REPORT OF THE COUNCIL ON SCIENCE AND PUBLIC HEALTH

CSAPH Report 5-A-13

Subject: Health Effects of the Gulf Oil Spill

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Referred to: Reference Committee D
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INTRODUCTION

At the 2010 Interim Meeting, the Council on Science and Public Health developed a brief report on contemporary views regarding health risks associated with the Gulf oil spill and summarized relevant activities of the American Medical Association.[1] Policy D-135.980, "Gulf Oil Spill Health Risks: Update on AMA Involvement," directs the Council to report back at the 2013 Annual Meeting on the results of studies examining the health effects of the Gulf oil spill.

METHODS

English-language reports were selected from a PubMed search of the literature from April 2010 to March 2013 using the search terms, "gulf oil spill," "deepwater horizon," and "macondo," alone and combined with "health," or "health effects." Additional studies and resources were identified from the reference list of materials reviewed. Additionally, relevant webpages of the U.S. Environmental Protection Agency (EPA), Food and Drug Administration (FDA), Gulf of Mexico Research Initiative, and National Resource Damage Assessment (NRDA) were consulted for information.

BACKGROUND

The Deepwater Horizon disaster began on April 20, 2010 with a blowout of British Petroleum (BP) Exploration and Production Inc.'s Macondo well located ~1500 m deep and 84 km from Venice, Louisiana, continuing until the well was successfully capped 87 days later. This spill was unique in its magnitude, duration, location (deep sea floor) and how it was managed, including the use of subsurface dispersants and controlled surface burns.[2]

OIL SPILL DYNAMICS

Human and ecological effects of the oil spill are directly related to rate and the quantity of oil and gas/hydrocarbon mixture released and dispersants that were used. The oil flow rate was eventually estimated at ~50,000-70,000 barrels per day, modestly decreasing over the duration of the spill for a total of almost 5 million barrels (or > 200 million gallons).[3] When an oil spill occurs underwater, plumes of oil droplets are formed that drift toward the ocean's surface. Surface slicks undergo "weathering" through various processes including evaporation, emulsification, dispersion, dissolution, sinking/sedimentation, biodegradation (microbial), and photo-oxidation.

Action of the AMA House of Delegates 2013 Annual Meeting: Recommendations in Report 5 of the Council on Science and Public Health Recommendations Adopted as Amended, and Remainder of Report filed.

Approximately 25% of the oil was removed or recovered via direct recapture from the riser pipe, burning, or skimming, primarily in offshore waters north of the wellhead.[4] Because of the characteristics of the Macondo oil (i.e., relatively light crude, enriched in low molecular weight compounds) and physical extremes of pressure and temperature at the well head, a substantial portion of the oil (23%) was physically dispersed/dissolved or evaporated on reaching the surface. Additionally, approximately 16% was chemically dispersed and 13% was degraded/consumed by bacteria. Little or no methane gas reached the ocean surface.[5] The remainder of the oil (~23%) is unaccounted for. This category includes tar balls, and oil on beaches or in shallow subsurface mats and deep sea sediments.[3]

A significant portion of the oil that was dispersed (chemically and naturally) was consumed by bacteria that had evolved in deep Gulf waters where oil seeps are common.[6] In the initial stages of May and June 2010, microbial community composition in the plume waters expanded and was highly enriched with previously uncharacterized oil-eating microbes capable of hydrocarbon and alkane degradation.[7] Beds of microbial proliferation, oil consumption, bacterial secretions and subsequent death of microorganisms and/or plankton created dense accumulations ("marine snow") comprising oily particulate matter and creating ocean floor sediment that may be several inches thick.[8] By August 2010, oil had dissipated to background levels offshore, but grounded oil remained in both deepwater and many shallow coastal areas around oiled marshes and near some beaches, potentially affecting some deep coral communities, shore birds, oysters, and sea turtles in particular.[2,9,10]

Use of Dispersants

Dispersants are a mix of solvents, surfactants, and additives used to facilitate the breakup of oil into tiny droplets that are more easily broken down by natural processes. Approximately 1.8 million gallons of dispersant (primarily Corexit® 9500) were applied during the Deepwater Horizon incident. More than 40% of this volume was applied directly at the wellhead more than 5,000 feet below the ocean's surface, a technique that had not been used before. This use was intended to promote more rapid degradation of hydrocarbons, eventually doubling the amount of chemically-dispersed oil from approximately 8% to 16%. An unknown portion of the dispersant remained associated with the oil and gas phases of the underwater plume, apparently undergoing only negligible or slow rates of biodegradation.[11]

