know that providing data will help both the individuals and others around them. One of the most important lessons learned from Katrina-related research was the need to build relationships and trust with communities of interest to assist community buy-in, increase retention rates, decrease bias, and enable culturally competent research.

Both qualitative and quantitative research methodologies are valuable. Osofsky described how qualitative research methodologies used in the beginning phases of research (e.g., through the establishment of community advisory boards) can help ensure that the research instruments used in larger quantitative studies are culturally sensitive and that the research "makes sense" to the affected communities and encourages ongoing collaboration.

Osofsky also described quantitative methodologies that have been used in past disasters and which NIOSH and others use today to assess mental health responses to disasters, as well as how those assessments are being modified to include measures of cumulative trauma for use in a Deepwater Horizon mental health response assessment. Screening will be available for all responders and all families in fishing communities, and the results of the modified assessment will be used to guide interventions, services, and resource availability. The adult assessment tool will include measures of substance abuse and family conflict in addition to measures of mental health.

According to Osofsky, a separate tool for children and adolescents will screen for post-traumatic stress and depressive symptoms. This survey is a modified version of a survey tool developed by the Louisiana State University Health Sciences Center and National Child Traumatic Stress Network for use in evaluating post-Katrina mental health. More than 23,000 children have been screened over the past 5 years. Either the children themselves or their parents complete the survey, depending on the child's age. Osofsky said that a high percentage of children and parents ask for counseling (for the children) after completing the surveys.

In his conclusion, Osofsky emphasized the importance of assessing the effectiveness of current interventions and using mental health assessment data to develop "strength-based" interventions, meaning interventions that help people use their individual strengths so that they can feel in control.

INFORMATION INFRASTRUCTURE FOR DETECTING AND MANAGING HEALTH EFFECTS OF THE OIL SPILL: LEARNING FROM THE PAST, PLANNING FOR THE FUTURE

Daniel R. Masys, Vanderbilt University Medical Center

Daniel Masys addressed biomedical informatics, the application of the principles of computer and information science to problems in medical research and health care education. He explored lessons learned from past disasters and possible applications to enhance surveillance activities related to the oil spill disaster.

Masys spoke of the many lessons learned in the aftermath of Hurricane Katrina. Many health records were lost following the hurricane. However, the one "bright spot" in biomedical informatics was that the VA's computerized patient-record system, which housed approximately 60,000 electronic records of New Orleans veterans, was transferred to Houston where it was reconstituted and running within 3 days. Within a week the records received 10,000 hits through a VA web interface and were used to track veterans and provide continuity of care to evacuees that were dispersed across more than 200 health care sites in 48 states.

Masys identified three key lessons learned from the Katrina experience. First, EHRs are the *sine qua non* of effective care delivery and health effects monitoring for regional- and national-scale health events involving a mobile population and uncertainty about where individuals are going to be at some time in the future. The dispersal of veterans

following Hurricane Katrina aptly illustrates that reality. Second, EHRs are still the exception rather than the norm in the United States. Only 1.5 percent of U.S. hospitals have fully adopted comprehensive EHRs, and only 17 percent of hospitals nationwide use computerized decision support at the point of entry to guide providers to make the right decisions. Third, effective analysis of health effects requires merging and analyzing data from a variety of sources. For instance, the purchase of over-the-counter medications could be combined with data concerning weather, ocean currents, and environmental sensors. As science is better able to measure individuals' molecular variation and correlate it with real-world events (such as oil spills), the amounts of data available to decision makers, including individual health care practitioners, will increase dramatically. Indeed, the number of facts that may bear on a health-related decision can reasonably be expected to exceed the capacity of unaided human cognition (Figure 6-1).

Masys also discussed the successes and limitations of particular efforts in the aftermath of Hurricane Katrina, including the emergence of a number of health-related websites. For example, KatrinaHealth.org pooled pharmacy data and created a resource for renewing prescriptions for individuals dispersed over the region. Nearly 30,000 retail pharmacies used the website. The site did, however, have some major limitations. For example, some providers were unaware of the site. And the obvious challenges following a hurricane, including telecommunications disruption, somewhat limited the site's use.

Masys referred to existing networks that can provide agile data capture and analysis for health research. For instance, the National Institutes of Health has developed the Clinical and Translational Science Awards (CTSA), which involves 46 different academic institutions throughout the United States. The CTSA has in turn supported the development of REDCap, the Research Electronic Data Capture system, a secure web-based tool for acquiring and analyzing data. REDCap is available free of charge and allows users to define a set of variables, acquire data from previous studies, and to merge data from multiple sources in a matter of minutes.

Finally, Masys outlined five keys for developing an information infrastructure for use in assessing the oil spill's health effects:

1. Because the needed EHR infrastructure does not exist, immediately add resources to strengthen the existing health-monitoring and -reporting mechanisms at local, state, and federal levels.

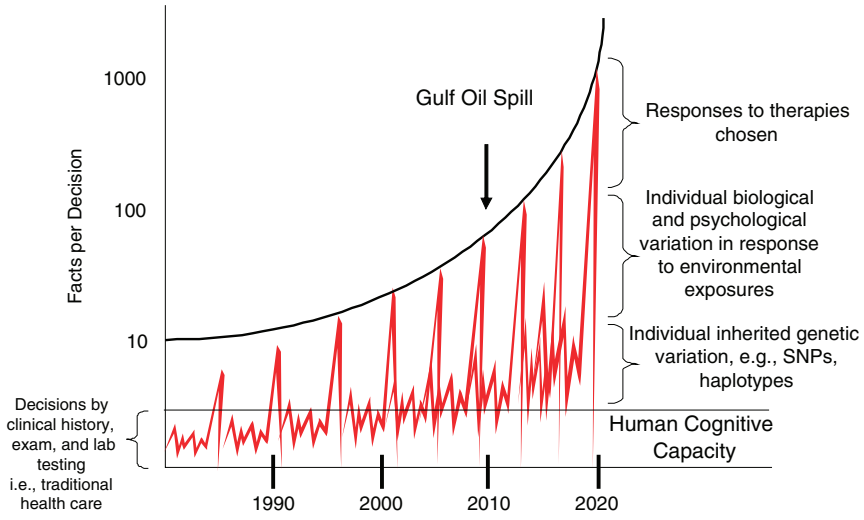

FIGURE 6-1 Helping individuals and professionals do the right thing in the face of escalating complexity: The need for person-specific decision support assistance.
NOTE: SNPs = single-nucleotide polymorphisms.

2. Accelerate the adoption of interoperable EHRs in medical practices in the region and create diagnostic codes for EHRs that are specific to exposures related to the oil spill so that data can be easily pooled for analysis of trends.
3. Create a Gulf Region Health Information Exchange that pools health data from practice-based EHRs across the region.
4. To aid research, use tools such as REDCap to create an agile research data infrastructure for specific projects on health-related conditions.
5. To relay data to the public and relevant decision makers, build the necessary capacity so that authoritative evidence-based decision support is available via alerts and reminders delivered through the EHR infrastructure and through publicly accessible sources such as the print and broadcast media, websites, cell-phone text messaging, and social networking media such as Twitter and Facebook.

REFLECTIONS ON SURVEILLANCE

John C. Bailar III, University of Chicago

John Bailar reflected on several surveillance-related issues. "Surveillance" is service to the individual—the one person who is standing or sitting in front of you at the time of a contact." Surveillance includes medical examinations, laboratory tests, personal medical histories, discussions about existing problems, and developing knowledge related to the effects of oil spills, said Bailar. The assembly of all the information gathered from contacts draws a picture of what is happening across the community. Conversely, "research is the handmaiden of surveillance and directly supports surveillance activities" by supplementing and refining current understandings of potential adverse health effects and vulnerabilities, continued Bailar. For example, research can help detect new effects, improve knowledge about the frequency and seriousness of various health effects, and identify susceptible subpopulations such as pregnant women and elderly people.

Bailar opined that research should be a highly centralized effort so that the various data collected by separate groups can be brought together to "tell a convincing story." For the Gulf oil disaster, he envisioned a single organization headed by a single person who has the responsibility and the authority to conduct the research operation. While he was hesitant to suggest who that organization might be, he mentioned CDC or perhaps a new organization created by the affected states' health departments or a consortium of regional universities. Surveillance, by contrast, should be highly decentralized. Bailar opined that, while it may be difficult to combine these two different, highly centralized and highly decentralized systems, it will be necessary.

Bailar addressed the types of surveillance that should be undertaken. He stated that there are several different types of surveillance, from passive surveillance (waiting to hear from affected persons or their providers) to active surveillance (periodic efforts to contact persons on a list). He strongly recommended that active surveillance be conducted whenever possible. Bailar also said that there will be a need for clear, specific operational rules about who to include in the surveillance program (e.g., clean-up workers, other responders and occupationally exposed persons, National Guard troops, local fishermen and -women, community residents, families of occupationally exposed individuals). There will be a need to include as controls exposed individuals, as well as those with limited or perhaps no exposure.

Bailar also urged that serious consideration be directed now toward covering the cost of surveillance. He predicted that surveillance would cost somewhere in the range of $3,000-$10,000 per person for lifetime follow-up. Later, Goldman responded that, while surveillance activities and the coordination of those activities will be costly, it is very difficult to project lifetime costs of surveillance. While certain types of surveillance are not very costly, others are. For example, measuring dioxin exposure for just a single individual, as part of Agent Orange exposure surveillance, can cost hundreds to thousands of dollars. Goldman cautioned against making specific cost projections, at least initially.

As so many other panelists had done, Bailar emphasized the urgency of the situation and the immediate need to begin collecting as much data as possible. He stated that it was already (at the time of the workshop) too late to collect some types of information, and he believed that the push for information will intensify over time as more questions arise.

Looking to the future, Bailar remarked that it will be important to allow individuals to join the surveillance group whenever they become aware that joining might benefit them. Bailar also thought that there will be a need for a substantial, dedicated staff to manage the surveillance activities and to learn what can be learned from other long-term follow-up programs, such as the National Cancer Institute's Surveillance Epidemiology and End Results Program, the Radiation Effects Research Foundation in Japan, the Framingham Study, the Nurses Health Study, and the World Trade Center follow-up.

QUESTIONS AND COMMENTS FROM THE AUDIENCE

What must be done to implement an active surveillance system so that preventive measures can be instituted quickly to protect workers from adverse effects?

Matte replied that, based on what Howard had described earlier during the workshop (see Chapter 4), some of the essential components of an active surveillance system are already in place. These components include (1) a way for injuries and illnesses to be reported such that workers do not feel threatened or inhibited and such that the information can be rapidly collated and disseminated; (2) access to acute illness and injury treatment in places where the examinations are being done; and (3) connections between surveillance managers, incident managers, and oth-

ers responsible for deploying the workforce, distributing personal protective equipment, etc. He explained that the deployment of new information infrastructures is about 10 percent technology and 90 percent sociology and that modeling the information flow (i.e., what observations need to be captured, who is in charge of those observations, and who has access to those observations) solves the majority of the problem. The necessary surveillance tools already exist (e.g., paper forms for one group of respondents, a phone survey for another, a website for yet another). What is needed now is a conceptualization of the body of information that needs to be acquired and how that information should be acquired and disseminated. Indeed, that was the primary purpose of this workshop—to build a framework for that conceptualization.

Will socioeconomic status, which clearly has a profound impact on health, be collected at an individual level as part of the surveillance effort?

