# *Chapter 5. Goal 3: Agricultural Health Outcomes Research on Exposures to Chemicals*

**Goal 3:** Determine the chronic effects of agricultural exposures/health outcomes from toxic exposures and develop appropriate interventions to reduce the incidence of disease.

## 5.1 Challenge or Issue

More than 85,000 chemicals are registered for commercial use today, an ever increasing number of which are pesticides used in agriculture. It can be fairly assumed that exposures to pesticides and other toxic substances found on the farm pose a serious health risk to the farming community since many of these toxicants are known to cause cancer, adverse reproductive effects, and neurological disease. However, research is needed to determine the extent of farm workers exposure to these chemicals and to determine the extent to which such exposures contribute to disease.

## 5.2 Activities

AFF Program efforts in recent years have focused on both areas of research—determining the extent of exposure among agricultural workers, and determining the rates of disease such as cancer, adverse reproductive effects and neurological disease among farm workers and their families.

### 5.2a Extent of Exposure

**Biomonitoring Research**

AFF Program researchers have developed biomonitoring methods (primarily for blood and urine specimens) to measure exposures to agricultural chemicals. These methods are used to assess worker exposures in a variety of agricultural settings. A major focus of these efforts has been to develop methods that are rapid, simpler to perform, and lower in cost. These methods were used to evaluate exposures in farm families, agriculture sprayers, residential exterminators and others. Aside from giving valuable information about personal burden of pesticide exposure, these efforts have helped to determine those work practices and operations that present the greatest potential for exposures. These efforts have resulted in suggesting changes in work practices or wearing of personal protective equipment that resulted in decreased worker exposures. (Appendices 5.2a-01, 5.2a-02, 5.2a-03. 5.2a-04, 5.2a-05, 5.2a-06, 5.2a-07, 5.2a-08)

AFF Program researchers have also developed and applied biomarkers of effects to assess potential injury or toxic response in persons exposed to agricultural products or chemicals. As part of the efforts to assess biomarkers of susceptibility, researchers have focused on two specific areas: differences in metabolism of chemicals and genetic susceptibility to effects of exposoure in a rural population. Research investigating variability of metabolism was conducted in cooperation with EPA. This work has been used by EPA to re-evaluate uncertainty factors used in risk assessments and have applied them to new risk assessments [Lipscomb 2004].

Research demonstrated that immunochemical methods are suitable for use in biomonitoring studies to evaluate exposure to the agricultural chemicals that were tested. Methods were demonstrated to be rapid, accurate and much simpler to perform than traditional analytical chemistry methods [Biagini 2002, 2004]. In addition these methods have proven to be adaptable for use in the field. They usually require less sample volume than other methods, making compliance easier for participants. These new methods have often resulted in rapid dissemination of investigative results to relevant partners and stakeholders, and development of strategies to decrease exposures. Research into variation of metabolic capacity has resulted in identifying the role of specific metabolic pathways on toxicological fate of numerous chemicals [Snawder 2000].

The new exposure assessment methods improved our understanding of the way workers are exposed. For example, in many pesticide application scenarios it has been found that the greatest exposure occurs through the hands and torso while mixing and applying pesticides [Winterlin 1984; Zwieg 1983; Popendorf 1979]. This information has led to recommendations that pesticide workers use gloves, aprons, and protective clothing. Current research indicates that many workers are not employing protective equipment. Intervention research is being developed to encourage workers to use protective equipment and to evaluate the barriers to their use.

Studies evaluating genetic markers of susceptibility have also explored the possible roles of polymorphisms of metabolic DNA repair enzymes and the development of glioma [Butler 2005].

## Take-home Pesticide Exposure

The health effects of low level chronic exposures to pesticides are still largely unknown, and the potential for agricultural workers, farmers, and farm children to be subjected to these exposures are considerable. Families are potentially exposed to contaminants that are inadvertently brought into the home by working members of the household. (Appendix 5.2a-09)

The primary purpose of the take-home pesticide exposure study was to describe the sources of pesticide contamination in farm homes and investigate the relationship between contamination and pesticide exposure of family members in the home. A combination of environmental and biological sampling was employed. Questionnaires were administered along with observations to determine practices and behaviors that may contribute to exposure. Conclusions from the study include the following:

- Farm homes are more likely to be contaminated with pesticides then nonfarm homes and farms that apply a particular pesticide to crops have higher levels of that pesticide inside the home than farms that do not apply the pesticide.
- Farmers who reported applying a pesticide had significantly higher urinary metabolite levels of that pesticide than nonfarmers, farmers who did not apply that pesticide, and farmers who had the pesticide commercially sprayed (P-value $< 0.05$). No statistically significant differences in urinary pesticide metabolite levels occurred between nonfarmers, farmers who did not apply the pesticide and farmers who had the pesticide commercially applied.
- Farm children are more exposed to pesticides than nonfarm children, but the exposure is generally below EPA reference doses [Curwin 2002, 2005, 2005, 2006, submitted].

Researchers at the University of Iowa have initiated further research on the take-home pesticide issue. The study protocol was largely developed based on results from our take home study. NIOSH has been asked to be a collaborator on this initiative.

**Engineering Controls**

Working collaboratively with manufacturers of environmental enclosures for tractors and with commercial pesticide applicators, AFF Program researchers were able to conduct measurements of airborne particulate in the working area of the pesticide applicator to demonstrate that these enclosures were able to provide a 50-fold reduction in exposure [Heitbrink 2003; Moyer 2005]. This was accomplished in four separate projects by:

- developing partnerships with manufacturers of environmental enclosures for tractors and with commercial pesticide applicators
- developing measurement techniques for quantifying aerosol exposures of this nature in the environment of interest
- establishing a baseline exposure during application of pesticide
- establishing procedures for reducing aerosol infiltration into cab
- re-evaluating exposures during application in modified cab
- promoting procedure for reducing aerosol infiltration for industry use

To provide insights into specific causes of the workers' exposures from integrated air sampling data, direct reading instruments for continuous monitoring of a worker's environment were used. When these instruments are used in conjunction with video recording equipment, they permit better assessment of the association of events and exposures. This allows more effective and focused recommendations for controlling the air contaminant exposures. AFF researchers developed a systematic approach to help identify the sources of workers' exposures and to provide an effective means for communicating the results to workers and management [Heitbrink, 2000, 2003].

This work makes use of the ability to conduct measurements of airborne particulate over a concentration range of several orders of magnitude and the ability to classify those aerosol particulates according to size to further define their toxicological effect. The measurements of airborne particulates in the working area of the pesticide applicator demonstrated that the enclosures suggested were able to provide a 50-fold reduction in exposure [Heitbrink 2003]. The video exposure monitoring techniques developed by AFF Program researchers were used to enhance controls for materials weigh out operations, bag dumping, maintenance, and bulk loading procedures, to list a few. (Appendix 5.2a-10)

These have been used to generate and quantify nanoparticles in the environment; reduce emissions from asphalt equipment; document hearing loss in migrant farm workers; and develop guidance for protecting building environments from airborne chemical, biological, and radiological attacks.

Another effort involved reducing carbon monoxide (CO) exposure. AFF program researchers have conducted an extensive amount of work to better understand how CO poisoning can occur with small gasoline-powered engines and tools such as power washers used to clean barn floors and equipment. This effort multidisciplinary effort involved surveillance, epidemiology, industrial hygiene, and engineering controls. AFF researchers were able to document the extent of the problem, show how quickly hazardous CO concentrations can be developed and recommend control solutions. In 1996, NIOSH published the *Alert: Preventing Carbon Monoxide Poisoning from Small Gasoline-Powered Engines and Tools* (NIOSH Publication No. 96–118) in cooperation with the Colorado Department of Public Health and Environment, the U.S. Consumer Product Safety Commission, OSHA, and EPA. As with many engineering problems, the approach was to quantify the problem and identify its source, isolate and/or control the source, and re-evaluate the exposure to determine the effectiveness of the controls.

*Analytical Methods Research and Field Support:* Key elements in pesticide exposure field studies are the ability to accurately sample and quantify exposures, distinguish exposure route(s), and determine the impact of worker actions on exposure. The AFF Program's methods development research program provides this by developing new methods and providing analytical services. Development of 11 new multi-analyte pesticide methods has supported the following research efforts: an agricultural health study, neurological effects of organophosphate pesticides in structural applicators, herbicide exposure assessment among custom applicators, and effectiveness of hand washing in reducing agriculture worker exposure to pesticides, take-home pesticides, and greenhouse workers (Appendices 5.2a-09, 5.2a-11, 5.2a-12, 5.2a-13, 5.2a-14).

### 5.2b Cancer

Several projects have been developed to address the higher incidence of cancer found in farmers and their families.

*Cancer Control Demonstration Projects for Farming Populations:* Although, overall, farmers experience lower cancer rates than the U.S. population, they are nevertheless at increased risk for certain site-specific cancers, such as brain, stomach, lymphatic, hematopoietic, lip, prostate, and skin cancer. In addition, compared to urban populations, rural cancer patients are more likely to be diagnosed at later stages of disease and are at a more advanced state of illness when referred to home health care agencies. In an effort to more fully address the health needs of farmers and their families, AFF developed the Cancer Control Demonstration Projects for Farming Populations in 1990. (Appendix 5.2b-01)

Our health studies conducted in the past decade focusing on cancer in the agricultural population found the following:

- Wisconsin white, male farmers had significantly lower mortality risks than comparable nonfarmers for melanoma (SMR: 0.66; 95% CI: 0.33-0.99) and colon cancer (SMR: 0.76; 95% CI: 0.60-0.93), a nonsignificant decrement for non-Hodgkin's lymphoma (SMR: 0.93; 95% CI: 0.65-1.21), and a nonsignificant increase for rectal cancer (SMR: 1.01; 95% CI: 0.61-1.42). This study corroborates numerous investigations demonstrating that farmers generally experience the same or lower mortality risks for these malignancies than the U.S. population [Hanrahan 1996].
- An increase in the proportion of advanced malignancies among rural residents may be due to reduced availability of screening services, demographic characteristics, and access to health care. In at-home interviews in 33 nonmetropolitan Iowa counties, 1,126 farmers collectively were older, more likely to have health insurance, and had lower incomes than 1,092 nonfarmers. Farm men were less likely to have had a checkup or prostate cancer screening during the past year than nonfarm men. Farm women older than 50 were less likely than nonfarmers to have had mammograms but more likely to have had sigmoidoscopy. Farm women aged 40–49 were more likely than nonfarmers to have had mammograms. Farm women and men were almost twice as likely as nonfarmers to have had skin exams. Controlling for demographic characteristics and insurance coverage, farmers and nonfarmers were equally likely to use multiple screenings according to American Cancer Society guidelines. Because of the increased risk of breast cancer among women older than 50, interventions aimed at increasing utilization of mammography should be implemented. Although the farm population was more likely to use skin

examinations, prevalence should be increased substantially to counteract the continuing rise in skin cancer [Muldoon 1996].

