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Tasman Spirit Oil Spill in Pakistan – Research Response and Lessons Learned

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Abstract

Background—This paper presents lessons learned from an investigation of the acute human health effects of the “Tasman Spirit' oil spill from a perspective of conducting rapid response investigations in developing countries.

Methods—We reviewed various steps in our investigation, other studies on oil spills in Pakistan and around the world, and reflected upon our discussions and interactions with various stakeholders.

Results—The paper highlights the importance of applying a public health, legal, and ethical framework for conducting rapid response investigations, developing a pre-established funding mechanism, and addressing study design issues, exposure and outcome measurements, political issues, community engagement, and communication of results.

Conclusion—There is need to develop ethical and legal framework and funding mechanism for conducting rapid response research in developing countries. A repository of study protocols, validated tools, and laboratory methods for exposure and outcome assessment would be greatly beneficial.

Keywords

Tasman Spirit; Oil Spill; Rapid Response Research; Developing Countries; Lessons Learned; Pakistan

INTRODUCTION

In recent years, large scale environmental disasters, both natural and man-made have highlighted the importance of resulting widespread human health consequences. However, these disasters have also brought to the forefront the limited capacity and challenges in evaluating immediate and long-term health consequences of such disasters. Health impact

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evaluation capacity is further constrained in developing countries. In this paper, we highlight the challenges of conducting an epidemiologic investigation of an environmental disaster in a developing country in context of an oil spill and summarize the lessons learned during the planning and execution of the study. We draw upon our experience of assessing the health effects of an oil spill in Karachi in 2003 [Janjua, et al. 2006]. It is one of most recent studies of an oil spill and the only one from a developing country. Also, it is one of the few epidemiologic studies conducted on an oil spill to date. Of 38 supertanker oil spills worldwide, human health effects were examined only in seven studies[Janjua, et al. 2006, Campbell, et al. 1993, Lyons, et al. 1999, Morita, et al. 1999, Palinkas, et al. 1993, Sim, et al. 2010, Suarez, et al. 2005]. Health effects of other major environmental disasters such as the Bhopal gas tragedy andChernobyl nuclear disaster are discussed elsewhere [Dhara and Dhara 2002, Mishra, et al. 2009].

STUDY BACKGROUND

On 27th July 2003, the Greek tanker, `Tasman Spirit,' carrying 67,000 tons of Iranian light crude oil from Iran to Pakistan, ran aground before entering the harbor channel at the Karachi port, Pakistan. About two weeks later, on the night between 13th and 14th of August 2003, the tanker split apart and released its cargo into the sea. Strong winds and rough sea facilitated the spread of oil to about 10 km of residential coastline. Two more outpourings of oil followed, the last occurring on the 29th of August 2003, resulting in a total spill of more than 35000 tons of crude oil. Most of the affected shoreline was a highly populated upscale residential and recreational area with few low income neighborhoods. Residents in this area included high ranking retired army officers, rich businessmen and high income professionals.

Chemical analysis of the Iranian light crude oil carried by the Tasman Spirit found that it contained a high quantity of aromatic hydrocarbons (personal communication, Lutfi SA), which included a high quantity of sulfur (1.35% by weight), 14% light naphtha, 20% heavy naphtha and 4% gasoline; it had a pour point of −29°C. Analyses of seawater and soil at various intervals after the spill found a large quantity of hydrocarbons in the water and soil [Ahsan, et al. 2011, Siddiqi, et al. 2009]. To address the concerns regarding potential health effects, we undertook an epidemiologic investigation to determine if exposure to the oil spill had resulted in increased acute ill health among the exposed resident population [Janjua, et al. 2006]. The study began on September 1, 2003, three weeks after the first spill and three days after the last spill.

A previous publication describes the study in detail [Janjua, et al. 2006]. In brief, we conducted a cross-sectional study comparing an exposed resident population (n=216) living in houses on the affected shoreline and two control groups (A (n=83) and B (n=101)) at 2 km and 20 km away from the sea. Systematic sampling was used to select households and interview adult male and female in each. Data were collected on respiratory, ocular, nervous system health effects including history of smoking and allergies. Subjects in the exposed area reported a higher occurrence of symptoms involving eyes, throat, skin, headaches and general malaise than areas away from the beach. There was a clear pattern of decreasing symptoms with increasing distance from the incident site. We computed a summary symptom score by assigning a score of “1” if a symptom was present and “0” otherwise “0” and by summing 48 different symptoms. The mean summary symptom score (14.5) in the exposed group was higher compared to control groups A (4.5) and B (3.5). Multivariable linear regression indicated a strong relationship between exposure groups and symptom score. Comparison between the proportion of each self-reported symptom among the exposed and the control groups indicated that they were highest for the exposed group located closest to the spill, followed by control group A and then by control group B.