Bailar replied that although economic status does not have a direct effect on health, it is a marker of things that do affect health (e.g., occupation, level of stress, place of residence and exposures that might exist there). He stated that he did not know what information would be collected as part of whatever surveillance system is implemented, but he said that he hoped that it would include other components of socioeconomic status that are more directly related to health. Matte added that efforts to study the physical and mental health outcomes as a result of exposures during the Deepwater Horizon event should not be conducted separately, given how much is known about how the two domains of health influence each other. Osofsky agreed that it is very crucial for the two types of outcomes to be studied in an integrated manner, given expanding knowledge about the interface and influences between physical and mental health.

Is there any personal sampling being conducted for inhalational exposure among the clean-up workers?

Matte pointed the questioner to information on the EPA and Occupational Safety and Health Administration (OSHA) websites for volatile organic compounds (VOCs) and related inhalational exposures.

Is it possible to correlate biomarkers or health effects with available exposure data for airborne hazards for clean-up workers?

Panelists replied that it may be possible but that most data are not being collected in a manner that allows for that type of correlation. Specifically, Matte replied that he was not aware of any available data with enough variability for potentially existing correlations to be measured. Time-activity information (e.g., number of days worked on tasks) may be more variable but is not currently being fully captured. Goldman stated that biological monitoring would have to be done concurrently with the environmental monitoring, otherwise it will be difficult to make those sort of correlations.

Were biological samples collected in the 9/11 studies?

Matte replied that there was a biological monitoring study on a small sample of responders a few weeks after 9/11 and that, since then, there have been many attempts to study exposure biomarkers. A key challenge with the Gulf oil disaster is that many of the same toxins associated with the disaster are also found in everyday situations (e.g., when people fill their vehicles or walk down a street amidst diesel exhaust), which makes it very difficult to differentiate disaster-related biomarkers from everyday-related biomarkers.

What authoritative, web-based resources does the panel suggest for the public to access Gulf oil-spill-related information?

Matte said that, although the richness of available data will "gradually get better" over time, there is already "pretty good" information online at several federal agency websites (e.g., the CDC, the EPA, OSHA, National Library of Medicine). The EPA, for example, provides not only an overview of the environmental monitoring being done but also provides actual data in real time. Goldman agreed that the availability of environmental monitoring data in real time is unprecedented and very helpful. She added that the state health departments are also providing information on their websites that is very relevant to particular geographic areas and local issues.

Why wasn't fundamental scientific research conducted after previous spills?

Palinkas (in the audience) remarked that once the litigation process related to the *Exxon Valdez* spill reached "full steam," research on the effects of exposure stopped. The challenge was not only to protect the confidentiality of research participants, but also to prevent the litigation efforts compromising the research process as a whole. For example, researchers were not able to communicate results back to the affected communities. Palinkas's story prompted Goldman to comment that protecting researchers from those types of legal barriers is an important public policy issue that needs to be addressed. Matte reflected on experiences in New York City after 9/11 and replied that two of the greatest challenges were the need to assemble resources and the lack of a leadership structure. He said, "Everyone involved wishes that things had started sooner." He commented on the additional challenge in this case of identifying a cohort for examining chemical exposure.

7

Developing Effective Surveillance and Monitoring Systems: Future Directions and Resource Needs

Nancy E. Adler, University of California, San Francisco
John C. Bailar III, The University of Chicago
Lynn R. Goldman, Johns Hopkins University
Maureen Y. Lichtveld, Tulane University
Linda A. McCauley, Emory University
Kenneth Olden, Hunter College of the City University of New York
Linda Rosenstock, University of California, Los Angeles
David A. Savitz, Mount Sinai School of Medicine

One of the main objectives of the workshop was to examine options for building a framework for short- and long-term surveillance systems that monitor the Gulf oil spill's effects on human health. In the final session of the workshop, the panelists considered the broad range of scientific evidence presented throughout the workshop, discussed individual participant's suggestions, and explored options for, and components of, a public health surveillance system. David Savitz moderated the panel discussion. This chapter summarizes the discussion that took place, while also drawing on relevant content presented throughout the workshop (i.e., as summarized in other chapters of this report). The suggestions compiled here were personal recommendations made by individual panelists. These recommendations are part of the factual summary of the workshop and should not be construed as reflecting consensus recommendations or findings by the National Academies, the Institute of Medicine, or workshop participants as a whole.

SUGGESTED DIMENSIONS AND COMPONENTS OF A SURVEILLANCE FRAMEWORK

A number of presenters throughout the workshop suggested specific dimensions, components, and resources to guide development of a comprehensive surveillance system and related research activities. Based on comments offered throughout the workshop, Nancy Adler proposed six possible dimensions to consider when designing such a framework. These dimensions include key characteristics, population(s), content, processes, use of existing data sources, and unanswered questions.

- *Key Characteristics.* Certain characteristics help define the scope of proposed frameworks for surveillance systems. Adler suggested that a surveillance framework must be long-term, flexible, multi-layered, and integrated.
- *Population(s).* A surveillance system needs to monitor all populations in order to establish a baseline for comparison. However, a framework must also focus on particularly vulnerable or at-risk populations, such as children, specific ethnic groups, or individuals with preexisting conditions or genetic susceptibilities.
- *Content.* Deciding what outcomes and methods of measurement best capture exposures and the effects of those exposures is imperative. Throughout the workshop, a number of participants suggested that a surveillance system must establish baseline rates for comparison. Exposures can be measured objectively and subjectively, and both are important, especially when monitoring the mental health of a population. Additional methods of collecting data include biospecimens and syndromic responses.
- *Processes.* A successful public health surveillance system will require public input from a wide variety of stakeholders, including communities and government agencies. To set priorities, processes must be in place to interact and coordinate across different sectors. With litigation threatening to compromise or limit research and surveillance activities, there must also be a process to guard the integrity of the surveillance system.
- *Use of Existing Data Sources.* A framework for surveillance can build on existing data sets or data-collection activities. Adler noted that a number of population surveys easily could be modified to target information relevant to the Gulf oil spill. Addition-

ally, baseline data already exists for a number of measures relevant to a surveillance system.

- *Unanswered Questions.* Identifying knowledge gaps and pertinent questions can be equally as informative to developing a framework for surveillance systems as what is already known. Based on discussions over the course of the workshop, Adler stated that many questions still remain, such as which outcomes to monitor, which covariants to measure and control for, whether to use passive or active data collection, and who should be responsible for different areas within a surveillance system.

As briefly noted in Chapter 2, Maureen Lichtveld also proposed six components of a multi-pronged action plan (see Box 7-1) to assess exposures, identify the risk of these exposures, and communicate the results and findings to affected populations throughout the Gulf Region.

BOX 7-1
Components of a Multi-Pronged Action Plan

- Characterize the contaminants of concern in all environmental media over time by conducting toxicity assays and seafood toxicity monitoring.
- Fingerprint exposures by developing novel biomarkers of exposure, gathering real-time exposure monitoring data, or geospatial modeling.
- Protect vulnerable populations through psychosocial interventions and through long-term monitoring and biospecimen banking (even if it is not yet clear what answers the biospecimen banking will provide) and perhaps by looking for susceptibility biomarkers.
- Communicate about the risks clearly, early, and in a way that accounts for varying levels of health literacy.
- Educate health providers so that they can provide answers to the community.
- Disseminate information “just in time” and “just in case” so that communities have it at their fingertips.

MAJOR OVERARCHING THEMES OF WORKSHOP DISCUSSIONS: PRINCIPLES OF A FRAMEWORK FOR SURVEILLANCE

The amount of uncertainty surrounding the Gulf oil disaster underscores a need to fill gaps in the current state of knowledge. Additional data can provide raw material for scientific discovery, observation, and theory, as well as desired information and answers most needed by at-risk populations, said Savitz. Within the context of surveillance, additional data can help identify high-risk hazards, identify the most at-risk populations, evaluate service needs and current capacities, and drive actions to better prevent or mitigate adverse health effects from future disasters. Moreover, as Nicole Lurie noted (see Chapter 1) surveillance systems and related research may have the potential to generate knowledge that could influence general public health responses and the overall delivery of health care services.

Complexity and Uncertainty

Assessing the effects of the Gulf of Mexico oil spill on human health is complex, and many questions remain about the hazards and risks posed to different populations. As elaborated throughout the workshop, there are many unanswered questions about at-risk populations, potential hazards (including exposures) to human health, the potential effects of these hazards, and how best to minimize hazards. Some of the uncertainty stems from the enormity and unprecedented magnitude and scope of the disaster. For example, as John Howard and Scott Barnhart discussed (see Chapter 2), proximity to the oil spill and response activities is a major risk factor for exposure by inhalation, ingestion, or dermal contact (see Figure 2-1), and everyone in the Gulf region, arguably even outside the region, is potentially vulnerable to feelings of anxiety and other negative psychological symptoms, conditions, or disorders.

But much of the uncertainty stems from the scarcity of scientific evidence about the types of risks to human health associated with various hazards. As Kenneth Olden remarked, "We are living in a state of toxic ignorance." Establishing a cause-effect relationship between a specific exposure and any given outcome is rarely straightforward, and the ongoing nature of the Gulf oil spill makes surveillance design and analysis more challenging. Edward Overton explained that very few of the thou-

sands of chemical compounds in oil have been tested for toxicity (see Chapter 1), and Savitz urged further investigation into the toxicology of specific chemicals. The use of chemical dispersants and controlled burns further complicates identification of high-risk chemical exposures. Several panelists and other participants commented about the lack of data on effects of exposure to "real-world" mixtures of chemicals. Thomas Bernard (see Chapter 3) explained that much is known about heat exposure and heat stress, but more information is needed about the cumulative effects of repeated exposures on human health, including heat-related disorders and injuries.

Data on the long-term human health consequences of exposure to oil-spill-related stressors are especially sparse, but are essential, noted Nalini Sathiakumar (see Chapter 3). This type of data becomes more important given the unique nature of the Gulf oil spill, where strenuous occupational conditions and substantial losses of economic and social stability threaten the short- and long-term physical and psychological well-being of the entire Gulf region.

Psychological and Socioeconomic Health

Many participants acknowledged that the Gulf oil disaster poses known risks to the physical health of individuals in the affected regions. However, there is growing concern about the short- and long-term effects on the psychological health of the Gulf region. Past scientific research has demonstrated the seriousness of the mental health consequences of disasters. For example, Palinkas's work following the *Exxon Valdez* disaster provided valuable information that identified worsening mental health as a serious problem. Linda Rosenstock opined that mental health status was of "grave concern," even among those far removed from direct exposure to toxins. Widespread socioeconomic disruption resulting from the Gulf oil spill poses a significant risk of adverse psychological health outcomes, stated Savitz.

A lack of mental health resources only compounds the problem. Howard Osofsky (see Chapter 3) noted the growing psychological impacts of the Gulf oil spill and expressed concern about access to services. Rosenstock suggested establishing a hotline for individuals to call with questions about the spill. Just the existence of a hotline sends the message that feelings of stress or anxiety are not uncommon, even for

someone 300 miles inland. That message, in and of itself, can contribute to improved mental health status, said Rosenstock.

Many workshop participants, including members of the affected communities and Gulf state policy makers, suggested that mental health was one of the most urgent public health concerns (see Chapters 3 and 4). Although the vast majority of surveillance data that had been collected to date by the state health offices was for acute physical illnesses at the time of the workshop, all five state public health officers who attended identified the need for increased and better targeted mental health surveillance as an immediate challenge.