The material data safety sheet for Corexit® 9500 identifies light petroleum distillates (10-30%), propylene glycol (1-5%) and organic sulfonic acid salt (10-30%) as hazardous substances.[12] The proprietary sulfonic acid derivative was later identified as dioctyl sodium sulfosuccinate, a commonly used stool softener for human use. Most water and sediment samples from near shore and offshore that were tested for major dispersant constituents did not exceed EPA's benchmark threshold for aquatic safety.[13,14] Although the toxicity of crude oil alone was comparable to the toxicity of oil-dispersant mixtures in limited aquatic species testing,[15] the long term implications and toxicity of dispersant-oil mixtures on myriad ocean species are largely unknown. Additional information is needed to better understand the risks of widespread dispersant use, especially subsurface application. See the Government Accountability Office report on oil dispersants for more discussion on the potential toxicity of oil dispersants and contemporary issues surrounding their use.[16]

SEAFOOD SAFETY

In recent years approximately 20% of the commercial seafood caught in U.S. waters came from the Gulf of Mexico.[17] During an oil spill, the National Oceanic and Aeronautic Administration (NOAA) has authority to close (and with the concurrence of the FDA, open) federal fishing waters (3-200 miles offshore), while states regulate fisheries in their costal waters (0-3 miles offshore). Of greatest concern from the crude oil spill was exposure to higher molecular weight polycyclic aromatic hydrocarbons (PAH) and perhaps certain dispersant constituents. This concern was based on the capacity of these substances for environmental persistence, bioactivity and/or human toxicity. PAHs can potentially cause skin and lung cancer and are reproductive and developmental toxins. Susceptibility of marine life to potential harmful effects is influenced by differential rates of metabolism and disposition of PAHs. Finfish are least susceptible due to their high capacity to eliminate PAHs. Crustaceans are somewhat intermediate in their metabolic efficiency, while oysters have only a very limited ability to eliminate PAHs and thus are most susceptible to accumulation and toxicity.[18]

At its peak, more than one-third of federal waters were closed to fishing, as were most state waters extending from Louisiana to the panhandle of Florida. Reopening of federal waters required an oil free period of 30 days and repeated tests on different types of seafood sampled over multiple days based on a unified protocol involving sensory (smell) testing coupled with chemical analysis of 13 different PAHs and their alkylated homologs.[19] The FDA estimated allowable thresholds (levels of concern or LOC) for PAHs intended to be protective of vulnerable populations. The risk assessment criteria differed for individual PAHs; some were based on a 5 year exposure for carcinogenic endpoints; others were based on a lifetime exposure estimate (noncarcinogenic endpoint). Sensory and chemical methods applied to >8,000 seafood specimens collected in federal waters of the Gulf found only low concentrations of PAHs, at least two orders of magnitude below levels of concern for human health based on the derived LOCs.[20] The assumptions used to create the FDA model have been criticized as not sufficiently protective of vulnerable populations (see Rotkin-Ellman et al).[21] Ultimately, by April 2011 all federal fishing waters were reopened. It is generally believed that these measures prevented oil-contaminated seafood from reaching the market.[22] Catastrophic losses of finfish populations in direct response to the oil spill itself were not observed.[23]

HUMAN HEALTH EFFECTS

Human health effects can be divided into those caused by chemical exposures and mental health consequences. Exposed populations include more than 100,000 workers employed during the clean up phase and community members with potential chemical exposures. Exposure routes include inhalation, dermal contact, ingestion of contaminated food or water, and contact with beach and soil residues.

Workers with Chemical Exposures

Worker exposure varied based on job assignment, training, and whether protective equipment was used effectively. Exposures were both offshore (booming and skimming; aerial and vessel dispersant release; in situ surface burning; containment and recovery work at the oil source) and onshore (beach and wildlife cleanup operations, decontamination and waste management activities). The National Institute of Occupational Safety and Health (NIOSH) catalogued a number of reported symptoms in workers including headaches, faintness, dizziness, or weakness, eye, nose, and throat irritation, lower respiratory symptoms, nausea and vomiting, and skin symptoms (itchy or red skin, or rash). Air sampling around off shore activities were unremarkable, and reported symptoms were considerably more prevalent in onshore work environments. For a summary of these findings see the final NIOSH health hazard evaluation summary report.[24] Exposure and health symptoms data[25] and additional analysis of injury and survey data also are available.[26]