*Upper Midwest Health Study; a Population-Based Case-Control Study of Primary Intracranial Glioma Among Rural Residents:* The known elevated incidence of brain cancer found among farmers was the impetus for this study. The study focused on Iowa, Michigan, Minnesota, and Wisconsin for several reasons: (1) CDC/WONDER showed elevated brain cancer incidence in the Upper Midwest; (2) collaborations had already been established with investigators in those States; and (3) those four States have substantial farm populations. The study objective was to identify rural or farm risk factors for primary intracranial gliomas and to evaluate the impact of genetic polymorphisms with their associated relevant exposures on susceptibility to gliomas (Appendix 5.2b-02). This research found the following:

- Moving to a farm as an adolescent (aged11–20) versus as an adult was associated with a greater risk of glioma [Ruder in Press]. This may point the way to interventions to protect adolescents.
- No evidence for association of pesticide exposure and glioma risk was found [Ruder 2006]. Further work may confirm that exposure levels of nonpesticide-using adults are indeed not carcinogenic, thus focusing intervention efforts on pesticide users.
- Compared with women who never breast-fed, women who breast-fed >18 months over their lifetime were at increased risk of glioma [Carreon 2005].

Another study focused on prioritizing pesticide exposure for a brain cancer case-control study using a subset of 134 pesticides that had been documented for their historical use in agricultural work [Sanderson 1997]. The methods developed for this study may be useful in prioritizing pesticides for other research studies.

### 5.2c Neurological Disease

*Neurological Effects of Organophosphate Pesticides in Structural Applicators:* Whether chronic low level pesticide exposure leads to neurological damage is an important public health question in the United States affecting potentially hundreds of thousands of agricultural and nonagricultural workers. *Neurological Effects of Organophosphate Pesticides in Structural Applicators*, funded by the EPA, began to address this question in 1996 by studying neurological function in 191 current and former termiticide applicators that had an average 2.4 years applying chlorpyrifos and 2.5 years applying other pesticides, and comparing their performance to that of 189 nonexposed controls (Appendix 5.2c-01).

*Grower applies low-insecticide bait that is targeted against western corn rootworms feeding on and laying eggs in these soybeans. Source USDA 2006.*

## Neurobehavioral Assessment

A number of different projects and activities addressed this program area. These include the following:

- neurobehavioral testing of migrant workers with exposure to organophosphate compounds
- neurobehavioral testing of pest control operators with exposure to methyl bromide and sufuryl flouride
- neurobehavioral testing of pest control operators with exposure to chlorpyrifos
- neurobehavioral testing of orchardists (with multiple pesticide exposures) and their families in a home setting
- development and assessment of a new test battery, aimed at revealing peripheral nervous system effects

Key findings from these health studies on neurological diseases among the farming community [Dick 2001, Hines 2001, MacKenzie 2000, Steenland 2000, Steenland 1994, Calvert 1998] included the following:

Limited acute effects, primarily on measures of postural sway, were found using a chlorpyrifos urinary metabolite as a measure of current chlorpyrifos exposure. Determinants of airborne chlorpyrifos exposure included minutes of chlorpyrifos application and working inside an enclosed crawl space. Determinants of urinary metabolite levels included day-of-the-week, chlorpyrifos air concentrations 1 and 2 days before urine collection, working inside an enclosed crawl space, and treating a commercial structure. Applicator’s weekly mean metabolite levels and weekly mean chlorpyrifos air concentrations were highly positively correlated.

An improved immunoassay method for the major human metabolite of chlorpyrifos in urine was strongly correlated with conventional analysis by GC/MSD. The method is useful for screening occupational exposure to chlorpyrifos.

Chlorpyrifos-exposed termiticide applicators reported more neurological symptoms than nonexposed controls. Few exposure-related effects were found for most neurological tests, and exposed and nonexposed groups did not differ for any test in clinical examination; however, exposed applicators perform less well on some tests. A pattern of delayed effects for applicators reporting prior poisoning was suggested. Organophosphate pesticide poisoning was associated with significant declines in sustained visual attention and changes in self-reported mood. Men with documented cholinesterase inhibition or who had been hospitalized for organophosphate pesticide poisoning, had significant changes in vibration sensitivity.

Sulfuryl fluoride exposure was associated with significantly reduced performance in tests of pattern memory and sense of smell. Fumigation workers also had significantly diminished dexterity in their dominant hand.

### 5.2d Adverse Reproductive Outcomes

*Birth Defects and Parental Occupational Exposures:* The relationship between parental pesticide exposure and birth defects is controversial. The *Birth Defects and Parental Occupational Exposures* project began in 2002 to focus on conducting a detailed exposure assessment of several maternal occupational exposures, including insecticides, herbicides, and agricultural fungicides. (Appendices 5.2d-01, 5.2d-02, 5.2d-03, 5.2d-04) The exposure data will be used for etiologic analyses of birth data and other information collected by CDC's NCBDDD to evaluate if maternal occupational pesticide use is related to birth defects in offspring. (Appendix 5.2d-05)

**Reproductive Health Assessment of Agriculture Workers and Their Families**

An ever-increasing number and variety of chemicals are used in agriculture that are known to be reproductive toxicants and endocrine disrtuptors. A prime example of these chemicals that pose great risk in agriculture are pesticides. Agriculture workers, their families, and the surrounding communities are at risk of exposure to these chemicals through the air, soil, food, or water, or through contamination brought home by agricultural workers, e.g., on their clothes.

The AFF Reproductive Health Assessment Team has taken a multipronged integrated approach to assess the reproductive health of agricultural workers and their families. A report by the President's National Science and Technology Council (NSTC) Committee on Environment and Natural Resources, "The Health and Ecological Effects of Endocrine Disrupting Chemicals: A Framework for Planning," provides a framework for planning Federal research related to the human health and ecological effects of endocrine disrupting chemicals, and categorizes three major areas needing research: 1) methods development, 2) model development, and 3) laboratory and field acquisition. AFF addressed each of these research areas by:

- developing sensitive and specific methods to biologically monitor reproductive health, (Appendices 5.2d-01, 5.2d-02, 5.2d-03, 5.2d-04)
- developing an animal model to study chemical reproductive toxicity, and
- conducting population studies using biomarkers to assess reproductive health in a variety of populations potentially exposed to a range of chemicals found in agriculture; many in these populations are underserved and vulnerable. (Appendix 5.2d-05)

Many of the studies conducted within the framework of this program evaluate the health effects of endocrine disrupting chemicals. Mixtures are generally formulated with insecticides and fungicides that are known to be synergistic (estrogenic and antiandrogenic). Male rabbits were exposed during their adolescence to demonstrate effects and provide guidance for the human study. Study populations included the following:

- young adult men and women in Hawaii exposed to a heptachlor in utero or during breast feeding

- an agriculture community in Illinois drinking ground water with high levels of atrazine
- pesticide appicators in Minnesota, Iowa, and Ontario
- a subsistence Native American community exposed to DDT in their soil, water, and food
- couples from the Texas gulf coast and Michigan exposed to pesticides in the environment, who were trying to conceive

As a result of this research, AFF has successfully developed both new methods of research and new models of research. These include the following:

**Methods Developed**

- sperm migration assay to measure sperm motility in specimens shipped overnight [Turner 2006]
- demonstration of the superiority of an LH immunoassay to reliably measure the preovulatory surge in urine [Kesner 1998]
- an algorithm for detecting features of the hormone profiles of the human menstrual cycle [Krieg 1999]
- endocrine markers of ovulation and of nonconceptus menstrual cycles [Baird 1999]
- silastic condoms for collection of semen samples [Schrader 1997]
- urinary creatinine measurement using multilayer dry film reagent technology [Knecht 2002]

**Models Developed**

- An animal model was developed to assess reproductive effects of pesticides (endocrine disruptors) during the peripubertal period. The rabbit was selected as the test species, since it has proven to be an excellent species for modeling reproductive toxicant effects in the male. The rabbit model was used to assess vinclozolin. Under the conditions of the study, vinclozolin reduced pubertal weight gain, weight of the accessory sex glands at maturity but paradoxically was associated with increased sperm count [Moorman 2000b].
- A model was developed to prioritize toxic chemicals for research. This model is ideal for use to prioritize chemicals found in agriculture, especially pesticides [Moorman 2000a].

In addition, significant findings from population studies include the following:

- 2,4D residues are present in the semen of about 50% of the participants in levels proportional to urinary 2,4-D levels [Arbuckle 1999].
- Agricultural workers who applied fungicides experienced a lower percentage of normal sperm morphology and lower sex ratio (male:female) of children they father, which in turn was correlated with serum testosterone levels of the men [Schrader 2000].

- The hand-held, backpack sprayer is the applicator method associated with highest urinary 2,4-D levels in men [Garry 2001].
- High urinary 2,4-D levels are associated with altered luteinizing hormone, follicle stimulating hormone, and testosterone levels and altered genomic stability (measured by V(D) J rearrangement frequency), which appears reversible [Garry 2001].
- Pesticide adjuvants exhibited positive dose-response for in vitro genotoxicity effects [Garry 1999].
- Preliminary data reveal that serum DDT levels in subsistence Native American women are directly correlated with follicular phase LH levels and inversely correlated with luteal phase FSH levels [Wainman 2004].

### 5.2e Respiratory Disease

*Prevention of Occupational Respiratory Disease in Agriculture:* This project addresses the knowledge gaps regarding respiratory health outcomes in agriculture including asthma, hypersensitivity pneumonitis, chronic bronchitis, and agricultural respiratory exposures. To accomplish the goal, we partnered with two existing studies to gather respiratory health outcomes data—the Agriculture Health Study (AHS) and the USDA NASS.