Immediacy

According to numerous participants, there is an immediate need to act based on existing data and resources and to begin new surveillance and research activities. Olden emphasized the importance of identifying evidence-based knowledge that should be applied before generating new knowledge. John Bailar agreed with Olden and emphasized that, as with the data-collection process itself, strategy development is critical but should not delay efforts to gain new knowledge. Both processes need to move forward in parallel, and both need vigorous proponents, said Bailar.

Learning from What Is Already Known

Despite the uncertainty and complexity involving assessment of the Gulf oil disaster's impact on human health, several panelists remarked that enough information exists to build a solid surveillance framework. For example, activities related to Hurricane Katrina highlight the usefulness of electronic health records. Based on those lessons learned, Daniel Masys suggested ways that electronic health records could be incorporated into surveillance activities related to the Gulf oil disaster (see Chapter 6). As another example, Palinkas's work following the *Exxon Valdez* disaster (see Chapter 3) provides information that can lead to a better understanding of what mental health is and how stressful events can affect specific measures of social and psychological health.

Additionally, Rosenstock mentioned some of the many ways that federal agencies involved in disaster response, such as the National

Institute for Occupational Safety and Health (NIOSH), have learned from past mistakes. For example, NIOSH is applying lessons learned from the 2001 World Trade Center disaster to its response to the Gulf oil crisis (e.g., by obtaining a full roster of all exposed workers). As another example, she referred to discussion among state health officers and their ongoing contact with the Centers for Disease Control and Prevention (CDC). Effective ongoing communications of that nature did not exist in the past, said Rosenstock.

New Data Collection

Several panelists called for the collection of as much data as soon as possible. As Bailar explained, people will be moving out of reach, memories will fade, and environmental contaminants will change over time. At the time of the workshop, several types of data were already being collected. As Howard stated, the CDC and NIOSH were compiling worker rosters; conducting surveillance, including worker illness and injury surveillance; and collaborating with states, OSHA, and BP to identify acute trends and potential chronic health effects (see Chapter 5). Osofsky described qualitative, mental health data from focus groups (see Chapters 3 and 6), and mentioned that the Environmental Protection Agency (EPA) was collecting environmental samples, with real-time monitoring data being posted on the EPA website (see Chapter 5). The states of Alabama, Florida, Louisiana, Mississippi, and Texas were engaged in syndromic and reporting surveillance activities (see Chapter 5).

Acknowledging that the workshop's goal was not to come to consensus on any single issue, Rosenstock remarked that a vast majority of participants appeared to agree that the collection and banking of biological and environmental specimens were needed. During her presentation in an earlier session, Brenda Eskenazi noted several "easy" ways to collect blood specimens for biobanking, for example, as part of routine prenatal alpha-fetoprotein screenings (see Chapter 3). Several participants called for immediate archiving of tissue and environmental samples for later analyses, in the likely event that unforeseen information will be needed in the future. However, Rosenstock cautioned that, because resources are limited, "it is really important that we are very smart and strategic about which of those samples we test for what."

Discussions also focused on the possibility of leveraging existing resources, mechanisms, or organizations, such as National Institutes of

Health (NIH) funding, to centralize research. Lynn Goldman described the National Science Foundation's rapid grant mechanism for non-health-related research focused on disasters. The mechanism involves very stringent peer review and has a very quick turnaround. The CDC and the NIH could use similar mechanisms, suggested Goldman, encouraging the agencies to collect public input on how funding is directed.

Immediate Action

Immediate actions based on current knowledge can also reduce occupational health hazards and increase worker health protections, noted a number of speakers, including Paul Lioy and Scott Barnhart (see Chapter 2) . Rosenstock explained that there may be gaps in jurisdiction with respect to who has responsibility for worker safety. If so, those regulatory gaps could be addressed quickly. Additionally, because different types of workers are exposed to different types of risks (see Chapter 2), some participants suggested that having a single point of contact to identify and communicate effective use of personal protective equipment would be helpful. It may be necessary to consider deployment of a federalized workforce, or some version thereof, to provide more uniform worker training, said Rosenstock.

Community Engagement

As described in Chapter 4, David Abramson suggested that the success of surveillance and monitoring activities is dependent on how results are communicated to the affected populations and incorporated into public health practice. One way to improve health and risk communications with the public involves engaging communities. The suggestions from workshop participants focused on two primary aspects of community engagement: (1) surveillance and related research activities; and (2) risk communication.

Surveillance and Related Research Activities

A number of workshop participants expressed that community participation is key to improving surveillance and research activities be-

cause it enhances community participation and better aligns the goals of the researcher and the community. Data can provide helpful information that can directly benefit communities affected by the Gulf oil spill, as Lichtveld and others explained during the workshop. However, many Gulf communities are skeptical of research participation after Hurricane Katrina.

Recognizing practical limitations of available resources, Olden stated that the foundation of a surveillance system must be built on the priorities expressed by affected communities. He emphasized the importance of listening to the opinions expressed during the public statement session (see Chapter 4) and the need to broaden community input even more. Several other workshop participants echoed Olden's call for engaging disaster-impacted communities early and often so that research activities are aligned with what communities want and need.

Health and Risk Communication—The Messenger

To establish effective communications between communities and the messengers, efforts to engage the public must begin as early as possible, be as factually accurate as possible, and be expressed in a manner that is relevant to affected communities, remarked Lichtveld. Savitz and others explained that, to this end, the messenger must have a strong command of the data and evidence, as well as a high degree of trustworthiness and credibility.

Unfortunately, it is not readily apparent who affected communities trust. As Abramson explained, some studies indicate that the CDC is trusted as an information source (see Chapter 4). Olden mentioned the National Cancer Institute's toll-free number that people can dial to hear automated answers to questions. He suggested that the federal government set up a similar information service to provide information to the public.

Not all panelists agreed that having a federal source of information as the clearinghouse is necessarily the best (or should be the only) strategy. Lichtveld and other participants stated that communities in the Gulf region did not trust federal authorities. Noting that the federal government did indeed have the requisite expertise and leadership, Bailar also expressed doubt that the federal government could effectively engage the public. Savitz suggested that state health officials may be in a better posi-

tion to understand the needs of communities within individual states. Linda McCauley added that trustworthy sources may differ by topic.

Panelists also discussed possible nongovernmental messengers. Rosenstock expressed the need for an "independent, respected scientific voice that has experience working across sectors." Lichtveld opined that centralizing communication efforts could be advantageous but that it was important to involve community leaders who can communicate in a way that will make sense to the people in affected communities. Bailar noted that health care professionals are also in a good position to serve as communicators with their patients. From a different perspective, McCauley described an opportunity to build community capacity by developing a network of youth ambassadors to help collect and disseminate information about data. Moreover, by directly participating in the solution, children could develop a sense of control over their lives, which could turn a frightening experience into an opportunity for empowerment.

Health and Risk Communication—The Message

Although panelists agreed that providing trustworthy information to the public is crucial, there was some disagreement about what to communicate with the public. Abramson stated that it is important to create a two-way dialogue between the messenger and members of the public that allows time for interpretation and deliberation (see Chapter 4). Savitz recommended creating a clearinghouse to identify information of direct relevance, stating clearly what is and is not known. Olden said that many of the questions that individuals have about the Gulf oil spill could have been answered within 2 to 3 days of the initial rig explosion through a telephone hotline.

In addition to accurate and reliable information, Abramson earlier noted that the members of the public may need tools to help them interpret complex or unfamiliar information (see Chapter 4). McCauley added that, because children perceive things differently than adults and because children use emerging technologies (e.g., Twitter), there may be a potential to do something innovative.

Health and Risk Communication—Additional Tensions

Finally, the panelists discussed additional tensions that may affect the relationship between communities and the messenger. As Adler described, "A tension exists between what communities want and what science produces." For example, to feel at ease, communities may want conclusive evidence that a certain compound will have no adverse effect on health. However, science is designed only to offer "no evidence of an effect." Additionally, the messenger must strike a balance between the need for prudence and caution with an eye to avoiding undue disruption to the economy, which can add to the cumulative effects on psychological and social well-being, said Savitz.

Coordination

Creating a framework for surveillance requires more than filling knowledge gaps. Several panelists agreed that the Gulf oil disaster's magnitude and complexity called for some form of high-level coordination of the various surveillance activities under way. Others suggested some form of centralization to coordinate and accelerate the initiation of research, but it is not immediately clear who should assume that role.

Rosenstock observed that the federal government has emerged as a single voice in charge, more or less, in terms of dealing with the environmental response. She opined that someone at the federal level needs to identify all the routine data being collected and determine how to put those data together to gain a more comprehensive and definitive understanding of the Gulf oil spill's impacts on human health.

One panelist suggested that perhaps a czar or other high-level person should be appointed to coordinate surveillance across agencies. This would be especially useful as each agency is currently conducting surveys based on its own priorities, and changing existing surveillance and research agendas will require authority to trump other decisions. Savitz suggested that the federal government appoint a National Disaster Research Coordinator. One audience member then nominated Surgeon General Regina Benjamin to serve in that role. Goldman agreed that situations, such as the Gulf oil spill, call for stronger levels of organization in the response, particularly on the federal level, and that agencies need to better coordinate their efforts with respect to using existing resources and increasing the capacity to collect and manage surveillance data.

However, she felt that it was not realistic to have a new directorate because of the number of federal agencies involved in the oil spill response. Rather, she suggested prioritizing existing roles.

Although some panelists agreed that having somebody in the federal government serving in that role could be effective, others did not. McCauley agreed that there needs to be stronger coordination among federal agencies, not only to clarify agency roles and to prioritize surveillance needs and resources, but also to align surveillance system priorities with the priorities of impacted communities. Bailar expressed concern that the public's trust and confidence in the information provided by the federal government may not be as high as their trust in information provided by a local source. He suggested asking the Gulf state governments to develop a regional consortium that could then co-opt somebody from the federal government or elsewhere to take on this responsibility. Savitz agreed that perhaps a consortium of state health officers—a group that typically interfaces with communities, government, and scientific communities—might be an appropriate level or forum for oversight.

Commitment

Understanding and addressing the disaster's potential health consequences will be an ongoing, long-term effort. Many workshop participants, such as Adler, suggested that effective surveillance systems must include long-term outcomes. This requires commitment from the federal, state, and local levels to support these activities over an extended period of time, especially if the goal of surveillance activities is to inform decisions about health care delivery, as described by Lurie in her opening remarks on the opening day of the workshop. Several panelists agreed that state-level public health agencies will require a sustained commitment and continuous funding from the federal government to build the surveillance capacity needed to respond to future, unforeseen disasters.

Investments in public health infrastructure will be a key determinant in whether surveillance activities can be sustained, said Rosenstock, echoing comments from other participants. She noted the gradual erosion in direct governmental support for local, state, and even federal public health that has been occurring since the 1980s. Public health agencies are underfunded and are functioning at a very basic, minimal level, said Rosenstock. By largely targeting resources on biosecurity and other time-specific topics, the public health infrastructure has developed around the

"disease *du jour*" and does not always build on the core functions that public health is supposed to deliver during disaster response, such as surveillance. When an event like the Gulf oil spill occurs, the expectation is that public health agencies will be able to ensure the safety of public health and track the consequences, said Rosenstock. However, in order to fully deliver on that perceived promise, many participants suggested that those agencies need more continuous investments so they can build the necessary capacities. While not disagreeing with the need for more federal-level resources, Lichtveld emphasized the importance of also building on existing consortia, partnerships, and mechanisms. Goldman also addressed concerns about funding. She said that making funds available for disaster-related health research should be a high priority and explained that funding could supplement existing research grants, or it could be used to launch completely new research initiatives.