Symptom-specific prevalence odds ratios showed a decreasing trend with increase in distance from the spill area.

CHALLENGES AND LESSONS LEARNED

The critical challenges that we encountered in our research response to the Tasman Spirit oil spill were logistical, scientific and political. Some of these challenges affected all aspects of the research response, while others had an impact on a specific component.

a. Logistical Challenges

Public health research legal framework—The laws and associated regulations in Pakistan do not appear to be fully developed to enable public health authorities and academic institutions to conduct rapid research investigations in response to an environmental disaster, in this case the response to the oil spill. The Pakistan Environmental Protection Agency (EPA) had the authority to conduct investigations but lacked infrastructure and resources to do so. We conducted the study with approval from the Sindh Environmental Protection Agency (SEPA), the provincial branch of the EPA located in the province of Sindh where the oil spill occurred.

Lesson learned: An important aspect of rapid response evaluations are studies on population health conducted under the statutory authority of government (i.e., legally mandated public health investigations). In developed countries (e.g., United States, Canada and Europe) and in some developing countries, this type of legislative support exists where public health authorities conduct investigations or collaborate and/or delegate work to academic researchers. In countries that do not have such a framework, the line of authority becomes unclear. Thus, there is a need to develop this aspect of public health response by clearly laying out legislations, regulations and mandates for conduct of public health investigations posing a threat to health of the population. Examples of such laws and regulations include British Columbia Public Health Act (http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_08028_01) and Environmental Management Act (http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/03053_04).

Obtaining ethical approvals—Typically, the usual channels of ethics review and approval takes several weeks to months; our study was conducted with the approval of SEPA, which was relatively expedited.

Lesson learned: Rapid review of research proposals by the relevant ethics boards will facilitate academic researchers in timely conduct of studies of oil spills and other emergencies. Models for rapid review of research proposal exist where IRBs have mechanisms in place to review rapid response research to meet the time demands of the situation. For example, at the University of British Columbia (UBC) faculty members who are also affiliated with provincial public health agencies conduct rapid response research related to infectious diseases and environmental exposures. To facilitate this, the UBC ethics board has developed a mechanism for rapid review of proposals involving time sensitive research needs. During the 2009 A/H1N1 influenza pandemic, a special mechanism was developed for rapid review and approval of research proposals at UBC and also at the national level in Canada[2009]. Discussions with relevant IRBs prior to such submission also help to expedite the review process. Tansey et al further explored and presented a framework for rapid ethics approvals in the context of public health emergencies[Tansey, et al. 2010]. Similar mechanism for rapid review can be developed and IRBs in developing countries can adopt such models.

Permissions from relevant stakeholders to access study participants—In this study, the SEPA arranged for our access into oil spill zone to conduct study. However, access to contact employed workers involved in clean-up operations was restricted, though others were able to conduct studies albeit on very small study sizes [Meo, et al. 2008, Khurshid, et al. 2008].

Lesson learned: In cases of oil spill or other environmental disasters, access to study participants (general population and workers) may be controlled by local administration, response agencies or contractors. Although recruitment would be context specific, a framework to layout permission processes that could expedite actual conduct of studies should be in place. Such a framework would require the involvement of the all stakeholders, including community groups. This is especially important for studies of health effects on workers who might be exposed to higher levels of pollutants for prolonged periods. Community engagement beginning in the study planning phase is crucial to inform the study design, would facilitate access to potential study participants and would also engage them in the research execution process incorporating their concerns.

Mobilizing funds to conduct the study—We found that access to funds was a major problem. We approached various likely contenders including the Defense Housing Authority (DHA, the civic agency responsible for the area), United Nation Environment Protection (UNEP) and the government with our proposal and budget. The government along with other agencies constituted a committee to fund and conduct an assessment of the environmental impact of oil spill. Initially, the terms of reference included human health impact, but at the time of execution, the funds were allocated to assessment of impact on marine life and the ecosystem[2003].

Furthermore, decisions about funding for environmental assessments were made several few weeks after the oil spill. Therefore, we assembled a team of volunteer medical students who helped in the translation of the questionnaire, the interviewing of study subjects and data entry. Logistic support such as local transport was provided by the Aga Khan University. The University of Alabama at Birmingham-International Training in Environment and Occupational Health (ITREOH) provided training to investigators that helped in the study design, execution and publication of results.