These findings apply only to acute exposures during the clean up phase. In order to examine potential long-term effects of exposure in clean-up workers and volunteers, the National Institute of Environmental Health Sciences (NIEHS) launched the GuLF STUDY (Gulf Long-term Follow-up Study) in February 2011. The study, which is enrolling up to 55,000 individuals, is expected to take 10 years and will be linked with various exposure scenarios based on area, job or task, date, geographic location and degree of exposure to weathered oil. The lapse in time between the start of the study and the activities of the response workers limits the use of comparative biologic markers of exposure and also may adversely affect recall accuracy.[27] Little evidence exists to support a significant effect of chemical exposure from the oil spill on the general health of community residents.[27]

Mental Health

Previous oil spills and disasters have shown that affected populations experience mental health effects that can be widespread and significant.[28,29] Evaluating mental health consequences of the Gulf oil spill is complicated by the fact that many areas were still recovering from Hurricane Katrina and coastal populations included those already suffering from a higher incidence of health disparities and poor health indices.[27]

In the first several months after the spill, one-third of inhabitants of Gulf coast counties suffered loss of income coupled with rates of depression, anxiety, and negative quality of life indicators that exceeded baseline levels.[30] Such responses were significantly correlated with loss of income.[31] A cross-sectional survey of more than 2500 Gulf coast residents revealed they were more likely than inland residents to score worse on the Emotional Health Index and to report a clinical diagnosis of depression.[32] A follow-up survey two years later indicated that residents of Gulf coast-facing counties were 31% more likely to report having ever been diagnosed with depression in the first four months of 2012 than they were in the same time period before the oil spill, although some improvements were noted in general reports of stress, worry, and sadness.[33] Finally, nearly 20% of parents reported that a child in the family had experienced emotional or behavioral problems following the oil spill that were not previously existent.[34] Further information will be forthcoming from the Women and their Children's Health (WATCH) Study. WATCH is a prospective cohort study of the physical, mental and community health effects resulting from the spill and its aftermath among women and their children in seven coastal Louisiana parishes closest to the oil spill.

ECOLOGICAL EFFECTS

Wide-ranging areas of the Gulf of Mexico were contaminated with oil including deep sea communities and ~1600 kilometers of shoreline. Multiple species of marine life and birds were affected. In addition to EPA dispersant testing, several large scale field efforts were performed including subsea plume and post spill assessments, shoreline and wildlife oiling impact assessments, and assessments of near coastal areas and estuaries (see Barron for review).[35] Accordingly, hydrocarbon footprints in near shore coastal sediments and salt marshes have been characterized, and the direct effects of oil and dispersants on microbial and insect communities, vegetation, and various aquatic species have been examined (see Symposium for review).[36] Potential effects of the oil spill on food webs and lower trophic ecosystems of the open ocean also have received attention.[36] The relationship of myriad *in vitro* experiments indicating potential harmful effects to real world phenomena remain uncertain but reinforce the need for continued vigilance.

COMMENT

Environmental, aquatic and coastal habitats, human health, social, and economic impacts are still being documented and evaluated as part of the Natural Resource Damage Assessment (NRDA)[37] and the Gulf Long Term Follow-up Study of the NIEHS. The NRDA is overseen by trustees from the states of Texas, Louisiana, Mississippi, Alabama, and Florida, the Department of the Interior and the Department of Commerce. It will continue to assess damage to natural resources and the public's access and use of those resources for many years and will also design and implement restoration projects. Findings also will continue to emerge from the Gulf of Mexico Research Initiative, a nonprofit organization that is disbursing $500 million donated by BP to scientists over 10 years. These peer-reviewed grants cover a wide range of topics including public health effects of the oil spill. The first interdisciplinary conference was held in January 2013.[36] Uncertainty remains about the potential for bioaccumulation of harmful residues. Accordingly, the overall impact of the Deepwater Horizon oil spill including human health effects, remains to be determined, but resources and mechanisms are in place to conduct long term assessments and remediation efforts.

RECOMMENDATIONS

The Council on Science and Public Health recommends that the following statements be adopted and the remainder of the report be filed.

1. That Policy D-135.980, "Gulf Oil Spill Health Risks: Update on AMA Involvement" be amended to read as follows.

   Our AMA will encourage the National Institute of Environmental Health Sciences and the Natural Resource Damage Assessment program to: (1) continue to monitor health effects (including mental health effects) and public health surveillance activities related to the Gulf oil spill, and provide relevant information and resources as they become available; and (2) monitor ~~report back at the 2013 Annual Meeting on~~ the results of studies examining the health effects of the Gulf oil spill, and provide. (Modify Current HOD Policy)

2. That Policy D-135.980 be renamed as follows:

   Gulf Oil Spill Health Risks and Effects (Modify Current HOD Policy)

Fiscal note: Less than $500

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