The AHS is one of the hallmark efforts currently underway on agricultural health in the United States. The study was initiated in 1993 by NCI, NIEHS, and EPA. The study uses a longitudinal cohort design and evaluates how lifestyle habits, genetic factors, and agricultural exposures at work and in the environment contribute to the risk of disease. More than 89,000 certified farmer pesticide applicators and their spouses from North Carolina and Iowa and licensed commercial pesticide applicators from Iowa are included in the study making it one of the largest agricultural health studies ever conducted in the United States. This large cohort provides a unique opportunity to apply our resources for the study of respiratory health outcomes in agriculture including asthma, hypersensitivity pneumonitis, and chronic bronchitis with the study of both prevalent and incident disease patterns, as well as risk factors related to pesticide and nonpesticide exposures.

This project also provides for collaboration on a national survey completed through contract with the USDA/NASS. The respiratory focus will be on asthma and respiratory exposures. The survey will target 25,000 farm operators nationally stratified by geography and commodity providing a large, representative sample. Results from these efforts will be shared with our partners nationally and applied to better direct exposure reduction and respiratory disease prevention efforts in agriculture. Study outcomes may also identify new research needs or be used to initiate new research studies addressing pesticide exposure and respiratory disease in agriculture.

Preliminary findings are showing some previously unrecognized (and unreported in the agricultural health literature) associations between pesticide exposures and respiratory health outcomes including chronic brohchitis, hypersensitivity pneumonitis, and asthma [Valcin 2006, Hoppin 2006, Hoppin Accepted]. Results from these efforts will be applied to better direct exposure reduction and respiratory disease prevention in agriculture. These preliminary findings also have moved researchers at NIOSH, NIEHS, and NCI to action in developing a new case control study addressing pesticide exposure, diesel exposure, and occupational asthma in agriculture. Study outcomes may also identify other new research needs or be used to initiate new research studies addressing pesticide exposure and respiratory disease. (Appendix 5.2e-01)

The AFF Program has also focused on preventing organic dust toxic syndrome. Some of our successes in this area include the following:

- A NIOSH Alert was developed based on composite findings from several HHE projects/ investigations to summarize findings on the occurrence of organic dust toxic syndrome and to provide national guidance on prevention [NIOSH 1994]. (Appendix 5.2e-02)
- A NIOSH hazard control was developed in conjunction with the NYCAMH. This new exposure control is focused on reducing the massive organic dust exposures from mechanically chopping bedding in animal confinement facilities. This hazard control was distributed nationally by NIOSH and by NYCAMH [NIOSH 1997].
- Two articles were published in the American Journal of Industrial Medicine (AJIM) describing our investigation of a case of acute respiratory illness, requiring hospitalization, following organic dust exposures from compost materials, and subsequent laboratory-based animal exposure studies on pulmonary response models. The articles illustrate some of the clinical difficulties in differentiating hypersensitivity pneumonitis from organic dust toxic syndrome following massive organic dust exposures, and show that animal exposure models can be useful in predicting the potential respiratory

Dusts from Silo Uncapping

*Organic Dusts from Bedding Chopping*

hazards associated with exposure to various organic dusts [Frazer 1993, Weber 1993]. (Appendices 5.2e-02, 5.2e-03, 5.2e-04, 5.2e-05, 5.2e-06)

### 5.2f Disease Interventions

Several of the studies related to specific diseases, especially cancer, included intervention efforts to reduce exposure and/or disease. Some of the findings from the interventions attempted include the following:

- An intervention of mailed pesticide information, educational programs on pesticides for physicians, elementary school training modules on pesticides, and safe pesticide handling displays in key business areas was delivered to pesticide-using farmers in two counties. The use of gloves and other protective clothing while handling pesticides increased in the intervention group over that in pesticide-using farmers in two counties not receiving interventions. Improvement was greater in those who had used protective equipment the least before the intervention [Weber 1993].
- Interventions at rural Iowa supermarkets (including flyers that identified fruits and vegetables on sale, recipes, menu ideas, a 50-cent coupon, and food demonstrations and nutrition-related signs) were evaluated with exit interviews and take-home surveys at baseline and approximately 1 year later. At follow-up, 43% of intervention store shoppers and 7% of control shoppers recalled seeing the flyer, 36% of intervention shoppers had used the coupon, and 18% had used a recipe. Purchase of fruits or vegetables on the interview day did not differ between intervention and control stores [Kristal 1997].
- Individual mailings containing information about breast cancer risk and community sources for screening, and information and screening were provided at county and community fairs. Rural participants in both intervention and control communities demonstrated significant changes in knowledge and attitudes about breast cancer. Education—rather than income, insurance coverage, or family history of breast cancer—was the most significant predictor associated with greater use of mammography [Gardiner 1995].
- Bilingual health educators met with farm worker communities near Merced and Modesto, CA, to determine barriers to seeking screening for breast and cervical cancer. Cancer education and screening program participants received a presentation in Spanish on breast and cervical cancer that included a pretest and posttest to assess increases in knowledge. Data from pretests and posttests indicated a statistically significant increase in knowledge about cancer and its prevention among participants. Clients were encouraged to receive free breast and cervical cancer screenings: 20% of participants redeemed vouchers for cancer screenings [Goldsmith 1996].
- A situation analysis identified constraints and opportunities for providing farm workers with cancer control information and services. Based on what was learned, recommendations for designing cancer control research and intervention for farm workers, especially migrant farm workers, include on-the-spot Pap smear determination so any warranted additional exam or

treatment can be done during the same visit, holding health fairs at migrant camps and day care centers, and insuring that staff include Spanish and Haitian speakers [Hooks 1996].

- Telephone interviews in six rural counties obtained data on chemically resistant glove and other protective equipment use as they relate to the type of farming practice, demographic characteristics of farmers and their farming operations, farmers' preventive health beliefs and behaviors, and factors related to their health care. Ninety-five percent of pesticide users believed in the effectiveness of protective equipment, 88% believed pesticide exposures were harmful, 56% wore chemically resistant gloves, and 22% wore other protective clothing ≥75% of the time when using pesticides. Glove use and certification to use restricted pesticides were less frequent for women [Mandel 1996].

## 5.3 Selected Outputs

The AFF has been successful in authoring publications of more than 400 articles in juried publications reporting the findings of our work, as well as abstracts, manuscripts, and book chapters. Almost all of these publications have been cited numerous times in the literature proving that this information is getting to its intended audiences. A bibliography is at the end of this chapter.

As cited earlier in this chapter, our research has been extremely effective in fostering new collaborative links with other Federal agencies, State health departments, universities, and the private sector. Such collaborative work has extended not only the breadth of our research, but also the reach of our findings to additional target audiences. This has enabled us to create educational materials that convert commonly understood prevention techniques and research findings into usable, occupationally specific guidance for farmers, farm workers, and their families. These materials can be used by farm worker organizations.

Selected outputs of note include the following.

**NIOSH Published Analytical Methods**

- NMAM 5602: Chlorinated Organonitrogen Herbicides (Air Sampling)
- NMAM 9200: Chlorinated Organonitrogen Herbicides (Hand Wash)
- NMAM 9201: Chlorinated Organonitrogen Herbicides (Dermal Patch)

These methods are detailed sampling and analytical procedures for measuring chlorinated organonitrogen herbicides in air, hand rinse, and dermal patch samples. The methods expand the capability of researches and practitioners to measure the exposure of farmers, farm workers, families, and others to this class of herbicides in several exposure matrices. In particular, two of the methods address dermal exposure, an often important route of exposure to pesticides. Accurate measurement and characterization of exposure leads to improved risk assessment.

- Method 9202: Captan and Thiophanate-methyl in hand rinse (HPLC)
- Method 9205: Captan and Thiophanate-methyl in dermal patch (HPLC)
- 6Method 9208: Captan in Air Samples by GC/MS

These methods are detailed sampling and analytical procedures for measuring captan and thiophanate-methyl in air, hand rinse, and dermal patch samples. The methods expand the capability of researchers and practitioners to measure the exposure of farmers, farm workers, families, and others to captan and thiophanate-methyl in several exposure matrices. In particular, two of the methods address dermal exposure, an often important route of exposure to pesticides. Accurate measurement and characterization of exposure leads to improved risk assessment.

From 1996 to 2005, we have developed and issued 12 methods (added to the *NIOSH Manual of Analytical Methods*, 4th ed.) and developed or updated 13 more methods that are applicable to monitoring chemicals used by agricultural workers. The NMAM (1994 ed.) had already contained 21 methods for monitoring chemicals used in agriculture. We have analyzed more than 22 sequences (more than 9,000 field samples) related to the field studies mentioned above. We have also conducted work to develop or improve the 25 methods mentioned above.

**Papers**

Carreón T, Butler MA, Ruder AM, Waters MA, Davis-King KE, Calvert GM, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2005]. Gliomas and farm pesticide exposure in women. Environ Health Perspect *113*(5):546–551. (No evidence for association of pesticide exposure and glioma risk was found. Further work may confirm that exposure levels of nonpesticide-using adults are indeed not carcinogenic, thus focusing intervention efforts on pesticide users.)

Curwin B, Hein M, Sanderson W, Barr D, Reynolds S, Ward E, Alavanja M [2005]. Urinary and hand wipe pesticide levels among farmers and non- farmers in Iowa. *Journal of Exposure Analysis and Environmental Epidemiology* 15(6):500-508.

Hines CJ, Deddens JA, Tucker SP, Hornung RW [2001]. Distributions and determinants of pre-emergent herbicide exposures among custom applicators. Annals Occup Hyg *45*:227–239. [cited 9 times] (This paper examined the extent of exposure of custom applicators to several commonly used herbicides applied to corn and soybean fields. Custom applicators are among the heaviest herbicide users in the United States. This study had a strong design in that applicators were systematically sampled at regular intervals that included spray and nonspray days (to approximate random sampling), repeated measurements (to estimate within- and between-worker variability) were obtained on each applicator, and multiple herbicides were measured in dermal, urinary, and salivary matrices. This study was also one of the earliest applications of mixed-effect regression models to identify exposure determinants in agriculture. Among the identified determinants, wearing gloves significantly reduced hand exposure and thigh exposure when herbicide was sprayed; however, wearing gloves was significantly associated with increased atrazine hand and thigh exposure on days that nonatrazine herbicides were sprayed. Herbicide exposure on nonspray days was widespread and indicated that a complete characterization of custom applicator herbicide exposures should include both spray and nonspray days. This study involved both intramural and extramural research to identify new herbicide metabolites and to develop new and innovative analytical methods for measuring herbicides in dermal and biological samples. This paper won the NIOSH 2002 Alice Hamilton Award for best paper in Human Studies.)