Lesson learned: It appears that in the immediate response to an environmental crisis such as an oil spill, the environment and ecosystem receive precedence over human health. Thus, a pre-established funding mechanism is essential to fund timely conduct of rapid response research to evaluate human health impacts. It may be accomplished at the national level by governments and/or by international entities such as the IUCN or the UNEP. Mechanisms include the requirement for industry to contribute to a fund under government control or independent trust. The fund can provide funding for research related to environmental exposures and also provide money for rapid response research during disasters.

Security of project staff—Our study was conducted in a densely populated urban upper middle socioeconomic status (SES) setting, where security was not a problem. However, our past experiences from other studies in rural areas or urban low SES settings suggest that security may be an issue in a rapid response situation.

Lesson learned: Liaising with local administration as part of the permission process helps in assessing and planning local security needs. In addition, involving community leaders in the planning process helps to mitigate security-related issues and in addition, improve access to study participants.

b. Scientific Challenges

Optimal study design—We used a cross-sectional study design. Since information was based on questionnaires administered at one point in time, there was a likelihood of symptoms being present before the spill occurred, a problem inherent to the study design. However, we addressed this limitation by attempting to determine the occurrence of symptoms related to the specific date of incident. The short recall and correlation of symptoms with a specific exposure facilitated the accuracy of the information. However, we were not able to follow-up study subjects. This would have provided useful data on medium- and long-term health effects as well as persistence and validation of short-term health effects. Few previous studies of cleanup workers suggest the occurrence of chronic effects mainly pertaining to respiratory dysfunction (reduced lung functions) and chromosomal abnormalities as potential long-term health effects [Rodriguez-Trigo, et al. 2010, Perez-Cadahia, et al. 2008, Perez-Cadahia, et al. 2008, Zock, et al. 2007].Natural disasters including oil spill also impact psychosocial well-being and could lead to post traumatic stress disorder.

Lesson learned: Studies of acute health effects will be limited by the problem of temporality. This may be addressed by conducting a baseline health assessment early in the disaster and then conducing follow-up measurements. However, early assessments soon after disasters might be difficult to conduct given that some lead time is required for development of tools, approval processes and mobilization of resources.

Optimally, a study cohort should be established which would allow an assessment of short-, medium- and long-term health effects. Inclusion of objective measurements such as the inclusion of biological markers of exposure (metabolites) and of outcomes (e.g., chromosomal abnormalities) will enhance the scientific rigor of such studies. Studies should also include baseline and follow-up assessment of psychosocial well-being of the affected population. Issue of adequate sample size and power would depend in size and population exposed, but where possible, efforts should be made to adequately power the study to assess health effects.

Exposure assessment—We used a surrogate measure of exposure, namely three different geographic locations to represent distance from the source of exposure to assign three levels of exposure. Biomonitoring and/or environmental levels of pollutants would have provided a more accurate assessment of exposure.

Lesson learned: Studies in developing countries seldom involve robust exposure measurement. Where possible, studies should incorporate a range of exposure measurement techniques including questionnaires (tasks/activities, duration etc), pollutant level measurements (personal and area) and geo-location. Biological measurements will help validate other exposure assessment methods. Comprehensive exposure assessment will allow the construction of exposure indices and the assessment of dose-response relationship. In addition to crude oil, exposure assessment should include assessment of exposure to dispersants and by-products of controlled burns.

In addition, data on exposures (e.g., extent of spill; air monitoring before and after the spill) may be collected by various stakeholders, including environmental protection and industry. Efforts should be made to make use of such data to develop a comprehensive understanding of exposure. For clean-up workers, very often exposure information may be collected only after the work has been completed. In such situations, detailed job exposure matrices would be useful.

Validated tools—Oil spills and other environmental disasters have been reported to increase anxiety, distress and depression among the exposed population. We used items from questionnaires used in previous studies of oil spill to assess acute health effect. We also developed our questions to assess perception of oil spill impact on daily life as well as to assess anxiety. .

Lessons learned: Future studies would benefit from a repository of validated tools hosted on an accessible portal to assess exposures, important confounders and health effects of oil spills and other environmental disasters as well as social and psychological effects. Existing portals for other exposure/diseases also provide useful compilation of tools [20,11]. Studies using questionnaire to assess exposure/health outcomes should include a validation component with objective measurements, whenever possible.