Over the course of the workshop, a number of panelists and participants, such as John Hosey, stated that surveillance and research activities should drive action rather than merely generate new knowledge. Thomas Matte defined surveillance as "actionable information to make things better now," and Bailar defined it as "service to the individual" (see Chapter 5). Accordingly, at several different times throughout the discussion, panelists commented on the importance of not only identifying individuals that need care but also providing a means for those individuals to receive care. For example, Osofsky explained how post-Katrina mental health surveillance has tracked symptoms and guided interventions, services, and resource availability (see Chapters 2 and 5). Rosenstock also expressed a desire to identify areas where additional mental health services are needed. For example, a hotline not only could collect information about potential exposures and adverse outcomes, but also could guide individuals toward available health care services.

Surveillance, Research, and Legal Liability

Although the Department of Health and Human Services (HHS) did not ask the Institute of Medicine (IOM) to consider how the threat of litigation may complicate surveillance and research design and implementation, panel members echoed concerns from workshop participants that litigation may compromise the reliability and the longevity of short- and long-term surveillance and research activities. Certain states have been reluctant to protect research data, explained Goldman. For example, she continued, by allowing research subjects to be recontacted, attorneys

have compromised the integrity of research results. Summarizing comments from workshop participants, Savitz stated that certificates of confidentiality may prevent the misuse of data by attorneys, litigants, government officials, or other interested parties. From another perspective, some speakers such as Wilma Subra (see Chapter 4) expressed concern that fear of litigation persuaded some employers to discourage employees from reporting or seeking treatment for adverse health effects. Bailar encouraged state health officers to work with their respective state attorneys general and federal government representatives to better protect research participants and their data.

Future Directions

Understanding and addressing the potential health consequences of the Gulf disaster will be an ongoing, long-term effort. This workshop was only an early step in that process, said Adler. Several participants commented on the importance of revisiting these questions and issues in the future through additional activities and collaborations.

Although it is difficult to predict the full magnitude of the Gulf oil disaster's impact on human health, there is an opportunity to help the communities whose well-being is in jeopardy and to prevent or mitigate similar outcomes in the future, according to many workshop participants. Touching on some of Bernard Goldstein's remarks about the connection between the environment and human health (see Chapter 1), Goldman identified the need for better health-impacts analyses of the policy decisions that led up to this disaster. She noted that the depth of the Deepwater Horizon oil break was not accidental; that is where the oil is. In the future, when additional oil reserves are needed, she opined that drilling decisions may entail entering even riskier environments. Goldman encouraged the health community to become more involved in energy decision making and policy development.

In conclusion, Adler echoed the opinions of other participants, encouraging federal, state, and local governments; academia; private industry; and community networks and programs to coordinate and share their expertise. By including the public in the development of monitoring and research activities and by protecting the integrity of data collection and analysis, surveillance systems could be developed to accurately inform decision makers and the public about the real risks to the physical and psychological health related to the Deepwater Horizon disaster.

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C

Workshop Agenda

Assessing the Human Health Effects of the Gulf of Mexico Oil Spill:
An Institute of Medicine Workshop

June 22-23, 2010

Hotel Monteleone, Queen Anne Ballroom
New Orleans, Louisiana

DAY 1 – TUESDAY, JUNE 22, 2010

8:00 a.m. **Registration**

8:30 a.m. **Welcome**
Harvey V. Fineberg, President, Institute of Medicine

8:40 a.m. **Charge to the IOM**
Nicole Lurie, Assistant Secretary for Preparedness and Response, U.S. Department of Health and Human Services

8:50 a.m. **Introductory Remarks**
Nancy E. Adler, Chair, Planning Committee and Director of the Center for Health and Community, University of California, San Francisco

9:00 a.m. **The Compelling Need to Understand the Effects of Oil Spills on Human Health**

- *Bernard D. Goldstein, University of Pittsburgh*
- *Blanca Laffon, University of A Coruña*
- *Edward B. Overton, Louisiana State University*

9:45 a.m. **The Response of the Federal Government to Health Concerns**

John Howard, Director, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention

SESSION I: AT-RISK POPULATIONS AND ROUTES OF EXPOSURE

Session Objective: Identify and discuss the populations (e.g., fishermen and -women, clean-up workers, and residents of the affected communities) that are most vulnerable to, or at increased risks for, adverse health effects related to the oil spill. Examine potential routes of exposure in select populations. Explore special considerations in the development and implementation of population-monitoring activities.

10:00 a.m. **Panel Discussion. Taking Stock: Who Is at Risk and How Are They Exposed?**

Moderator: *Linda Rosenstock, University of California, Los Angeles*

- Routes of Exposure and At-Risk Populations
  Paul J. Lioy, Rutgers University
- Residents of Affected Regions: General and Special Populations
  Maureen Y. Lichtveld, Tulane University
- Occupational Risks and Health Hazards: Workers and Volunteers
  Scott Barnhart, University of Washington

SESSION II: SHORT- AND LONG-TERM EFFECTS ON HUMAN HEALTH

Session Objective: Identify and explore potential short- and long-term effects on human health from the oil spill. Particular attention will be placed on potential physical effects, psychological stress, heat stress and fatigue, and neurological and carcinogenic outcomes. Examine potential health effects on children and pregnant women. Consider monitoring strategies and data tools that should be used to assess potential health effects.

11:10 a.m. **Panel Discussion. The Here and Now: What Are the Short-Term Effects on Human Health?**
Moderator: *Linda A. McCauley, Emory University*

- Short-Term Physical Effects
  Nalini Sathiakumar, University of Alabama at Birmingham
- Short-Term Psychological Stress
  Howard J. Osofsky, Louisiana State University
- Heat Stress and Fatigue
  Thomas E. Bernard, University of South Florida

12:20 p.m. **LUNCH**

1:30 p.m. **Panel Discussion. The Need to Know: What Are the Potential Delayed and Long-Term Effects on Human Health?**
Moderator: *Kenneth Olden, Hunter College of the City University of New York*

- Neurological, Cancer, and Other Chronic Conditions
  Peter S. Spencer, Oregon Health and Science University
- Human Reproduction
  Brenda Eskenazi, University of California, Berkeley

- Impact on Health and Vulnerabilities of Children
  Irwin Redlener, National Commission on Children and Disasters
- Stress
  Sheldon Cohen, Carnegie Mellon University
- Lessons Learned from Previous Oil Spills
  Lawrence A. Palinkas, University of Southern California

SESSION III: STRATEGIES FOR COMMUNICATING RISK

Session Objective: Explore how to identify and address the health concerns of affected individuals and groups and of the public at large. Explore effective communication strategies to convey information about health risks accounting for culture, health literacy, language, and technological and geographic barriers. Consider specific strategies to engage selective at-risk populations. Engage the public in a dialogue about the populations most at risk and how to establish monitoring systems that will provide credible, reliable, and actionable data.

3:00 p.m. **Engaging the Public, Protecting Health**
David Abramson, Columbia University

3:20 p.m. **Dialogue with Workshop Participants**
Moderator: *Mike Magee, Healthy-Waters.org*

- Brief Invited Remarks—Community Perspectives
  Myra M. Lewis
  Diem Nguyen
  Wilma Subra
  John Hosey
- Open Dialogue with Audience

4:20 p.m. **Day 1 Closing Remarks**
Nancy E. Adler, University of California, San Francisco

4:30 p.m. **ADJOURN**

DAY 2 – WEDNESDAY, JUNE 23, 2010

8:30 a.m. **Registration**

9:00 a.m. **Recap of Day 1 Discussions and Overview of Day 2**
Nancy E. Adler, University of California, San Francisco

9:10 a.m. **Remarks from the Surgeon General of the U.S. Public Health Service**
The Honorable Regina M. Benjamin

SESSION IV: OVERVIEW OF HEALTH-MONITORING ACTIVITIES

Session Objective: Explore monitoring activities already being organized by state governments in relation to the spill. Identify and discuss opportunities and barriers to ensure coordination among ongoing efforts and strategies to minimize redundancy. Consider resource requirements to ensure that data collected informs policies for appropriate preventive strategies and delivery of health care services.

9:20 a.m. **Panel Discussion. How Are State Governments Currently Monitoring the Effects of the Gulf of Mexico Oil Spill on Human Health?**
Moderator: *LuAnn E. White, Tulane University*

- *Jimmy Guidry, Louisiana State Health Officer*
- *Mary Currier, Mississippi State Health Officer*
- *Ana M. Viamonte Ros, Florida State Surgeon General*
- *Donald E. Williamson, Alabama State Health Officer*
- *Bruce Clements, Director of the Community Preparedness Section, Texas Department of State Health Services*

10:20 a.m. **Additional Federal Perspectives**

Mathy V. Stanislaus, Assistant Administrator, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency

Alexander G. Garza, Assistant Secretary for Health Affairs and Chief Medical Officer, U.S. Department of Homeland Security

SESSION V: RESEARCH METHODOLOGIES AND DATA SOURCES

Session Objective: Consider methodologies and available data sources (including ongoing health surveillance and surveys) that could be used to monitor effects of the oil spill. Identify characteristics of a framework that can most efficiently and effectively identify and monitor potential short- and long-term adverse health effects. Identify the components and needs to ensure the establishment of an integrated and coordinated health-monitoring system.

10:30 a.m. **Panel Discussion. Critical Thinking: What Research Methodologies and Data Sources Could Be Used in Surveillance and Monitoring Activities?**

Moderator: *John C. Bailar III, University of Chicago*

- Overview of Research Methodologies and Data Collection
  Lynn R. Goldman, Bloomberg School of Public Health, Johns Hopkins University
- Surveillance and Monitoring
  Thomas D. Matte, Hunter College of the City University of New York
- Environmental Assessment, Risk, and Health
  William H. Farland, Colorado State University
- Mental Health
  Howard J. Osofsky, Louisiana State University
- Biomedical Informatics and Registries
  Daniel R. Masys, Vanderbilt University School of Medicine

12:20 p.m. **LUNCH**

SESSION VI: FUTURE DIRECTIONS AND RESOURCE NEEDS

Session Objective: Identify and discuss overarching themes that emerged throughout the workshop. Identify significant gaps in our knowledge base. Discuss what opportunities and constraints exist to implementing the frameworks and models discussed throughout the workshop. Consider what resources are required to implement the changes necessary to ensure that the most efficient and effective frameworks are in place to identify and monitor potential short- and long-term adverse health effects.

1:30 p.m. **Panel Discussion. Looking Ahead: How Do We Develop Effective Surveillance and Monitoring Systems?**

Moderator: *David A. Savitz, Mount Sinai School of Medicine*

- *Nancy E. Adler, University of California, San Francisco*
- *John C. Bailar III, University of Chicago*
- *Lynn R. Goldman, Bloomberg School of Public Health, Johns Hopkins University*
- *Maureen Y. Lichtveld, Tulane University*
- *Linda A. McCauley, Emory University*
- *Kenneth Olden, Hunter College of the City University of New York*
- *Linda Rosenstock, University of California, Los Angeles*

3:20 p.m. **Closing Remarks**

Nancy E. Adler, University of California, San Francisco

3:30 p.m. **ADJOURN**

D

Public Questions and Comments

As explained in Chapter 1 of this summary, communication with the public about risk and research strategies could strengthen existing and future surveillance and monitoring systems. The workshop included four methods by which the public could submit comments to the Institute of Medicine (IOM): (1) submitting electronic comments through the IOM website; (2) submitting a written comment sheet during the workshop; (3) completing question cards for individual panels; and (4) making a 3-minute statement during an open dialogue with the audience.