Ruder AM, Waters MA, Carreón T, Butler MA, Davis-King KE, Calvert GM, Schulte PA, Ward EM, Connally LB, Lu J, Wall D, Zivkovich Z, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Brain Cancer Collaborative Study Group [2006]. The upper midwest health study, a case-control study of primary intracranial gliomas in farm and rural residents. J Agric Safe Health *12*:255-274. (Moving to a farm as an adolescent [11–20] versus as an adult was associated with a greater risk of glioma [OR 1.96, CI 1.13-3.39]. This may point the way to interventions to protect adolescents.)

Ruder AM, Waters MA, Butler MA, Carreón T, Calvert GM, Davis-King KE, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2006]. Gliomas and farm pesticide exposure in men. Arch Environ Health *59*:650-657. (No evidence for association of pesticide exposure and glioma risk was found. Further work may confirm that exposure levels of nonpesticide-using adults are indeed not carcinogenic, thus focusing intervention efforts on pesticide users.)

Sanderson WT, Talaska G, Zaebst D, Davis-King K, Calvert G [1997]. Pesticide prioritization for a brain cancer case-control study. Environ Res *74*:133–144. (The methods used to select this subset of 134 pesticides document historical usage and may be useful in prioritizing pesticides for other research studies.)

**National and International Presentations**

Butler MA, Ruder AM, Levine AJ, Werren DM, ONeill VL, Masterson KJ, Schulte PA [1999]. Successes in biological specimen collection from cancer cases and controls in rural areas. Proc Am Assn Cancer Res *40*:612. Presented at the AACR, Philadelphia, PA, March. (This presentation and the paper [in preparation] offer guidance for collection of biological specimens in rural areas.)

Curwin B, Hein M, Sanderson W, Barr D, Reynolds S, Ward E, Alavanja M [2004]. Urinary pesticide levels among farmers and nonfarmers in Iowa [Abstract]. Presented at X2004: Exposure Assessment in a Changing Environment, Utrecht University, The Netherlands, June 16–18.

Hines CJ, Deddens JA, Striley CAF, Brown KK, Lu C, MacKenzie BA, Biagini RE, Shoemaker DA, Fenske RA, Hull RD [2004]. Biological monitoring for atrazine and

2,4-D among custom applicators. I. Results of exposure determinant modeling, X2004. Utrecht University, The Netherlands, June 16–18.

Ruder AM, Butler MA, Sanderson W, Carreón T, Waters MA [2001]. Development of a retrospective pesticide reference database. Presented at the American Public Health Association meeting, Atlanta, GA, October. (Linking the reference database to the participant data allows us to convert trade names to generics. Data can be analyzed by individual generic, by class of pesticide (organophosphate, etc.), by carcinogenicity rating from the International Agency for Research on Cancer, and by the weight of evidence as to whether a pesticide has endocrine-disrupting activity. This database will be useful to others assessing self-reported pesticide exposure histories.)

Waters M, Ruder A, Echeverria D [1999]. A new method for retrospective occupational exposure data collection in a case-control study of cancer. Proc Am Indus Hyg Conf Expos; 59A:46. Presented at the AIHCE, Toronto, Ontario, June. (Exposure specific followup questionnaires were developed for 22 exposure categories of interest, including pesticides, with questions about factors related to exposure intensity, duration, and frequency and protective equipment use. This new methodology improves the precision of exposure estimates.)

**A complete list of outputs can be found in section 5.9 at the end of this chapter.**

## 5.4 Intermediate Outcomes

### 5.4a Extent of Exposure

*Exposure Biomonitoring:* Results of our biomonitoring studies have been used by the EPA to re-evaluate uncertainty factors used in risk assessments and have applied them to new risk assessments and dose-response models [Environmental Protection Agency 2006].

Results from our take-home pesticide study have been used by researchers at the Utrecht University, The Netherlands, and the University of Iowa to further their research in this field. At Utrecht University, researchers have conducted preliminary work on take-home pesticides. Discussions have been on-going with them to conduct additional pesticide take-home work among farmers in the Netherlands based on their preliminary results and from the NIOSH take-home pesticide study results [Heederik 2006]

Research developing standards for measurement of blood cholinesterases demonstrated that widely used commercial kits and procedures to measure ChEs in the rat and human are not conducted under optimum conditions and in some situations may yield grossly inaccurate results. Our work led to an approach to optimize the colorimetric assay which has been adopted by the State of California into their guidelines for clinical laboratories.

Further results of our work on cholinesterase have had a demonstrable impact in northwest agricultural safety and health. In 1995, a TAG formed by the WSDLI found that a cholinesterase monitoring program was technically feasible and necessary to protect worker health. The recommendations outlined in the TAG report, Cholinesterase Monitoring in Washington State, were used by the Washington State Supreme Court to decide if a monitoring system was feasible and their recommendations greatly informed the resulting program [Washington State Department of Labor and Industries 2006]. The TAG report recommended the following:

- Medical supervision for workers who mix, load, or handle Class I or II OPs or carbamates.
- Testing for workers who handle pesticides more than 3 consecutive days, or more than a total of 6 days in a 30-day period.
- A single pre-exposure baseline measurement taken from workers each year prior to exposure.
- Follow-up testing every 3 to 4 weeks (depending on spray cycle) until spray activities are completed for the season.
- Removal of workers whose red blood cell cholinesterase is at or below 70% of baseline levels or plasma cholinesterase is at or below 60% of baseline. Workers would not be exposed to OP or carbamate pesticides until their cholinesterase levels return to 80% or more of their baseline.

In 2000, the Washington State Supreme Court mandated that the WSDLI develop a Cholinesterase Monitoring Program for workers handling acutely toxic pesticides. The new rule was implemented in February 2004, requiring agricultural employers to provide blood testing to workers who handle organophosphorus and carbamate pesticides [Washington State Department of Labor and Industries 2005].

*Engineering Controls:* AFF engineering control studies resulted in the development of voluntary standards by equipment manufacturers, based primarily on the EPHB particle size data, for cabs manufactured in the United States (American Society of Agricultural Engineers Standard S525). An international committee has been formed including U.S. equipment manufacturers such as John Deere, Case / International Harvester, and Adco, to promote the ISO adaptation of similar standards for production of agricultural enclosures worldwide.

Control of CO emissions resulted in the development of automatic engine shut-off sensors to stop equipment operation before CO concentrations reach hazardous levels.

### 5.4b Adverse Reproductive Effects

The project on Reproductive Health Assessment of Agriculture Workers and Their Families has helped direct further research in this area. In addition, a commercial diagnostics company (PerkinElmer) adapted two immunoassays developed by the program for manufacture and sales.

### 5.4c Neurological Effects

Subsequent to the AFF Program neurological effects study and taking into consideration other data, EPA banned the use of chlorpyrifos for residential use. This action was taken primarily to protect children. In addition, chlorpyrifos is no longer used as a termiticide, thereby eliminating its exposure to termite control workers [Environmental Protection Agency 2002].

## 5.5 End Outcomes

Much work has been done to determine the extent of exposure of farm workers and their families to chemicals, primarily pesticides and herbicides, and several intermediate outcomes have been accomplished as documented above. Similarly, AFF Program surveillance and health studies have shown the association of these exposures with cancer, neurological diseases, respiratory effects, and reproductive effects. In addition, various interventions have shown to be effective in reducing both exposure and disease. However, we are still working to quantitatively document reduced exposures, morbidity, and mortality.

Our efforts to date are critical to reaching our end outcomes. Without the laboratory methodologies we developed, we would be unable to measure actual exposure levels both in the environment and in humans. Similarly without surveillance we would not know the extent of disease, nor would we be able to measure any reductions. Finally, without the health studies we would be unable to draw the association between level of exposure and type of disease. All of these activities lay the foundation for achieving our end outcomes.

## 5.6 External Factors

Two areas that will shift the focus of AFF Program efforts relate to the changing demographics of the population of agricultural workers. First, the traditional farm family is changing. The population is aging and the number of small family farms is decreasing. With the reduction in traditional tobacco farming a large segment of small farms in the southeast United States will be changing to different crops or leaving farming altogether. Secondly, more and more farm workers are nonnative and/or migratory. Communication with these workers is difficult because of the language barrier and tracking them for any amount of time becomes problematic.

In addition, the number and variety of chemicals used in agriculture continues to increase, providing a challenge to prioritize and assess the toxicity in humans. Advances in our understanding of the toxicity of endocrine disruptors, for example, highlight the threat of many agricultural chemicals. New methods continue to be needed to provide researchers with state-of-the-art biological markers of disease.

Finally, an increased emphasis on worker protection related to terrorist and disaster incidents is anticipated.

## 5.7 Future Directions

AFF Program researchers will continue to develop new laboratory methods to assess worker exposures to agricultural chemicals. These methods are proceeding in two primary directions; multiplexed methods (i.e., measuring multiple analytes simultaneously in a single sample) and field portable methods. These will allow rapid determination of exposures in the field and also provide near instantaneous evaluation of control practices. NIOSH has expanded its capacity to conduct research into biomonitors of effect. New technology is allowing researchers to examine minute changes in proteins, genes, and enzymes in biological fluids that are indicative of very early stages of disease, long before clinical signs may develop. Further pursuit of these techniques will allow for very early intervention to prevent more severe disease. Engineering control research will continue. Aerosol research will also continue to develop information and measurement techniques relevant to small particle exposures, with nanoparticles becoming a significant portion of this work.
With regard to cancer research, data analysis is ongoing for *The Upper Midwest Health Study; a Case-Control Study of Primary Intracranial Gliomas among Rural Residents*, so some still unresolved questions in glioma etiology may be answered by future analyses. Analysis of data on pesticide users (on the farm, in the house and garden, and on nonfarm jobs) is the top priority. Analysis of the relation of other uniquely farm exposures (raising crops and animals, handling manure, using farm equipment) is also a high priority. This analysis may provide some understanding of why farmers are at higher risk of brain cancer, as well as pointing the way toward working to reduce the relevant exposures.