Laboratory capacity for biomarkers of exposure—Assessment of metabolites with short half-lives in biological media requires sophisticated collection, storage and laboratory testing capacity in epidemiological investigations. We discussed the possibility of assessment of urinary biomarkers for benzene, toluene and xylene with our local chemistry laboratory, but were not successful, because they lacked the capacity to conduct these tests to meet the needs for an epidemiological study.

Lesson learned: Biomonitoring of urinary or blood metabolites may not be feasible at the local level in many developing countries. Thus, similar to portal for sharing protocols and tools as discussed elsewhere in the paper, there should also be a collaborative network/ listing of scientists and laboratories who would be interested in collaborations with investigators in developing countries. Transitional countries may have some capacity, but may need to work on calibration and other quality assurance procedures to be functional in rapid response situations.

Outcomes—In our study, we only assessed the immediate toxic health effects using self reports. However, as mentioned above, data from other studies suggest that the health effects of oil spills may occur in the long-term as well as in the short-term. Besides physical health, oil spills have been shown to affect the psychosocial and socio-economic well-being of exposed populations. In addition, individuals with certain cultural practices, ethnic background, and socio-economic groups may be more vulnerable than others.

Lesson learned: Studies should incorporate wide range of outcomes, acute (physical and physiological), long-term such as cancers (leukemia, lymphomas etc.), respiratory problems (altered lung functions), anxiety and depression, domestic violence and other evidence of psychosocial and economic disruption. Some long-term effects such as cancer have a long induction period; measurement of markers for genetic and immune alteration may be used as early indicators of long-term health effects. Studies also need to identify populations at high risk of exposure and disease and psychosocial effects and institute immediate mitigation measures. This will also provide important working knowledge for reducing adverse health impacts in future disasters. Studies will benefit from interdisciplinary research teams working together to assess various type of exposures and outcomes.

Funding restriction limits scope of study—Our study size was based on the available time and resources for conducting this investigation rather than statistical considerations. This resulted in a small study size, which resulted in imprecise results. Lack of funds also precluded objective measurements of health outcomes as well as bio-monitoring for crude oil metabolites.

Lesson learned: As highlighted above, pre-established funding mechanism would help conduct adequately powered and scientifically rigorous studies.

Management of seafood safety—Following the oil spill, the sale of seafood in the affected area of Karachi decreased significantly. People refused to buy fish due the oily smell or a general assumption that the fish was tainted. The fishing industry was severely affected in the area. Even though the government conducted ecological and marine impact of the oil spill, the local or the state government authorities did not put out any advisories or risk communication to inform the community about seafood safety.

Lesson learnt: Typically in US and other developed countries, the authority to manage seafood to protect human health resides with state health agencies. If a state concludes that eating contaminated finfish or shellfish collected from state waters poses an unacceptable human health risk, it may issue local fish consumption advisories or harvest closures for specific water bodies or parts of water bodies and specific species. Developing countries must adopt guidelines for seafood safety. Rapid response investigations collecting and testing fish from affected waters could inform the risk communication around food safety. However, regular ongoing monitoring would be needed to advise public on safety of the seafood. This is particularly important as seafood constitutes majority of the diet in the coastal population. Sea food monitoring can also inform the need for supplementary food for communities depending on seafood as a primary source of their nutrition. It is also important to take into consideration the medium of risk communication in populations with low educational levels and limited access to main stream media. Furthermore, testing and analytical capacity would vary from country to country; countries lacking resources could harness collaborations outlined elsewhere for monitoring fish for contaminants.

c. Political issues

Role of the scientists in the midst of varying interest groups—Environmental disasters are embedded with economic, political, and litigation issues. The challenge for public health scientists is to provide an unbiased objective assessment of the health impact. In our discussions with various stakeholders, we learned that stakeholders have varied interests. Some were interested in health effect data to pursue litigation and seek compensation. The government sought to quell fears and maintain calm and stability in the affected area. The media was intent on publicizing potential health effects and to also address any cover-up by the government.

Lesson learned: Scientists must recognize the context and controversies and ensure transparency and objectivity of scientific evidence. Ideally, funding should be independent from industry or other interest groups. Community consultations, scientific and community advisory boards and oversights enhance the objectivity, credibility and hence acceptance of evidence. External scientific groups could also help local scientists in raising issues without being influenced by local government, industry and other interest groups.

Community engagement—We were not able to engage the community in the form of consultation at the time of the design and conduct of the study.