Between the four methods, the IOM received comments from more than 60 members of the public. The vast majority of questions and comments fell into one of eight categories (Box D-1). A majority of the comments described in this chapter are also described in the main body of the report in the summaries of the question-and-answer periods. However, this chapter includes additional comments, such as those submitted through the IOM's website. Although this appendix does not describe each additional comment, it does provide a general overview of the types of questions and comments that are at the forefront of the public's mind. This section also references specific data sources and references when possible.

BOX D-1
Categories of Questions and Comments
Submitted to the Institute of Medicine During the Workshop
Assessing the Human Health Effects of the Gulf of Mexico Oil Spill

Category	Sub-Categories
Populations at Risk	On- and Offshore Workers Residents Vulnerable Populations
Exposure	Contaminated Sources Contaminants
Health Effects	Physical Mental Social
Data Collection	Sources Integrity
Research and Analysis	Measured Outcomes Design Ethics and Litigation
Community Engagement	Risk Communication Research Development and Participation
Coordination	Research Activities Disaster Response
Action	Preventive Measures Available Resources

Populations at Risk

On- and Offshore Workers

One comment stated that offshore workers are at greatest risk for exposure because they work directly with oil closest to the source. Proximity increases the risk of contact with the oil through multiple routes of exposure, including inhalation, dermal contact, and ingestion. Another comment also noted that the worker population also includes members of the military and volunteers.

General and Vulnerable Populations in Affected Areas

A number of comments noted the risk to the general population in affected areas and expressed concern that changing weather events could increase the number of people directly exposed to the oil and contaminants related to the oil response.

A number of comments cited particularly vulnerable populations, including women, children, persons with disabilities and preexisting conditions, fishermen and -women, low-income and medically under-served populations, disabled persons, and residents affected by previous disasters, including recent floods. A few comments specifically addressed mental health research. One comment cited an article by Kessler that found a correlation between five or more stress factors and an increased risk of serious emotional disturbance. Additionally, one comment suggested that mental health professionals may also be vulnerable to adverse health outcomes.

Exposure

Contaminants and Contaminated Sources

A number of participants stated that exposure to all contaminants related to the oil spill and response activities were of concern. Specifically, public comments mentioned heavy metals and dispersants, and questioned whether the chemicals in the oil were yet known.

A couple of comments referenced oil in ocean sediment, one noting that oil on the ocean floor is the result of multiple spills and leaks over time. Another comment explained the potential for changing weather patterns to expand the scope of the problem from local to regional.

In addition to more familiar sources of exposure to contaminants, one person suggested that experts consider how the use of desalinization plants could affect exposure rates.

Health Effects

Physical

A number of physical health effects were mentioned, including respiratory, gastrointestinal, and cerebrovascular conditions. One comment suggested that infection rates, cardiac arrhythmias, and liver function may also be compromised as a result of oil spill exposures. A few comments highlighted the physical effects of heat stress, including fatigue, musculoskeletal issues, and premature aging. Two comments were concerned about cancer risk.

Psychological and Social

A number of psychological and social health effects were mentioned by members of the public, including domestic violence, drug and alcohol abuse, post-traumatic stress disorder, and stress. A few comments also mentioned that fear and "mass hysteria" could result from mixed messages to the public. One comment noted that stable income is important for maintaining the well-being of families and children. Food insecurity was also mentioned.

One specific comment explained that the Behavioral Risk Factor Surveillance System (coordinated by the Centers for Disease Control and Prevention) is conducted continuously with rolling probability samples in every state. The system tracks health-related quality-of-life measures by using a battery of five basic questions that investigate the presence and causes of, as well as the responses to, activity limitation. Some states include an additional five questions that target pain, depression, anxiety, sleeplessness, and vitality.

Data Collection

Sources

To measure occupational exposure, a few comments suggested using air and water sampling. Another comment listed individual medical histories as a source of information. At a local level, some private corporations have initiated data collection. For example, Cerner Corporation

established the HealthAware Coast Initiative, which used electronic health records to aggregate summary-level counts of adverse health effects across health care facilities. Another question from the audience suggested that health care providers could use standardized exam procedures, which would help establish baseline data. Finally, one comment specifically identified the National Library of Medicine Specialized Information Services Division's website as a reliable source of information on crude oil spills and health.

Integrity

One comment expressed concern that data and research results may not be made available to the public. Along these lines, another comment suggested that researchers publish both positive and negative research findings. Another comment suggested that a lack of worker training may affect surveillance and monitoring systems targeting workers.

Research and Analysis

Measured Outcomes

A number of comments suggested specific endpoints to include in future surveillance systems, including cardiac arrhythmias, impaired liver function, infection rates, and depression. For women and children, one comment mentioned stillbirth, birth defects, low birth weight, preterm birth, and neonatal deaths. Another comment listed the following outcomes by type of physical health: respiratory (cough, asthma, respiratory infections); gastrointestinal (food poisoning, nausea, vomiting, and diarrhea); cerebrovascular (headache, dizziness, and confusion); infection rates (viral and bacterial). Finally, one member of the public suggested that both risk and protective factors (e.g., factors associated with resiliency) are important to track.

Design

A number of comments were concerned with different aspects of biomonitoring and specimen banking, including what should be measured, how it would be used, whether it was necessary, and how to maintain specimens. To track worker health, one comment suggested the use of worker health surveys and follow-up surveillance. Finally, a comment recommended designing research to drive comprehensive outreach, education, and interventions. The effects of proximal and previous exposures were also of concern.

Ethics and Litigation

Although the IOM was not charged with examining ethical or legal considerations associated with developing surveillance systems, a number of comments pertained to this topic. One comment was concerned about litigation affecting long-term research, citing differences in mental and physical effects of disasters that do and do not encounter litigation. A number of individuals expressed concerned with the misuse of personal data. A few comments offered suggestions for improving research activities, including the use of Certificates of Confidentiality and the establishment of standing institutional review boards to speed the approval for baseline data collection.

Community Engagement

Risk Communication

A number of comments noted the need for assistance in navigating the information available about the oil spill. Suggested activities included holding organizations accountable for presenting clear and concise risk-mitigating information, using "gatekeepers" to screen for reliable and requested information, establishing a coordination care center, and holding town meetings. Other comments noted the absence of reliable information to inform day-to-day decisions.

Research Development and Communication

To improve public trust, one comment stated that stakeholders (including the workers and residents) should be engaged prior to conducting research, during research, and during follow-up. Another comment suggested that one organization be charged with reviewing data and releasing that information to the community.

Coordination

Research and Response

A number of public comments expressed the need to coordinate across response and research activities related to the oil spill. Suggestions included establishing a National Disaster Research Coordinator. One comment noted that this type of approach could reduce confusion that will result if the community receives the same proposal from multiple entities.

Action

Preventive Measures

A number of public comments focused on using surveillance systems to prevent future adverse health impacts. Suggestions included adopting regulations to limit day-to-day worker exposures, establishing best practices for both physical and mental prevention behaviors. A few comments wondered if more training for workers was warranted.

Available Resources

A number of comments noted the absence of adequate resources to address both physical and psychological health effects of the oil spill. For example, one comment noted that few mental health doctors or therapists are available in some of the affected communities.

E

Speaker Biographies

David Abramson, Ph.D., M.P.H. is director of research at Columbia University's National Center for Disaster Preparedness. He is the principal investigator of the longitudinal Gulf Coast Child & Family Health Study, an examination of need recovery among more than 1,000 randomly sampled displaced and impacted families in Louisiana and Mississippi. Dr. Abramson is also an associate editor of the American Medical Association (AMA) peer-reviewed journal, *Disaster Medicine and Public Health Preparedness.* His areas of study include disaster recovery and resiliency, the social ecology of vulnerability, risk communication targeted to high-risk or elusive communities, and survey research on preparedness attitudes and behaviors. Other current disaster-related research activities include a study of "Elusive Communities" and how hidden populations such as undocumented immigrants hear and respond to public health emergency messages; the American Hotspots project, which focuses on the measurement and mapping of social vulnerability and hazard; and an evaluation of risk messaging and community engagement, funded by the Centers for Disease Control and Prevention, to identify appropriate mechanisms for two-way communication. Dr. Abramson holds a Ph.D. in socio-medical sciences with a specialization in political science and a master's of public health, both from Columbia University.

Nancy E. Adler, Ph.D. *(planning committee chair)* is a professor of medical psychology in the Departments of Psychiatry and Pediatrics, vice chair of the Department of Psychiatry, and director of the Center for Health and Community at the University of California, San Francisco. A social psychologist by training, Dr. Adler's research interests include the impact of risk perception on reproductive and sexual health decision

making and identification of mechanisms by which socioeconomic status (SES) influences health. In the area of risk perception, she has studied how adolescents' perceptions of the risk of sexually transmitted diseases and pregnancy influence sexual behavior and use of contraceptives. Dr. Adler's research on SES and health has focused on how social, psychological, and biological factors associated with SES act together to determine the onset and progression of disease, and how the relationship of SES and health may differ depending on gender and ethnicity. She is the author of more than 150 articles, books, and book chapters and is currently a member of the editorial boards for the journals *Annals of Behavioral Medicine*, *Journal of Health Psychology,* and *Journal of Applied Social Psychology*. Dr. Adler was elected to the Institute of Medicine (IOM) in 1994. She served as a member of the IOM Committee on Prevention and Control of Sexually Transmitted Diseases and chaired the Committee on Psychosocial Services to Cancer Patients/Families in a Community Setting. Dr. Adler received her Ph.D. in psychology from Harvard University.

John C. Bailar III, M.D., Ph.D. *(planning committee member)* is a professor emeritus at the University of Chicago and founding chair of the Department of Health Studies there. A retired commissioned officer of the U.S. Public Health Service, Dr. Bailar worked at the National Cancer Institute in Bethesda for 22 years, and since then he has held academic appointments at Harvard and McGill Universities. Dr. Bailar's research interests focus on the interpretation of statistical evidence in medicine, with special emphasis on cancer. For 6 years Dr. Bailar was editor-in-chief of the *Journal of the National Cancer Institute*. For 11 years he was the statistical consultant for the *New England Journal of Medicine*, and more recently he has been a member of the editorial board of that journal. Dr. Bailar is a member of the Institute of Medicine and earned his M.D. from Yale in 1955 and his Ph.D. in statistics from American University in 1973.

Scott Barnhart, M.D., M.P.H. is a professor of medicine and global health and division director of Health Systems Strengthening at I-TECH at the University of Washington. Dr. Barnhart's background and training have included extensive clinical work, as well as developing training and research programs in medicine, occupational health, and health systems in resource-limited environments. Prior to his current position, Dr. Barnhart was the associate dean for clinical affairs, the medical di-

rector of the Harborview Medical Center, and a senior clinical advisor at the I-TECH Department of Global Health. Dr. Barnhart received his medical degree from George Washington University in 1979 and his master's of public health in 1986 from the University of Washington.