The critique of *Cancer Control Demonstration Projects for Farming Populations* suggested that one future role for the AFF Program was in publishing guidelines for organizing cancer prevention and control projects among farming populations. This overall evaluation and summation of the project remains to be done. Another role suggested was the convening of Federal agencies and national associations to assure the dissemination of findings, such as the Agricultural Safety and Health Conference held in Morgantown, West Virginia, in 1997.

As data analysis has not yet begun for *Birth Defects and Parental Occupational Exposures,* no future directions have been identified or have been planned to date.

The AFF plans to continue with some existing collaborations with the following activities:

Agricultural Health Study - This collaboration with NCI/NIEHS/EPA on a 90,000 person study will provide useful information on the potential relationship between farm exposures and a variety of health outcomes. A study of this size is only feasible via collaborative efforts with other federal agencies. NIOSH is contributing expertise in exposure assessment methods and respiratory disease.

CDC Birth Defects Registries - This collaboration with the CDC NCBDDD and several state birth defect registries is in data collection phase but will provide the opportunity to evaluate any potential relationship between occupational exposures, such as pesticides, and birth defects. This is very good example of research that would not be possible without partnering with another agencies with similar interests.

Extent of Exposure - the Environmental Protection Agency is a key partner is our efforts to better characterize exposures to pesticides. We anticipate that we will continue to develop biomonitoring methods to detect pesticide exposures in agriculture workers and to conduct field investigations to characterize the determinants of exposures and identify effective interventions.

## 5.8 List of NIOSH projects that are included in this chapter

- DART-92700A2-Immunochemical Biological Monitoring for Occup Exp & Dis (Appendix 5.2a-01)
- DART-9278234-Use of a Hepatocyte Model for Identifying Biomarkers (Appendix 5.2a-02)
- DART-9278314-A Method for Simultaneous Analysis of Multiple Pesticides (Appendix 5.2a-03)
- DART-9278351-Biomonitoring Methods for Agricultural Exposures (Appendix 5.2a-04)
- DART-9278159-Pesticides by GC-AED (gas chromatography-atomic emission detector) (Appendix 5.2a-05)
- DART-VQK425-Short-term Method Development to Support Field Studies (Appendix 5.2a-06)
- DART-9278484-Method development for Field Research (Appendix 5.2a-07)
- DART-9278413-Analytical Method Development for Emerging problems (Appendix 5.2a-08)
- DSHEFS-9277421-Take-home Pesticide Exposure (Appendix 5.2a-09)
- DRDS-9278113-Environmental Tractor Cab System Integrity (Appendix 5.2a-10)
- DSHEFS-9277132-Ag Health Study, Pesticide Exposure Among Farmer Applicators (Appendix 5.2a-11)
- DSHEFS-9278573-Emerging Agricultural Problems – effectiveness of hand washing in reducing agricultural worker exposure to pesticides (Appendix 5.2a-12)
- DSHEFS-9278578-Pesticide Exposure of Rose Greenhouse Workers (Appendix 5.2a-13)
- DSHEFS-9278605-Herbicide Exposure Assessment Among Custom Applicators (Appendix 5.2a-14)
- DSHEFS-9278577-Cancer Control Demonstration Projects for Farming Populations (Appendix 5.2b-01)
- DSHEFS-9278514-A Case-Control Study of Primary Intracranial Gliomas Among Rural Residents (Appendix 5.2b-02)

- DSHEFS-9278570-Neurological Effects of Organophosphate Pesticides in Structural Applicators (Appendix 5.2c-01)
- DART-VOO8006-Investigations of Pesticides as Endocrine Disruptors (Appendix 5.2d-01)
- DART-92700A1-Reproductive Health Assessment of Male Workers (Appendix 5.2d-02)
- DART-9278278-Methods for Assessing Male Reproductive Toxicity (Appendix 5.2d-03)
- DART-9278287-Methods to Evaluate Reproductive Potential of Women (Appendix 5.2d-04)
- DSHEFS-9278428-Birth Defects and Parental Occupational Exposures (Appendix 5.2d-05)
- DRDS-927Z1NG-Prevention of Occ. Respiratory Disease in Agriculture (Appendix 5.2e-01)
- DRDS- VKH8215-Ag Dusts: Field-Based Evaluation of Exposures & Acute Respiratory Illness (Appendix 5.2e-02)
- DRDS-9278165-Agricultural dusts: Animal models of asthma (Appendix 5.2e-03)
- DRDS-9278163-Agricultural Dusts: Elucidation of Disease Mechanisms (Appendix 5.2e-04)
- DART-9278430-Method Development for Fungi in Occupational Diseases (Appendix 5.2e-05)
- DART-9278456-Applied Monitoring Studies (Appendix 5.2e-06)

## 5.9 Outputs

### Analytical Methods

A Computer Program to Promote Understanding of the Monitoring Method Evaluation Guidelines Used at NIOSH - M. T. Abell and E. R. Kennedy [1997]

A Laboratory Comparison of Two Media for Use in the Assessment of Dermal Exposure to Pesticides - C. D. Lorberau and J. L. Pride [2000]

A Sampling and Analytical Method for the Simultaneous Determination of Multiple Organonitrogen Pesticides in Air - E. R. Kennedy, J. Lin, J. M. Reynolds and J. B. Perkins [1997]

Analytical Performance Criteria Standards Activities of the ASTM International Committee on Atmospheric Sampling and Analysis - K. Ashley [2004]

An Evaluation of Worker Lead Exposures and Cleaning Effectiveness During Removal of Deteriorated Lead-Based Paint - A.L. Sussell, C. Hart, D. Wild and K. Ashley [1999]

Application of the Gas Chromatography-Fatty Acid Methy Ester System for the Identification of Environmental and Clinical Isolates of the Family Micrococcaceae - S. M. Pendergrass and P. A. Jensen [Aug. 1998]

ASTM Standards for Lead Paint Abatement and Mitigation of Lead Hazards - K. Ashley [1996]

ASTM Standards for Monitoring Chemical Hazards in the Workplace - K. Ashley and M. Harper [2004]

Chemical Sampling - E. R. Kennedy [2005]. Analytical Performance Criteria ASTM International Standards for Monitoring Chemical Hazards in Workplaces - K. Ashley and M. Harper [2005]

Chlorinated and organonitrogen herbicides (hand wash) 9200 OSHA: Datachem [1998], also 9201 [2004] (NIOSH Manual of Analytical Methods (NMAM), Fourth Edition ).

Detection and Characterization of Airborne Mycobacterium tuberculosis H37Ra Particles, A Surrogate for Airborne Pathogenic M. tuberculosis - M. P. Schafer, J. E. Fernback and M. K. Ernst [1999]

Determination of Capsaicin and Dihydrocapsaicin in Air in a Pickle and Pepper processing Plant - S. P. Tucker [2001]

Development of Sampling and Analytical Methods for Concerted Determination of Commonly Used Chloracetanilide, Chlorotriazine, and 2,4-D Herbicides in Hand Wash, Dermal Patch and Air Samples. - S. P. Tucker, J. M. Reynolds, D. C. Wickman, C. J. Hines and J. B. Perkins [2001]

Direct Detection of Histoplasma Capsulatum in Soil Suspensions by Two-Stage PCR - T. M. Reid and M. P. Schafer [1999]

Evaulating a Spot Test for Detecting Air-borne Lead in the Workplace - K. Ashley and T. J. Fischbach [1996]

Exposure Assessment Research at NIOSH - A Key to Improving Worker's Health - E. R. Kennedy [2001]

Field Test of a Portable Method for the Determination of Hexavalent Chromium in Workplace Air - D. A. Marlow, J. Wang, T. J. Wise and K. Ashley [2000]

Guidelines for the Evaluation of Direct Reading Monitors - E. R. Kennedy, M. L. Woebkenberg, R. Song, D. L. Bartley and P. C. Schlecht [2002]

Histoplasmosis Protecting Workers at Risk - S. W. Lenhart, M. P. Schafer, M. Singal and R. A. Hajjeh [1997]

Interlaboratory and Intralaboratory Variabilites in the Environmental Lead Proficiency Analytical Testing (ELPAT) Program - P. C. Schlecht, R. Song, J. H. Groff, H. A. Feng and C. A. Esche [1997]

International Standard Procedure for the Extraction of Metal Compounds Having Soluble Threshold Limit Values - K. Ashley [2001]

Laboratory and Analytical Method Performance of Lead Measurements in Paint chips, Soils and Dusts - P. C. Schlecht, J. H. Groff, H. A. Feng and R. Song [1996]

Laboratory Investigation of the Mass Stability of Sampling Cassettes from Inhalable Aerosol Samplers - J. P. Smith, D. L. Bartley and E. R. Kennedy [1998]

NIOSH Analytical Methods -Evaluation and Validation - K. Ashley and E. R. Kennedy [2004]

NIOSH Publication No. 2004-146, Worker Health Chartbook 2004 Chapter 3; Focus on Agriculture [Sestito and Lunsford collaborated on document]

NMAM 2nd supplement Alachlor in Air, 5603, Bioaerosol Sampling, 0800. [http://www.cdc.gov/niosh/nmam/nmam2sup.html].