Lessons learned: Community engagement in research design is a good research practice that informs local needs during a disaster and helps incorporate them into the health effect study. Communication with the community at the completion of study to share results closes the loop of community engagement. Future studies should make every effort to engage community in the research process. This also helps in conducting field work, enhances response rate and enhances credibility of generated knowledge. New and emerging social

media technologies such as cell phones, Facebook, twitter and other social media portals where possible could provide efficient forums for engagement.

Communication of study results—We did not outline a clear communication strategy of study results and to whom the results were to be communicated at the design phase. Communication of study results may have implications for different stakeholders.

Lessons learned: There needs to be a realistic understanding of who the target audiences are and what the potential implications of the results may be. Apart from the scientific community, there are various other stakeholders with different expectations, and there needs to be a clear understanding of how the results would be disseminated. A communication plan at the design phase would be useful. New and emerging social media tools such as Facebook and twitter could also be used for communication and communication engagement.

FUTURE RECOMMENDATIONS FOR A RAPID RESEARCH RESPONSE TO OIL SPILLS IN DEVELOPING COUNTRIES

It is unrealistic to think that even the strongest framework as in a developed country can anticipate and overcome all challenges in a crisis. Based on the lessons learned from our investigation, the Institute of Medicine (IOM) recommendations [Spill 2010] and other suggestions [Savitz and Engel 2010], we recommend the following to enhance a rapid response research to oil spills in developing countries:

1. Development of national framework for public health assessments

Overall, there is a need for developing a national frame-work for conducting investigations of environmental disasters including oil spills. Such a framework should include legal and ethical mechanisms, funding, execution of scientifically rigorous studies and communication of results. The frame work should also include a mechanism for involvement of pubic health authorities and academic researchers which may require different levels of review and approval process.

2. Funding sources

There is need to establish a funding mechanism for assessment of health effects of environmental disasters that can be mobilized at the time of need. The fund may be managed by one of the agencies of the United Nations, and can be sourced through governments. Establishment of expedited review mechanisms with quick turnaround time in the matter of days rather than weeks or months would be an essential element for funding mechanism to be successful. The fund can pre-establish its priority areas and reviewers for efficiency.

3. Protocols and assessment tools repository

A repository of study protocols, and validated exposure and outcome assessment tools including collection, processing and testing of biological markers would reduce the lead time to an investigation and enhance the quality of collected data. There is a need to conduct studies on behavioral, psychological health in addition to acute and chronic health impacts. There is also a need to assess and document disparities in exposures and outcomes by socio-economic status, race/ethnicity and other indicators of disadvantage in a given area.

4. Collaborations

Investigators in developed countries and those who have conducted studies and have expertise in epidemiologic methods and exposure measurement could also provide useful

guidance and insight for new studies in developing countries. Training of scientists in disaster response research is also important to develop and maintain human resources to rapidly conduct disaster response studies. The portal for protocols and tools could also provide a networking platform that can list and help investigators find likely and willing collaborators. The portal could also provide list of scientists and laboratories who might be interested in collaborating with investigators in developing countries in conducting laboratory testing as part of epidemiological investigations. For example, the Fogarty International Centre training program on environmental and occupational health could support such a portal.

5. Value of research

Research should generate knowledge that is useful for immediate mitigation of exposures and health effects among those affected by spill and involved in clean-up efforts. Studies should also generate data for use in management of future disasters and related exposures.

6. Community engagement and communication

Researchers should engage the community in developing research response and should also evaluate various communication and engagement strategies to assess which are the most effective for disaster and disaster-preparedness. Studies should also include a plan for communication of results with the community on completion of the study.

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Table 1

Recommendations for health impact assessment in response to environmental disasters

1. Development of national framework for public health assessments Framework should include legal and ethical mechanisms, funding, and execution of scientifically rigorous studies and communication of results.
2. Funding sources Need for establishing a funding mechanism including scope and source of funding, application, review process and turnaround time for assessment of health effects of environmental disasters.
3. Protocols and assessment tools repository Repository of protocols and validated tools adapted to the local settings would reduce the lead time to an investigation and enhance the quality of collected data.
4. Collaborations and capacity building A portal for connecting scientists and laboratories from north and south could enhance overall research response and its quality. Training of scientists in disaster response research is also important to develop and maintain human resources to rapidly conduct disaster response studies.
5. Value of research Research should generate knowledge that is useful for immediate mitigation of exposures and health effects among those affected by spill and involved in clean-up efforts.
6. Community engagement and communication Research should engage community in developing research response and should also evaluate various communication and engagement strategies. Use of social media tools could enhance engagement and communication.