The Honorable Regina M. Benjamin, M.D., M.B.A. is the 18th Surgeon General of the U.S. Public Health Service. As America's Doctor, she provides members of the public with the best scientific information available on how to improve their health and the health of the nation. Dr. Benjamin also oversees the operational command of 6,500 uniformed health officers who serve in locations around the world to promote, protect, and advance the health of the American people. Dr. Benjamin is founder and former CEO of the Bayou La Batre Rural Health Clinic in Alabama, former associate dean for rural health at the University of South Alabama College of Medicine in Mobile, and immediate past chair of the Federation of State Medical Boards of the United States. She was the first physician under age 40 and the first African-American woman to be elected to the American Medical Association Board of Trustees. She served as president of the American Medical Association (AMA) Education and Research Foundation and chair of the AMA's Council on Ethical and Judicial Affairs. In 2002, she became president of the Medical Association of the State of Alabama, making her the first African American female president of a state medical society in the United States. Dr. Benjamin is a member of the Institute of Medicine and a fellow of the American Academy of Family Physicians. She was a Kellogg National Fellow and a Rockefeller Next Generation Leader. She serves on numerous boards, including the Robert Wood Johnson Foundation, Kaiser Commission on Medicaid and the Uninsured, Catholic Health Association, and Morehouse School of Medicine. In 1998, Dr. Benjamin was the U.S. recipient of the Nelson Mandela Award for Health and Human Rights. Dr. Benjamin has a B.S. in chemistry from Xavier University, New Orleans; an M.D. from the University of Alabama, Birmingham; an M.B.A. from Tulane University; and five honorary doctorates. She attended Morehouse School of Medicine and completed her family medicine residency in Macon, Georgia. She also established a clinic in a small fishing village in Alabama to help its uninsured residents.

Thomas E. Bernard, Ph.D. is a professor in the College of Public Health and chair of the Department of Environmental and Occupational Health at the University of South Florida. His primary research interest is

heat stress exposure assessment. In particular, he has proposed methods to account for protective clothing in the context of occupational exposure guidelines pertaining to customary heat stress. In addition, Dr. Bernard investigates the use of personal monitoring to limit heat stress exposures or to demonstrate good management practices. He has also consulted with government and industry on heat stress management. In addition to his teaching responsibilities in occupational health and safety, Dr. Bernard is the current president of the board of directors of the *Journal of Occupational and Environmental Hygiene*. He is a current member and past chair of the ACGIH Physical Agents Committee. Dr. Bernard earned his Ph.D. from the Graduate School of Public Health at the University of Pittsburgh, and he holds engineering degrees from Carnegie Mellon University.

Bruce Clements, M.P.H. serves as preparedness director at the Texas Department of State Health Services where he is responsible for health and medical preparedness and response programs ranging from pandemic influenza to the health impact of hurricanes. He holds undergraduate degrees in disaster preparedness, bioenvironmental engineering, and business administration, and a master of public health degree. His military experience includes more than 23 years of service with assignments that include serving as a nuclear, biological, and chemical warfare defense instructor and as a public health officer. He has also served as the public health preparedness director for the state of Missouri and as an infection control occupational health intervention manager at BJC Healthcare. He has lectured extensively on public health preparedness topics, published peer-reviewed articles and books on preparedness, and served as a media resource for outlets such as CNN, FOX News, National Public Radio, and the Associated Press.

Sheldon Cohen, Ph.D. is the Robert E. Doherty Professor of Psychology at Carnegie Mellon University. He is also an adjunct professor of pathology and psychiatry at the University of Pittsburgh Medical School as well as a member of the Pittsburgh Cancer Institute. Dr. Cohen's work focuses on the roles of stress, affect, and social support systems in health and well-being. He has published theoretical and empirical work on the effects of aircraft noise on the health and development of school children and on the roles of stress and social networks in physical and mental health. Over the past 25 years he has studied the effects of psychological stress, social support, and social status on immunity and susceptibility to

infectious disease. This work attempts to identify the neuroendocrine, immune, and behavioral pathways that link stress, personality, and social networks to disease susceptibility. He is also involved in studies of the effects of psychosocial factors on the onset and progression of asthma, and on the effectiveness of social support interventions in facilitating psychological adjustment and disease progression in women with breast cancer. His current work focuses on how interpersonal dispositions and behaviors influence immunity and host resistance to infectious disease. He is the recipient of the American Psychological Association's Award for Distinguished Scientific Contributions to Psychology, the American Psychological Society's James McKeen Cattell Fellow Award for outstanding lifetime contribution to research in applied psychology, and is a member of the Institute of Medicine.

Mary Currier, M.D., M.P.H. became Mississippi's state health officer in 2010 after serving as state epidemiologist from 1993 to 2003, and again from 2007 to 2009. Prior to serving as state epidemiologist, she was a medical consultant with the agency. Dr. Currier began her public health career with the Mississippi State Department of Health as a staff physician for the prenatal care, family planning, STD, and pediatrics programs. Dr. Currier received her M.D. from the University of Mississippi School of Medicine in 1983 and her master's in public health from the John Hopkins School of Hygiene and Public Health in 1987.

Brenda Eskenazi, Ph.D. *(planning committee member)* is the Maxwell Professor of Maternal and Child Health and Epidemiology at the University of California (UC), Berkeley, School of Public Health. She is director of the UC Berkeley Center for Excellence in Children's Environmental Health Research, which investigates pesticide and other chemical exposures and their health effects on pregnant women and their children with support from the National Institutes of Health (NIH) and the U.S. Environmental Protection Agency (EPA). As a neuropsychologist and epidemiologist, she has spent more than 30 years examining the effects of environmental exposures on male and female fertility, pregnancy, and children's health and development, and she has studied numerous agents including cigarette smoke, environmental tobacco smoke, benzene and other solvents, lead, manganese, dioxin, organochlorine and organophosphate pesticides, flame retardants, as well as other environmental agents. Dr. Eskenazi is a fellow of the American College of Epidemiology and is on the editorial boards of the *American Journal of*

Epidemiology, *Environmental Health Perspectives*, and *Journal of Environmental and Public Health*. She was a member of the National Academy of Sciences Board on Children, Youth, and Families and is currently a member of the Expert Committee for the Stockholm Convention.

William H. Farland, Ph.D. is the vice president for research at Colorado State University in Fort Collins, Colorado. He is also a professor in the Department of Environmental and Radiological Health Sciences, School of Veterinary Medicine and Biomedical Sciences. In 2006, Dr. Farland was appointed deputy assistant administrator for science in the EPA's Office of Research and Development (ORD). He had served as the acting deputy assistant administrator since 2001. He served as the EPA's acting science advisor throughout 2005. Formerly, he was the director of the ORD's National Center for Environmental Assessment. In 2002, Dr. Farland was recognized by the Society for Risk Analysis with the Outstanding Risk Practitioner Award, and in 2005 was appointed as a fellow of the society. In 2007, he was elected as a fellow of the Academy of Toxicological Sciences. Dr. Farland holds a Ph.D. from University of California, Los Angeles, in cell biology and biochemistry.

Alexander G. Garza, M.D., M.P.H. is the assistant secretary for health affairs and chief medical officer of the Department of Homeland Security. He manages the department's medical and health security matters; oversees the health aspects of contingency planning for all chemical, biological, radiological, and nuclear hazards; and leads a coordinated effort to ensure that the department is prepared to respond to biological and chemical weapons of mass destruction. Prior to joining the department in August 2009, Dr. Garza spent 13 years as a practicing physician and medical educator. He most recently served as the director of military programs at the ER One Institute at the Washington Hospital Center, and he has served as the associate medical director of the emergency medical services (EMS) for the state of New Mexico, and director of EMS for the Kansas City, Missouri, health department. While practicing medicine he also served as a professor at leading medical institutions including Georgetown University, the University of New Mexico, and the University of Missouri–Kansas City. Dr. Garza served in the U.S. Army Reserve and was a battalion surgeon and public health team chief during Operation Flintlock in Dakar, Senegal. He also served as a public health team chief during Operation Iraqi Freedom and as a special investigator and medical expert for Major General Raymond Odierno. He holds an

M.D. from the University of Missouri–Columbia School of Medicine, a master's of public health from the Saint Louis University School of Public Health, and a B.S in biology from the University of Missouri–Kansas City.

Lynn R. Goldman, M.D., a pediatrician and an epidemiologist, is a professor of environmental health sciences at the Johns Hopkins University Bloomberg School of Public Health. Her areas of focus are children's environmental health research, public health preparedness, and environmental health policy. She has joint appointments in the Departments of Health Policy and Management and Epidemiology and in Emergency Medicine at the Johns Hopkins School of Medicine. From 1993 to 1998, Dr. Goldman served as assistant administrator for the EPA's Office of Prevention, Pesticides, and Toxic Substances. Between 1985 and 1993, Dr. Goldman served at the California Department of Health Services, most recently as head of the Division of Environmental and Occupational Disease Control. She has a B.S. from UC Berkeley, a master's in public health from the Johns Hopkins University School of Public Health, an M.D. from UC San Francisco, and pediatric training at Children's Hospital, Oakland, California. She has served on numerous boards and expert committees, including the Committee on Environmental Health of the American Academy of Pediatrics and the CDC Lead Poisoning Prevention Advisory Committee. Dr. Goldman is a member of the Institute of Medicine and vice chairman of the Institute of Medicine Roundtable on Environmental Health Sciences.

Bernard D. Goldstein, M.D. is a professor of environmental and occupational health and the former dean of the University of Pittsburgh Graduate School of Public Health. He is a physician, board certified in internal medicine, hematology, and toxicology. He is an elected member of the IOM and of the American Society for Clinical Investigation. Dr. Goldstein served as assistant administrator for research and development at the EPA from 1983 to 1985. He has chaired a dozen National Research Council (NRC) and IOM committees and is a member of the IOM Roundtable on Environmental Health Sciences, Research, and Medicine, as well as the National Academy of Sciences Roundtable on Science and Technology for Sustainability. He has been president of the Society for Risk Analysis, is currently editor-in-chief of the Scientific Committee on Problems of the Environment (SCOPE), and has served as a member or chairperson of numerous U.S. governmental and World Health Organiza-

tion committees, including chairperson of the NIH Toxicology Study Section and the EPA's Clean Air Scientific Advisory Committee. He was the initial chair of the National Board of Public Health Examiners.

Jimmy Guidry, M.D. is currently the state health officer of Louisiana, and he also serves as the medical director for the Department of Health & Hospitals (DHH). Prior to this, Dr. Guidry served as the assistant secretary for the Office of Public Health from October 1996 through January 2000, and as the medical director of the Acadian region from April 1990 through April 1991. In addition, Dr. Guidry served as the director of adolescent services at Louisiana State University (LSU) School of Medicine, Pediatric Department, Earl K. Long Hospital, from January 1985 to March 1990. He also worked in pediatric private practice from July 1981 through December 1984. Dr. Guidry presently chairs various task forces, including the DHH Obesity Task Force, the Child Death Review Panel, and the Governor's Task Force on Tuberculosis. He received his B.S. degree from the University of Southwestern in 1974, earned his doctorate from the LSU School of Medicine in 1978, and completed his residency at Earl K. Long Hospital in 1981. He has been board certified since 1984 and is a fellow of the American Academy of Pediatrics.

John Howard, M.D., M.P.H., J.D., LL.M. is the director of the National Institute for Occupational Safety and Health (NIOSH) in the U.S. Department of Health and Human Services in Washington, DC. Prior to his appointment as director of NIOSH, Dr. Howard served as chief of the Division of Occupational Safety and Health in the California Department of Industrial Relations from 1991 through 2002. Dr. Howard received his M.D. from Loyola University of Chicago in 1974, his master's of public health from the Harvard School of Public Health in 1982, his doctor of law from the UCLA in 1986, and his master of law in administrative law from the George Washington University in Washington, DC, in 1987. Dr. Howard is board certified in internal medicine and occupational medicine. He is admitted to the practice of medicine and law in the State of California and in the District of Columbia, and he is a member of the U.S. Supreme Court bar. He has written numerous articles on occupational health law and policy.