Performance Criteria and Characteristics of Field Screening Test Methods - K. Ashley, R. Song and P. C. Schlecht [2002]

Performance Criteria and Characteristics of Field Screening Test Methods - R. Song, P. C. Schlecht and K. Ashley [1998]

Performance of Laboratories Analyzing Organic Solvents in the Proficiency Analytical Testing Program - S. A. Shulman, J. H. Groff, P. C. Schlecht and D. Xue[1996]

Protecting Workers Exposed to Lead-Based Paint Hazards - K. Ashley, G. Burr, J. Gittleman, L. Mickelsen, H. Nagy, G. Piacitelli, R. Roscoe, A. Sussel and E. Whelan [1998]

Sampling and Analytical Method Development for Qualitative Assessment of Airborne Mycobacterial Species of the Mycobacterium Tuberculosis Comples - M. P. Schafer, J. E. Fernback and P. A. Jensen [1998]

Sampling Environmental Media ASTM STP 1282 - K. Ashley, P. C. Schlecht, R. Song, H. A. Feng, G. Dewalt and M.E. McKnight [1996]

Survey of Anlytical Methods - P. C. Schlecht and M. E. Cassinelli [1997]

Survey of Analytical Methods: Part II - P. C. Schlecht and M. E. Cassinelli [1997]
Ultrasonic extraction and portable anodic stripping voltammetric measurement of lead in paint, dust wipes, soil, and air: An interlaboratory evaluation - K. Ashley, R. Song, C. A. Esche, P. C. Schlecht, Baron PA and T. J. Wise [1999]

Uniformity Test of Bias When the Reference Value Contains Experimental Error - R. Song, E. R. Kennedy and D. L. Bartley [2001]

Workplace Monitoring for Volatile Organic Compounds Using Thermal-Desorption-Gas-Chromatography-Mass Spectrometry - A. A. Grote and E. R. Kennedy [2002]

**Book Chapters**

Schrader SM [1997]. Ch 22: Male reproductive toxicants. In: Massareo EJ, ed. CRC Handbook of Human Toxicology. New York: CRC Press, pp. 961–980 (ISI Web of Science: Cited 1 time as of 11/20/06)

**Database**

A DART repository contains biological specimens (blood and tumor tissue) from more than 1,000 case and control participants in the Upper Midwest Health Study. Nonidentifying case and control demographics are in a companion database. This repository is available to the scientific community for hypothesis testing to evaluate susceptibility factors in the development of glioma.

**Manuscripts**

Hoppin JA, Umbach DM, Henneberger PK, Kullman GJ, London SJ, Alavanja MCR, Sandler DP (forthcoming). Agricultural factors associated with farmers' lung among farm residents in the Agricultural Health Study.

Valcin M, Henneberger PK, Kullman GJ, Umbach DM, London SJ, Alavanja MCR, Sandler DP, Hoppin JA (forthcoming). Chronic bronchitis among non-smoking farm women in the Agricultural Health Study. Submitted to European Respiratory Journal.

**Presentations**

Baron PA. Generation and behavior of airborne biological particles. Presentation at the Public Health Response to Bioterrorism Meeting, April 8–9, Atlanta, GA.

Baron PA [2002]. Aerosol measurement. Presentation at Department of Civil and Environmental Engineering, University of Cincinnati, February 22, Cincinnati, OH.

Baron PA [2003]. Measurement of fibers. Presentation at Department of Civil and Environmental Engineering, University of Cincinnati, May 16, Cincinnati, OH.

Baron PA, Aizenberg V [2001]. Versatile output dust generation system. Presented at the American Association for Aerosol Research Meeting, October 15–19, Tacoma, WA.

Baron PA, Deye GJ [2005]. Generation of very low density fibrous carbon powders (single walled carbon nanotubes and pyrograf III). Presented at the American Association for Aerosol Research Conference, Oct. 17–21. Austin, TX.

Baron PA, Martinez A [2000]. A large-particle size distribution analyzer. Presented at the American Association for Aerosol Research Meeting, November 6–10, St Louis, MO.

Baron PA, Box M, Echt A, Shulman S [2004]. Sampling issues related to silica. Presentation at the American Society for Testing Materials Symposium on Silica: Sampling and Analysis. April 22–23, Salt Lake City, UT.

Baron PA, Deye GJ, Aizenberg V, Castranova V [2001]. Generation of size-selected fibers for a nose-only inhalation toxicity study. Presented at Inhaled Particles, September 2–6, Cambridge, UK.

Baron PA, Martinez A, Jones E [2003]. Droplet distortion effects in aerodynamic particle sizing instruments. 22nd American Association for Aerosol Research Conference. Anaheim, CA, October 20–24. Also at Particulate Matter (AAAR), March 31–April 4, Pittsburgh, PA.

Baron PA, Maynard A, Porter D, Castranova V [2002]. Measurement of an ultra-low-density particle aerosol. Am Association for Aerosol Research Annual Meeting, October, Charlotte, NC.

Baron PA, Maynard A, Reese T, Fotedar L [2001]. Preliminary measurements of carbon nanotube material in aerosol form. Nanospace, March 25–29, Galveston, TX.

Baron PA, Maynard AD, Shvedova A, Kisin K, Murray A, Gandelsman V, Foley M, Castranova V [2003]. preliminary studies of generation, exposure, and toxicity of carbon nanotubes. 22nd American Association for Aerosol Research Conference. October 20–24, Anaheim ,CA.

Baron PA, Shulman S, Ramsey D, Volkwein J, Vinson R, O'Shaughnessy P, Ramachandran G [2004]. Evaluation of size distribution measurement precision obtained with a personal cascade impactor. Presented at the European Aerosol Conference, September 6–10. Budapest, Hungary.

Butler MA, Ruder AM, Carreón T, Waters MA, Yeager M, Welch R, Chanock S, Schulte PA [2004]. Polymorphisms in the estrogen metabolism genes CYP17, CYP1B1, CYP1A2, COMT and ER alpha and susceptibility to primary intracranial brain gliomas in women. Proc Am Assn Cancer Res *45*:4511. Presented at AACR, Orlando, Florida, March.

Butler M, Ruder A, Carreón T, Waters M, Yeager M, Welch R, Chanock S, Schulte P [2005]. Polymorphisms in DNA repair genes and susceptibility to primary intracranial brain gliomas. Neuro-Oncology *7*:287. Presented at Second quadrennial meeting of the World Federation of NeuroOncology, Edinburgh, Scotland, May.

Butler MA, Ruder AM, Daly AK, Waters MA, Carreón T, Schulte PA [2003]. Polymorphisms in GSTM1, GSTT1, GSTP1, and NAT2 and susceptibility to primary intracranial brain gliomas. Proc Am Assn Cancer Res *44*:128. Presented at AACR, Washington, DC, August.

Butler MA, Ruder AM, Levine AJ, Werren DM, ONeill VL, Masterson KJ, Schulte PA [1999]. Successes in biological specimen collection from cancer cases and controls in rural areas. Proc Am Assn Cancer Res *40*:612. Presented at the AACR, Philadelphia, Pennsylvania, March.

Butler MA, Ruder AM, Waters MA, Daly AK, Schulte PA [2001]. Successes in DNA preparation for identification of biomarkers of exposure, effects of exposure, and susceptibility in cancer cases and controls in rural areas. Proc Am Assn Cancer Res *42*:885–886. Presented at the AACR, New Orleans, Louisiana, March.

Carreón T, Butler MA, Ruder AM, Waters MA, Davis-King KE, Calvert GM, Schulte PA, Connally LB, Ward EM, Sanderson WT, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G [2003]. Farm exposure to pesticides and glioma in women. Proc Am Assn Cancer Res 44:1466–1467. Presented at AACR, Washington, DC, August.

Carreon T, Ruder AM, Waters MA, Butler MA, Yeager M, Welch R, Chanock S, Schulte PA [2006]. Lead exposure and glioma among rural residents: The Upper Midwest Health Study. Am J Epidemiol *163*:S251. Presented at Congress of Epidemiology, Seattle, Washington, June.

Curwin BD, Hein MJ, Sanderson WT, Striley C, Heederik D, Kromhout H, Reynolds SJ, Alavanja M. Pesticide dose estimates for children of Iowa farmers and non-farmers. Abstract presented at the ISEA/ISEE International Conference on Environmental Epidemiology and Exposure, September 2 – 6, 2006, Paris, France

Curwin BD, Hein MJ, Sanderson WT, Striley C, Heederik D, Reynolds SJ, Alavanja M. Urinary pesticide levels in Iowa farm spouses and children. Abstract presented at the 15th Annual Conference of the International Society for Exposure Analysis, Tuscon, Arizona October 30 – November 3, 2005

Curwin BD, Hein MJ, Sanderson WT, Nishioka N, Buhler W. Nicotine Exposure and Decontamination on Tobacco Harvesters' Hands. Abstract presented at the 14th

Annual Conference of the International Society for Exposure Analysis, Philadelphia, Pennsylvania October 17-21, 2004.

Curwin BD, Hein MJ, Sanderson WT, Barr D, Reynolds SJ, Ward E, Alavanja M. Urinary Pesticide Levels Among Farmers and Non-Farmers in Iowa. Abstract presented at X2004: Exposure Assessment in a Changing Environment, Utrecht, Netherlands June 16-18, 2004

Curwin BD, Hein MJ, Sanderson WT, Reynolds SJ, Nishioka M, Ward E, Alavanja M. Farm Family Take-Home Pesticide Exposure Study. Abstract presented at 2003 American Industrial Hygiene Conference and Expo, Dallas, Texas May 12-15, 2003

Curwin BD, Brown A, Acquavella J. International Symposium on Agricultural Exposures and Cancer: Exposure Assessment Summary. Summary presented at the International Symposium of Agricultural Exposure and Cancer, Oxford, England November 18-22, 2002.

Curwin BD, Hein MJ, Sanderson WT, Nishioka N, Buhler W. Acephate Exposure and Decontamination on Tobacco Harvesters' Hands. Abstract presented at the 12th Annual conference of the International Society for Exposure Analysis, Vancouver, British Columbia, Canada August 11-15, 2002.

Curwin BD, Sanderson WT, Reynolds SJ, Nishioka M, Ward E, Alavanja M. Pesticide Contamination Inside Farm and Non-Farm Homes and Vehicles. Abstract presented at the 12th Annual conference of the International Society for Exposure Analysis, Vancouver, British Columbia, Canada August 11-15, 2002.

Curwin BD, Sanderson WT, Reynolds SJ, Hein MJ, Alavanja M. Pesticide Use and Practice Among 25 Farms Enrolled in the Iowa Farm Family Pesticide Exposure Study. Abstract presented at the 2002 American Industrial Hygiene Conference and Expo, San Diego, California June 3-6, 2002.

Doswell WM, Kesner JS, Knecht EA [1998]. Urine endocrine measurements during female pubertal onset. Society for Research on Adolescence.

Draheim L, Falk C, Anderson HA, Handrahan L, Steenport D, Schrader S, Turner T, The Great Lakes Consortium [1997]. Male reproductive function studies: challenges in recruiting men for semen collection clinics. Presentation at Health Conference 97, Montreal, Canada, May 12–15.

Hines CJ, Deddens J [2002].Biological and air monitoring of chlorpyrifos exposures among termiticide applicators: application of mixed-effect models. AIHCE, San Diego, CA, June 3–6.

Holland SE, Garry VF, Schrader SM, Kesner JS, Knecht EA [2002]. testosterone levels in male pesticide applicators and the sex of their children. 27th Annual Meeting of the American Society of Andrology, Seattle, Washington, April 24–27, Journal of Andrology Suppl.

Hoppin JA, Umbach DM, London SJ, Henneberger PK, Kullman GJ, Alavanja MCR, Sandler DP [2006]. Pesticide Exposure and Allergic and Non-Allergic Asthma in the Agricultural Health Study. 2nd North American Congress of Epidemiology, 2006 Society for Epidemiologic Research, Seattle, WA, June 21–24.

Huang K, Whelan EA, Ruder AM, Deddens J, Davis-King KE, Carreón T, Waters MA, Butler MA, Calvert GM, Schulte P, Zivkovich Z, Heineman E, Mandel J, Morton R, Reding D, Rosenman K, Brain Cancer Collaborative Study Group [2003]. Reproductive factors and risk of glioma in women. Proc Am Assn Cancer Res 44:1365. Presented at AACR, Washington, DC, August.

Kesner JS [1997]. Evaluating the effects of occupational hazards on the reproductive health of women. Indiana American Industrial Hygiene Association Conference, Indianapolis, IN, September 13.

Kesner JS [1998]. Evaluating the effects of occupational hazards on the reproductive health of women. 10th Annual Meeting, Allegheny-Erie Regional Chapter of the Society of Toxicology, Pittsburgh, PA, May 15.

Kesner JS [1999]. Evaluating the effects of occupational hazards on the reproductive health of women. Indiana American Industrial Hygiene Association Conference, Indianapolis, IN, September 13.

Kesner JS [2004]. Biological evaluation of menstrual cycle function in women exposed to occupational and environmental hazards. International Congress on the Prevention of Occupational and Environmental Disorders of Reproductive Health, June 30, Volgograd, Russia.

Kesner JS, Knecht EA, Krieg EF Jr [1997]. Measuring endocrine profiles of women in field studies. International Symposium on Environment, Lifestyle & Fertility, Aarhus, Denmark, December 9.

Kesner JS, Knecht EA, Krieg EF Jr [2003]. Assessing the endocrine effects of occupational exposures on menstrual cycle function. International Conference on Environment and Health, Perm, Russia, May 13–18.

Knecht EA, Krieg EF Jr, Clark JC, Kesner JS [2002]. Urinary creatinine measurement using a Vitros 250 chemistry analyzer compared with the Jaffe method. 54th Annual Meeting of the American Association for Clinical Chemistry, July 30, Orlando, FL. Clin Chem *48*:A55.

MoormanWJ, Cheever KL, Skaggs SR, Clark JC, Turner TW, Marlow KL, Schrader SM [1999]. Male adolescent exposure to endocrine disrupting pesticides: vinclozolin exposure in peripubertal rabbits. Presented at Molecular Aspects of Male Reproductive Toxicology. November 13–14, Rauischholzhausen, Germany.

Ruder AM for the Brain Cancer Collaborative Study Group [2004]. The Upper Midwest Health Study: Etiologic agents and susceptibility markers in adult glioma. Society for Neuro-Oncology Ninth Annual Conference, Toronto, Canada: November.

Ruder A [2006]. Polymorphisms in genes for enzymes affecting folate metabolism and risk of glioma: The Upper Midwest Health Study. Brain Tumor Epidemiology Consortium meeting, Visby, Sweden, May.

Ruder AM, Butler MA, Sanderson W, Carreón T, Waters MA [2001]. Development of a retrospective pesticide reference data base. Presented at the American Public Health Association meeting, Atlanta, Georgia, October.

Ruder AM, Waters MA, Carreón T, Butler MA, Davis-King KE, Calvert GM, Schulte PA, Ward EM, Connally LB, Lu J, Wall D, Zivkovich Z, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2003]. The Upper Midwest Health Study: A case-control study of primary intracranial gliomas among rural residents: demographics. Am J Epidemiol 157:S14. Presented at SER, Atlanta, Georgia, June.

Ruder AM, Waters MA, Butler MA, Carreón T, Calvert GM, Davis-King KE, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2003]. Farm exposure to individual pesticides and glioma in men. Proc Am Assn Cancer Res 44:1466. Presented at AACR, Washington, DC, August.

Schrader SM [1998]. Methods of assessing male reproductive capacity. Hazardous Substances and Male Reproductive Health—An International Conference. New York, May 14–15.

Schrader SM [2003]. Occupational exposures and altered semen quality; what are the risk factors? Presented at the 28th meeting of the American Society of Andrology, Phoenix, AZ. March 31.

Schrader SM, Garry VF [2001]. Abnormal sperm morphology and offspring sex ratio in male fungicide applicators. International Workshop on Endocrine Disrupting Chemicals and Their Toxicological Evaluation. Presented in Tsukiba, Japan, Feburary.

Valcin M, Henneberger PK, Kullman GJ, Umbach DM, London SJ, Alavanja MCR, Sandler DP, Hoppin JA [2006]. Risk factors for chronic bronchitis among non-smoking farm women in the agricultural health study. 2nd North American Congress of Epidemiology, 2006 Society for Epidemiologic Research, Seattle, Washington, June 21–24.

Wainman B, Tsuji L, Nieboer E, Kesner J, Weber J-P, Vasquez R [2004]. The effects of persistent organic pollutants (POPs) and toxic metals (TMs) on menstrual cycle function in the Cree of Western James Bay, Canada [Abstract]. International Federation of Fertility Societies 18th World Congress on Fertility & Sterility. May 23–28, Montreal, Canada.

Waters M, Ruder A, Echeverria D [1999]. A new method for retrospective occupational exposure data collection in a case-control study of cancer. Proc Am Indus Hyg Conf Expos 59A:46. Presented at the AIHCE, Toronto, Ontario, June.

Waters M, Stewart P [1999]. Development of a solvent exposure data base for use in case-control studies. Presented at the International Symposium on Occupational Exposure Databases and Their Application for the Next Millennium, London, England, November.

Waters M, Stewart P, Ruder A [2003]. Development of a chlorinated solvent exposure data base for use in case-control studies. Presented at the International Society for Exposure Assessment, Stresa, Italy, September.

Waters MA, Stewart PA, Ruder AM [2004]. Some specific examples using an exposure determinants data base for case-control exposure assessment. Tijdschrift voor toegepaste Arbowetenschap *2*(Suppl):5. Presented at Exposure Assessment in a Changing Environment, Utrecht, The Netherlands, June.

**Publications**

Aizenberg VA, Choe K, Grinshpun SA, Willeke K, Baron PA [2001 Evaluation of personal aerosol samplers challenged with large particles. J Aerosol Sci *32*(6):779–793. (ISI Web of Science: Cited 10 times as of 11/20/06)

Aizenberg V, Grinshpun SA, Willeke K, Smith JP, Baron PA [2000]. Performance characteristics of the button personal aerosol sampler. Am Ind Hyg Assoc J *61*(3):398–404. (ISI Web of Science: Cited 25 times as of 11/20/06)

Aizenberg V, Grinshpun SA, Willeke K, Smith JP, Baron PA [2000]. Measurement of the sampling efficiency of personal inhalable aerosol samplers. J Aerosol Sci *31*:169–179. (ISI Web of Science: Cited 11 times as of 11/20/06)

Ames RG, Steenland K, Jenkins B, Chrislip DW, Russo JR [1995]. Chronic neurologic sequelae to cholinesterase inhibition among agricultural pesticide applicators. Arch Environ Hlth *50*(6):440–444. (IS I Web of Science: Cited 42 times as of 11/20/06)

Anger WK, Letz R, Chrislip DW, Frumkin H, Hudnell K, Russo JM, ChappellW, Hutchinson L [1994]. Neurobehavioral test methods for environmental health studies of adults. Neurobehavioral Toxico Teratol *16*(5):489–497. (IS I Web of Science: Cited 31 times as of 11/20/06)

Arbuckle TE, Schrader SM, Cole D, Hall JC, Bancej CM, Turner LA, Claman P [1999]. 2,4-D residues in semen of Ontario farmers. Reproductive Toxicol *13*:421–429. (ISI Web of Science: Cited 24 times as of 11/20/06)

Baird DD, Weinberg CR, Zhou H, Kamel F, McConnaughey DR, Kesner JS, Wilcox AJ [1999]. Preimplantation urinary hormone profiles and the probability of conception in healthy women. Fertil Steril *71*:40–49. (ISI Web of Science: Cited 24 times as of 11/20/06)

Baron PA [1991]. Measurement of airborne fibers: a review. Ind Health (Japan) *39*(2):39–50.

Baron PA [ 2001]. Evaluation of alternate cyclones for respirable dust sampling. Technical Report Submitted to OSHA.
Baron PA [2002]. Using a Filter bypass leakage test for aerosol sampling cassettes. (Case Studies Column, Dawn Tharr, ed.) Appl Occup Environ Hyg *17*(9):593–597.

Baron PA [2004]. Chapter L: Measurement of Fibers. In: NIOSH Manual of Analytical Methods. Cincinnati, NIOSH.

Baron PA [2004]. Chapter N: Aerosol sampling: minimizing particle loss from cassette bypass leakage. In: NIOSH Manual of Analytical Methods. Cincinnati, NIOSH.

Baron PA [2004]. Chapter O: Factors affecting aerosol sampling. In: NIOSH Manual of Analytical Methods. Cincinnati, NIOSH.

Baron PA, Bennett J [2002]. Calculation of leakage in plastic filter cassettes. Aerosol Sci Technol *36*(5):632–641. (ISI Web of Science: Cited 2 times as of 11/20/06)

Baron PA, John W [2000]. Sampling for thoracic aerosol. In: ACGIH Monograph on Particle Size Selective Sampling in the Workplace ACGIH, Cincinnati OH.

Baron PA, Heitbrink W [2001]. An approach to performing aerosol measurements. In: Baron PA, Willeke J, eds. Aerosol Measurement: Principles, Techniques, and Applications. J. Wiley & Sons.

Baron PA, Willeke K, eds. [2001]. Aerosol Measurement: Principles, Techniques, and Applications. 2nd ed., J. Wiley & Sons.