Blanca Laffon, Ph.D. is an associate professor at the University of A Coruña, Spain. Her area of scientific activity is the study of the effect of pollutants on organisms, especially at the molecular and cytogenetic

level. During her 13 years of professional research activity, she has conducted several studies in vitro and in human populations aimed to evaluate the genotoxicity and cytotoxicity associated with exposure to chemical substances present in the environment. In 1996, she earned her bachelor in pharmacy with honors and an extraordinary award and her honors degree from the University of Santiago de Compostela, Spain. She received her Ph.D. in pharmacy from the University of Santiago de Compostela, Spain, with honors and an extraordinary award in 2001. She is also a postgraduate in genomics, proteomics, and bioinformatics (2002, University of Barcelona, Spain) and in genetic and molecular epidemiology (2006, Autonomous University of Barcelona, Spain).

Maureen Y. Lichtveld, M.D., M.P.H. *(planning committee member)* has a 28-year career in public health and currently is a professor and chair of the Department of Environmental Health Sciences, Tulane School of Public Health and Tropical Medicine. Her research interests include environmentally induced disease such as asthma and cancer, environmental health policy, community-based participatory research, disaster preparedness, and public health systems. She holds an endowed chair in environmental policy and was also appointed as associate director, population sciences of the Louisiana Cancer Research Consortium. Dr. Lichtveld is the principal investigator and chair of the Steering Committee for Head of Environmental Asthma in Louisiana (HEAL), an NIH-funded study. She provides scientific oversight for all clinical, environmental, and community engagement aspects of this novel pediatric asthma intervention examining the relationship between exposure to post-Katrina mold and exacerbation of childhood asthma. Dr. Lichtveld also serves on the Science Board of the American Public Health Association. She was recently elected as the chair of the Environmental and Occupational Health Council of the Association of Schools of Public Health. Dr. Lichtveld completed a successful 18-year career at the CDC in several leadership capacities. During her tenure at CDC, Dr. Lichtveld received numerous honors, including Special Service Award for her participation in the aftermath of September 11, 2001; Public Health Service Special Recognition Award; and CDC Environmental Health Scientist of the Year.

Paul J. Lioy, Ph.D. is a professor and vice chair of the Department of Environmental and Occupational Medicine at University of Medicine and Dentistry of New Jersey (UMDNJ) Robert Wood Johnson Medical

School (RWJMS), Piscataway, New Jersey. He is deputy director for government relations and director of exposure science at the Environmental and Occupational Health Sciences Institute of Rutgers University and UMDNJ-RWJMS. Dr. Lioy is a member of the Science Advisory Board of the EPA, and he was on the National Research Council Board on Toxicology and Environmental Studies. He has been a member of or chaired National Research Council committees and Science Advisory Board committees. He was also the co-chair of the World Trade Center Expert Technical Panel from 2004 to 2006. He is a fellow of the Collegium Ramazzini, Carpi, Italy, and was also a founder and past-president of the International Society for Exposure Science. He was an academic councilor to the New Jersey Legislature and was chair of the Clean Air Council. Dr. Lioy has been executive editor or associate editor of scientific journals and is currently an associate editor of the *Journal of Environmental Health Perspectives* and the *Journal of Exposure Science and Environmental Epidemiology*. He recently published the book, *Dust: The Inside Story of Its Role in the September 11th Aftermath,* which was written to discuss what was learned, the unknowns, and ways the government and public can evaluate and prepare in the face of any future natural or terrorist events.

Nicole Lurie, M.D., M.S.P.H. is the assistant secretary for preparedness and response at the U.S. Department of Health and Human Services. Prior to that, she was senior natural scientist and the Paul O'Neill Alcoa Professor of Health Policy at the RAND Corporation. There she directed RAND's public health and preparedness work as well as RAND's Center for Population Health and Health Disparities. She has previously served in federal government as principal deputy assistant secretary of health in the U.S. Department of Health and Human Services; in state government as medical advisor to the commissioner at the Minnesota Department of Health; and in academia as professor in the University of Minnesota Schools of Medicine and Public Health. Dr. Lurie has a long history in the health services research field, primarily in the areas of access to and quality of care, managed care, mental health, prevention, public health infrastructure, and preparedness and health disparities. Dr. Lurie attended college and medical school at the University of Pennsylvania, and she completed her residency and M.S.P.H. at UCLA, where she was also a Robert Wood Johnson Foundation Clinical Scholar. She serves as senior editor for *Health Services Research* and has served on editorial boards and as a reviewer for numerous journals. She has served on the council

and was president of the Society of General Internal Medicine, is currently on the board of directors for the Academy of Health Services Research, and has served on multiple other national committees. She is a member of the Institute of Medicine. Finally, Dr. Lurie continues to practice clinical medicine in the health care safety net in Washington, DC.

Mike Magee, **M.D.** is president of Positive Medicine Inc., a strategic health communications firm. In 2007, with input from the United Nations, Dr. Magee launched the Healthy-Waters Movement to educate the public regarding the topic of water and to mobilize health professionals on behalf of our environment. Working with the creative team that produced Al Gore's *An Inconvenient Truth*, Dr. Magee produced the *Healthy-Waters Tour*, a 1-hour, high-impact, big-screen presentation that addresses the relationship between water and agriculture, industry, energy, urban policy, disaster management, population growth, war, and disease. Dr. Magee has served as a senior fellow in the humanities to the World Medical Association, a David Rockefeller Fellow, and a master scholar at New York University School of Medicine. He is a past-president of the National Association of Physician Broadcasters and past chairman of the board of Very Special Arts (VSA) for the Disabled at the Kennedy Center.

Daniel R. Masys, M.D. is professor and chair of the Department of Biomedical Informatics at Vanderbilt University Medical Center. An honors graduate of Princeton University (biochemistry and molecular genetics) and the Ohio State University College of Medicine, he completed postgraduate training in internal medicine, hematology, and medical oncology at the University of California, San Diego (UCSD), and the Naval Regional Medical Center, San Diego. Dr. Masys served as chief of the International Cancer Research Data Bank of the National Cancer Institute, National Institutes of Health, and was director of the Lister Hill National Center for Biomedical Communications, which is the computer research and development division of the National Library of Medicine. Prior to joining Vanderbilt, Dr. Masys was director of Biomedical Informatics and professor of medicine at UCSD and medical director of UCSD's Human Research Protections Program (IRB). Dr. Masys is an elected member of the Institute of Medicine of the National Academies. He is board certified in hematology and medical oncology, a fellow of the American College of Physicians, and a fellow and past-president of the American College of Medical Informatics. He was a founding associ-

ate editor of the *Journal of the American Medical Informatics Association*, and he has received numerous awards including the NIH Director's Award and the U.S. Surgeon General's Exemplary Service Medal.

Thomas Matte, M.D., M.P.H. is a professor of urban public health in the environmental and occupational health science track at Hunter College at the City University of New York School of Public Health. Prior to joining the Hunter in 2010, he served as a medical epidemiologist at the National Center for Environmental Health and the New York City Department of Health and Mental Hygiene. At the health department, Dr. Matte directed studies to improve population exposure assessment, surveillance, and prevention of illness and death related to extreme heat and air pollution. He also participated in public health responses to the World Trade Center attacks and anthrax cases in 2001, the 2003 blackout, and the H1N1 outbreak in 2009. His prior work included studies of pathways, risk factors, and prevention of lead exposure; asthma in daycare populations; prenatal and early life exposures and their relationship to later health; and public health program evaluation.

Linda A. McCauley, Ph.D., FAAN, R.N. *(planning committee member)* is a professor and the dean of Emory University's Nell Hodgson Woodruff School of Nursing. Dr. McCauley has special expertise in the design of epidemiological investigations of environmental hazards and is nationally recognized for her expertise in occupational and environmental health nursing. Her work aims to identify culturally appropriate interventions to decrease the impact of environmental and occupational health hazards in vulnerable populations, including workers and young children. Dr. McCauley was previously the associate dean for research and the Nightingale Professor in Nursing at the University of Pennsylvania School of Nursing. She received a bachelor of nursing degree from the University of North Carolina, a master's in nursing from Emory, and a Ph.D. in environmental health and epidemiology from the University of Cincinnati. She became a member of the Institute of Medicine in 2008 and previously served on the committees for Update 2006 and Update 2008 in the Veterans and Agent Orange series.

Kenneth Olden, Ph.D., Sc.D., L.H.D. *(planning committee member)* was recently appointed founding dean of the School of Public Health at the City University of New York. He is former director of the National Institute of Environmental Health Sciences (NIEHS) and director of the

National Toxicology Program (NTP). He was the first African American to become director of 1 of the 18 institutes of the National Institutes of Health during the history of the agency. Before going to NIEHS, he was director of the Howard University Cancer Center and professor and chairman of the Department of Oncology at Howard University Medical School, Washington, DC. He joined Howard in 1979 as associate director for research after a stint at the National Institutes of Health, first as a senior staff fellow, then expert, then research biologist in the Division of Cancer Biology and Diagnosis at the National Cancer Institute. Dr. Olden is the recipient of numerous awards, including the City of Medicine Award and an inaugural award for public policy leadership in protecting health and the environment by the National Association of Physicians for the Environment. He earned his bachelor's degree in biology from Knoxville College, his master's degree at the University of Michigan, and his doctoral degree from Temple University, with research done at the University of Rochester. He is a member of the Institute of Medicine.

Howard J. Osofsky, M.D., Ph.D. is the Kathleen and John Bricker Chair of the Department of Psychiatry at Louisiana State University Health Sciences Center (LSUHSC). Under his leadership, LSUHSC's Department of Psychiatry has expanded services for the underserved in New Orleans. He has played an important role in developing community psychosocial preparedness programs for first responders and mental health professionals to improve responses following disaster and terrorism. He is co-director of the Louisiana Rural Trauma Services Center (LRTSC), part of the National Child Traumatic Stress Network. In the aftermath of Hurricane Katrina, Dr. Osofsky was asked to be clinical director for Louisiana Spirit, the Department of Health and Hospital's Crisis Counseling Program under the Stafford Disaster Act. At the request of the mayor of New Orleans, he led services for first responders and their families and worked with reopening schools in devastated parishes. He has consulted and provided training in New York following 9/11, in China and Taiwan following earthquakes and typhoons, and in Chile following the recent earthquake. In 2010, he received the Humanitarian Award from the Society of Biological Psychiatry, the Distinguished Public Service Award from New York-Presbyterian Hospital and the Departments of Psychiatry at Columbia University College of Physicians and Surgeons and Weill Cornell Medical Colleges, and a Presidential

Commendation at the Distinguished Fellows Convocation at the Annual Meeting of the American Psychiatric Association.

Edward Overton, Ph.D. is currently a professor emeritus in the Department of Environmental Sciences, School of the Coast and Environment at Louisiana State University in Baton Rouge. Until his retirement in May 2009, he was the Clairborne Professor of Environmental Toxicology and Air Quality, and he is the founder and chairman of the Board of Analytical Specialists Inc., a technology start-up company commercializing Overton's invention of a small, fast, portable Gas Chromatography instrument. Dr. Overton was the lead chemist for National Oceanic and Atmospheric Administration's Hazardous Materials Response Division for more than 25 years, providing chemical hazard assessments for oil and hazardous chemical spills in all marine areas under U.S. jurisdiction. His expertise includes the detection and fates and effects of petroleum hydrocarbons in the environment.

Lawrence Palinkas, Ph.D. is the Albert G. and Frances Lomas Feldman Professor of Social Policy and Health in the School of Social Work at the University of Southern California (USC). He also holds appointments in the Departments of Anthropology and Preventive Medicine at USC and is an adjunct professor of medicine and family and preventive medicine at the University of California, San Diego. A medical anthropologist, his research interests focus on implementation science, community-based participatory research, the sociocultural and environ-mental determinants of health and health-related behavior, and health disparities. His current research encompasses mental, immigrant, and global health and includes studies of the mental health needs of individuals in extreme and unusual environments and communities impacted by manmade disasters; cultural explanatory models of mental illness and service utilization; evaluation of academic–community research practice partnerships; and the implementation of evidence-based practices for delivery of mental health services. He has served as deputy chief officer of the Life Sciences Standing Scientific Committee on Antarctic Research in 2002; chair of the National Space Biomedical Research Institute's External Advisory Council in 2003; and as a committee member for the National Academies. He is the recipient of the Antarctic Service Medal by the National Science Foundation and the U.S. Navy. Dr. Palinkas is also an elected fellow of the American Anthropological Association and Society for Applied Anthropology.

Irwin Redlener, M.D. is professor of clinical population and family health and director of the National Center for Disaster Preparedness at Columbia University, and he is 1 of 10 members of the congressionally established National Commission on Children and Disasters. Dr. Redlener speaks and writes extensively on national disaster preparedness policies, pandemic influenza, the threat of terrorism in the United States, and related issues. Dr. Redlener is also president and cofounder of the Children's Health Fund and has expertise in health care systems, crisis response, and public policy with respect to access to health care for under-served populations. Dr. Redlener, a pediatrician, has worked extensively in the Gulf region following Hurricane Katrina, where he helped establish ongoing medical and public health programs. He also organized medical response teams in the immediate aftermath of the World Trade Center attacks on 9/11 and has had disaster management leadership experience internationally and nationally. He is the author of *Americans at Risk: Why We Are Not Prepared for Megadisasters and What We Can Do Now*, published in August 2006 by Alfred A. Knopf, Inc.

Linda Rosenstock, M.D., M.P.H. *(planning committee member)* is currently dean of the UCLA School of Public Health. Prior to this position, she served as director of the National Institute for Occupational Safety and Health (NIOSH), where she was instrumental in creating a framework for guiding occupational safety and health research. This agenda was developed in collaboration with 500 external partners. Dr. Rosenstock has been active internationally in teaching and research in occupational and environmental health and has served as an advisor to the World Health Organization. She has expertise in occupational and environmental medicine health care delivery as well as in the role of federal government in health sciences research and policy. She is a recipient of the Presidential Distinguished Executive Rank Award and was elected to the IOM in 1995.

Nalini Sathiakumar, M.D., Dr.P.H. is associate director of the Sparkman Center for Global Health and associate professor of epidemiology at the School of Public Health, University of Alabama at Birmingham (UAB). Her area of research includes environmental and occupational epidemiology, and her work spans South Asia and the United States. She is the principal investigator of the UAB-South Asia International Training and Research in Environmental and Occupational Health (ITREOH)

now in its ninth year of funding from the NIH-Fogarty International Center. Partnering with three premier institutions in Pakistan, India, and Sri Lanka for the ITREOH, Dr. Sathiakumar's research centers on air pollution (indoor and outdoor), heavy metals, and pesticides with a special focus on the adverse health effects in pregnant mothers and young children. She has also investigated the acute effects of the oil spill from the Greek supertanker, the *Tasman Spirit*, which ran aground in Karachi, Pakistan. Besides research, she has developed curriculum and initiated the M.P.H. program in applied epidemiology in two of the three international institutions. In the United States, Dr. Sathiakumar's research has mainly focused on occupational health. Her research includes follow-up studies of workers in the synthetic rubber, petroleum, chemical, plastics, semiconductor, and pesticide manufacturing industries. Dr. Sathiakumar has a fellowship in pediatric medicine and a doctoral degree in epidemiology with a specialization in environmental and occupational health. She is the recipient of the President's Award for Excellence in Teaching and a UN-USA Birmingham Chapter award for outstanding public health service.

David A. Savitz, Ph.D. *(planning committee member)* is the Charles W. Bluhdorn Professor of Community and Preventive Medicine and director of epidemiology, biostatistics, and disease prevention at Mount Sinai School of Medicine. He was assistant professor in the Department of Preventive Medicine and Biometrics at the University of Colorado School of Medicine and moved to the University of North Carolina School of Public Health in 1985. He served as the Carey C. Boshamer Distinguished Professor and chair of the Department of Epidemiology until the end of 2005. His teaching is focused on epidemiologic methods, and he recently authored a book titled *Interpreting Epidemiologic Evidence*. He directed 29 doctoral dissertations at the University of North Carolina and 13 master's theses. He has served as editor at the *American Journal of Epidemiology* and as a member of the Epidemiology and Disease Control-1 study section of the National Institutes of Health and currently is an editor at *Epidemiology*. He was president of the Society for Epidemiologic Research and the Society for Pediatric and Perinatal Epidemiologic Research and North American regional councilor for the International Epidemiological Association. His primary research activities and interests are in reproductive, environmental, and cancer epidemiology. Dr. Savitz received his undergraduate training in psychology at Brandeis University, a master's in preventive medicine at Ohio State

University in 1978, and Ph.D. in epidemiology from the University of Pittsburgh Graduate School of Public Health in 1982.

Peter S. Spencer, Ph.D., FRCPath. is professor of neurology in the Oregon Health & Science University (OHSU) School of Medicine, a senior scientist in the OHSU Center for Research on Occupational and Environmental Toxicology (CROET), and founding director of the OHSU Global Health Center. Previously, Dr. Spencer was a professor of neuroscience, neurology, and pathology-neuropathology, and the director of New York's Albert Einstein College of Medicine (AECM) Institute of Neurotoxicology. He moved to Portland to found the CROET, an OHSU research institute that he directed for 21 years. Dr. Spencer has served on the Science Advisory Board, National Center for Toxicological Research; on the National Advisory Environmental Health Science Council; and on boards and committees of the National Research Council and Institute of Medicine. At OHSU, he has led federally funded research initiatives addressing the response of the nervous system to chemical exposures, including the Portland Environmental Hazards Research Center, a Superfund Basic Research Center, and a Child Health and Neurotoxicogenomics Research Center. His body of research on the etiology and pathogenesis of human neurological disease, including a focus on the neurotoxicology of petroleum chemicals, has received national and international recognition. He is presently collaborating with the Chinese Centers for Disease Control and Prevention in a joint effort to seek the genetic basis of an individual's susceptibility to occupational hydrocarbon solvent neurotoxicity. An experienced neurotoxicologist, Dr. Spencer received his baccalaureate and doctoral degrees from the University of London and underwent postdoctoral training at Albert Einstein College of Medicine, where he was named Joseph P. Kennedy, Jr. Fellow in the Neurosciences.

Mathy V. Stanislaus, J.D. is the assistant administrator for the EPA's Office of Solid Waste and Emergency Response. Mr. Stanislaus is responsible for the EPA's programs on hazardous and solid waste management, hazardous waste clean-up including corrective action, under the Resource Conservation and Recovery Act, Superfund and federal facilities clean-up and redevelopment, Brownfields, oil spill prevention and response, chemical accident prevention and preparedness, underground storage tanks, and emergency response. Prior to assuming his current position, Mr. Stanislaus cofounded and codirected the New

Partners for Community Revitalization, a New York not-for-profit organization whose mission is to advance the renewal of New York's low- and moderate-income neighborhoods and communities of color through the redevelopment of Brownfields sites. Mr. Stanislaus has also been an advisor to other federal government agencies, Congress, and the United Nations on a variety of environmental issues.

Ana M. Viamonte Ros, M.D., M.P.H. is Florida's first state surgeon general and the first woman and Cuban American to serve as head of the department. She is charged to act as the state's leading advocate for wellness and disease prevention. Dr. Viamonte Ros is a member of several health advisory groups focused on the health of Florida's children, including the Governor's Council on Physical Fitness, the Governor's Task Force on Autism Spectrum Disorders, and the Children and Youth Cabinet. Dr. Viamonte Ros came to the Department of Health from Armor Correctional Health Services, where she oversaw the clinical operations of Florida's eight largest jail systems, as well as three correctional facilities in Virginia. She has also volunteered with programs such as the Camillus House Homeless Initiative in Miami, the Health through Walls Organization in the Caribbean, and the Brookside Community Health Center in Massachusetts. Throughout her entire career, she has been a strong advocate for disadvantaged individuals and minority communities. In 1983, the surgeon general earned her M.D. from the University of Miami School of Medicine, graduating with several awards and honors. In 2005, Dr. Viamonte Ros received her master's of public health from the Harvard School of Public Health.

LuAnn E. White, Ph.D., D.A.B.T. is the director of the Tulane Center for Applied Environmental Public Health (CAEPH) at Tulane School of Public Health and Tropical Medicine. She is a toxicologist and professor in the Department of Environmental Health. She directs the Academic Partners of Excellence for the Environmental Public Health Tracking (EPHT) Network funded by the CDC. She also directs the New Orleans Study Center for the NIH National Children's Study. Dr. White's research focuses on environmental factors that impact children's health, particularly childhood lead poisoning and environmental triggers of asthma. She also studies other vulnerable populations including the elderly affected by Hurricane Katrina. She also works on several studies with the EPHT network on the impact of air pollutants on respiratory and cardiovascular diseases. Dr. White has been a leader in developing mod-

els for environmental health training and education programs. She initiated the first master's degree programs in environmental and occupational health using distance learning technologies in 1994. Currently, CAEPH offers four master's degree programs by distance learning to build capacity among environmental and occupational health professionals. Dr. White received her Ph.D. and completed a NIH postdoctoral fellowship at Tulane University School of Medicine in New Orleans, Louisiana.

Donald E. Williamson, M.D. was appointed state health officer and director of the Alabama Department of Public Health in 1992 after serving as director of the Bureau of Preventive Health Services from 1988 to 1992. Prior to that, he was director of the Division of Disease Control. Before joining the Alabama Department of Public Health, Dr. Williamson served as state tuberculosis control officer at the Mississippi State Department of Health. Dr. Williamson has been the recipient of a number of awards, including the 2009 Wallace Alexander Clyde Award from Children's Hospital, the 2000 Arthur T. McCormack Award from the Association of State and Territorial Health Officials for dedication and excellence in public health, and the 1999 Child Health Advocate Award from the American Academy of Pediatrics. On a national level, Dr. Williamson serves on the Region IV Federal Emergency Management Agency (FEMA) Advisory Council. He served on the Executive Committee of the Association of State and Territorial Health Officials and was president of the association from 1997 to 1998. He served as a member of the National Vaccine Advisory Committee, the Board of Directors of the Public Health Foundation, and the Steering Committee on Access for the Uninsured of the National Academy for State Health Policy. Dr. Williamson received his medical degree, cum laude, from the University of Mississippi School of Medicine in 1979. He completed a residency in internal medicine at the University of Virginia Hospital in 1982 and is board certified in that specialty.