Baron PA, Willeke K [2001]. Bridging science and application in aerosol measurement: accessing available tools. In: Ruzer L, Harley N, eds. Aerosol Measurement: Principles, Techniques, and Applications. 2nd ed., J. Wiley & Sons.

Baron PA, Willeke K [2001]. Aerosol fundamentals. In: Baron PA, Willeke K, eds. Aerosol Measurement: Principles, Techniques, and Applications. J. Wiley & Sons..

Baron PA, Willeke K [2001]. Gas and particle motion. In: Baron PA, Willeke J, eds. Aerosol Measurement: Principles, Techniques, and Applications. J. Wiley & Sons.

Baron P, Deye GJ, Aizenberg V, Castranova V [2002]. Generation of size-selected fibers for a nose-only inhalation toxicity study. In: Ogden TL, Donaldson K, Cherry N, eds. Inhaled Particles IX. Annals of Occupational Hygiene.

Baron PA, Khanina A, Grinshpun S [2002]. Preventing leakage and dust loss in plastic filter cassettes: a particle count leak test. Aerosol Sci Technol (2002) 36(8) 857-865.

Baron PA, Maynard AD, Foley M [2003]. Evaluation of aerosol release during the handling of unrefined carbon nanotube material. NIOSH Report NTIS PB2003–102401.

Baron PA, Mazumder MK, Chen YS [2001]. Direct Reading Techniques Using Optical Particle Detection. In: Baron PA, Willeke J, eds. Aerosol Measurement: Principles, Techniques, and Applications. J. Wiley & Sons.

Baron PA, Sorenson CM, Brockmann JM [2001]. nonspherical particles: shape factors, fractals and fibers. In: Baron PA, Willeke J, eds. Aerosol Measurement: Principles, Techniques, and Applications. J. Wiley & Sons.

Barr D, Landsittel D, Nishioka M, Thomas K, Curwin B, Raymer J, Donnelly KC, McCauley L, Lasarev M, Ryan PB [2006]. A survey of laboratory and statistical issues related to farmworker studies. Environmental Health Perspectives 114(6):961-968 doi:10.1289/ehp.8528. [Online 16 February 2006]

Barr D, Thomas K, Curwin B, Landsittel D, Raymer J, Lu C, Donnelly KC, Acquavella J [2006]. Biomonitoring of exposure in farmworker studies. Environmental Health Perspectives 114(6):936-942 doi:10.1289/ehp.8527. [Online 16 February 2006]

Bartley D L, Martinez, AB, Baron PA, Secker DR, Hirst E [2000]. droplet distortion in accelerating flow. J Aerosol Sci *31*(12):1447–1460. (ISI Web of Science: Cited 4 times as of 11/20/06)

Biagini RE, MacKenzie BA, Sammons DL, Smith JP, Striley CAF, Robertson SK, Snawder JE [2004]. Evaluation of the prevalence of antiwheat-, anti-flour dust, and anti-alpha-amylase specific IgE antibodies in US blood donors. Ann Allergy Asthma Immun *92*(6):649–653, (ISI Web of Science: Cited 1 time as of 11/20/06) NN: 20025383.

Biagini RE, Murphy DM, Sammons DL, Smith JP, Striley CA, MacKenzie BA [2002]. Development of multiplexed fluorescence microbead covalent assays

(FMCAs) for pesticide biomonitoring. Bull Environ Contam Toxicol *68*(4):470–477, NN: 20023004.(ISI Web of Science: Cited 6 times as of 11/20/06)

Biagini RE, Smith JP, Sammons DL, MacKenzie BA, Striley CA, Robertson SK, Snawder JE [2004]. Development of a sensitivity enhanced multiplexed fluorescence covalent microbead immunosorbent assay (FCMIA) for the measurement of glyphosate, atrazine and metolachlor mercapturate in water and urine. Anal Bioanal Chem *379*(3):368–374, NN 20026130. (ISI Web of Science: Cited 2 times as of 11/20/06)

Buck, GM, Lynch CD, Stanford JB, Sweeney AM, Schieve LA, Rockett JC, Selevan SG, Schrader SM [2004]. Prospective pregnancy study designs for assessing reproductive and developmental toxicants. Environ Health Perspect *112*:79–86. (ISI Web of Science: Cited 11 times as of 11/20/06)

Butler MA, Ruder AM, Carreón T, Waters MA, Yeager M, Welch R, Chanock S, Schulte PA [2004]. Polymorphisms in the estrogen metabolism genes CYP17, CYP1B1, CYP1A2, COMT and ER alpha and susceptibility to primary intracranial brain gliomas in women. Proc Am Assn Cancer Res *45*:4511.

Butler M, Ruder A, Carreón T, Waters M, Yeager M, Welch R, Chanock S, Schulte P [2005]. Polymorphisms in DNA repair genes and susceptibility to primary intracranial brain gliomas. Neuro-Oncology *7*:287.

Butler MA, Ruder AM, Daly AK, Waters MA, Carreón T, Schulte PA [2003]. Polymorphisms in GSTM1, GSTT1, GSTP1, and NAT2 and susceptibility to primary intracranial brain gliomas. Proc Am Assn Cancer Res *44*:128.

Butler MA, Ruder AM, Levine AJ, Werren DM, ONeill VL, Masterson KJ, Schulte PA [1999]. Successes in biological specimen collection from cancer cases and controls in rural areas. Proc Am Assn Cancer Res *40*:612.

Butler MA, Ruder AM, Waters MA, Daly AK, Schulte PA [2001]. Successes in DNA preparation for identification of biomarkers of exposure, effects of exposure, and susceptibility in cancer cases and controls in rural areas. Proc Am Assn Cancer Res *42*:885–886.

Calvert GM, Mueller CA, Fajen JM, Chrislip D, Russo J, Briggle T, Fleming LE, Suruda AJ, Steenland K [1998]. Health effects associated with sulfuryl fluoride and methyl bromide exposure among structural fumigation workers. Am J Public Health *88*:1774–1780. (ISI Web of Science: Cited 10 times as of 11/20/06)

Carreón T, Butler MA, Ruder AM, Waters MA, Davis-King KE, Calvert GM, Schulte PA, Connally LB, Ward EM, Sanderson WT, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G [2003]. Farm exposure to pesticides and glioma in women. Proc Am Assn Cancer Res 44:1466–1467.

Carreón T, Butler MA, Ruder AM, Waters MA, Davis-King KE, Calvert GM, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2005]. Gliomas and farm pesticide exposure in women. *Environ Health Perspect 113*(5):546–551. (ISI Web of Science: Cited 1 time as of 11/20/06)

Carreon T, Ruder AM, Waters MA, Butler MA, Yeager M, Welch R, Chanock S, Schulte PA [2006]. Lead exposure and glioma among rural residents: The Upper Midwest Health Study. Am J Epidemiol *163*:S251.

Connally LB, Schulte PA [1996]. Cancer control in rural farm populations. J Rural Health 12:255–257.

Connally LB, Schulte PA, Alderfer RJ, Goldenhar LM, Calvert GM, Davis-King KE et al. [1996]. Developing the National Institute for Occupational Safety and Health's cancer control demonstration projects for farm populations. J Rural Health *12*:258–264. (IS I Web of Science: Cited 2 times as of 11/20/06)

Castranova V, Jones W, Blake T, Ye J, Shi X, Deye JG, Baron P [2000]. Critical role of fiber length in the bioactivity and cytotoxicity of glass fibers. In 23rd Cotton and Other Organic Dusts Conference. Memphis, TN, National Cotton Council.

Chen C-C, Yu T-S. Shih T-S, Baron P [2001]. computer simulation of particle count overlap in fiber count samples. AIHAJ *62*(3):281–287.

Curwin B, Sanderson W, Reynolds S, Hein M, Alavanja M [2002]. Pesticide use and practices in an Iowa farm family pesticide exposure study. J Agric Saf Health 8: 423-33.

Curwin B, Brown A, Acquavella J [2005]. International symposium on agricultural exposures and cancer: Sessions on exposure assessment. Scandinavian Journal of Work, Environment and Health 31(suppl 1):63-65

Curwin BD, Hein MJ, Sanderson WT, Barr DB, Heederik D, Reynolds SJ et al. [2005]. Urinary and hand wipe pesticide levels among farmers and nonfarmers in Iowa. J Expo Anal Environ Epidemiol 15: 500-8

Curwin BD, Hein MJ, Sanderson WT, Nishioka M, Reynolds SJ, Ward E, Alavanja M [2005]. Pesticide contamination inside farm and non-farm homes. Journal of Occupational and Environmental Hygiene 2(7):357-367

Curwin BD, Hein MJ, Sanderson WT, Striley C, Heederik D, Kromhout H, Reynolds SJ, Alavanja M [006] Urinary pesticide concentrations among children, mothers, and fathers living in farm and non-farm households in Iowa. Annals of Occupational Hygiene doi:10.1093/annhyg/mel062 [online September 19, 2006]

Curwin BD, Hein MJ, Sanderson WT, Nishioka M, Buhler W [2005] Nicotine exposure and decontamination on tobacco harvesters' hands. Ann Occ Hyg 49(5):407-413 doi:10.1093/annhyg/meh112

Curwin BD, Hein MJ, Sanderson WT, Nishioka M, Buhler W [2003]. Acephate exposure and decontamination on tobacco harvesters' hands. Journal of Exposure Analysis and Environmental Epidemiology 13(3):203-210

Dick RB, Steenland K, Krieg EF, Hines CJ [2003]. Evaluation of acute sensory-motor effects and test sensitivity using termiticide workers exposed to chlorpyrifos. Neurotoxicol Teratol 2001; 23:381–393. (ISI Web of Science: Cited 9 times as of 11/20/06)

Dunn KH [2003]. NIOSH research on controlling carbon monoxide poisoning on boats, U.S. DHHS, CDC, NIOSH.

Dunn KH [2003]. NIOSH research on generator exhaust configurations and carbon monoxide houseboats, U.S. DHHS, CDC, NIOSH.

Dunn, KH, Shulman S, et al[2003]. Carbon monoxide and houseboats: an evaluation of a stack exhaust system to reduce poisonings associated with generator exhaust. Professional Safety: 47–5

Dunson DB, Weinberg CR, Baird DD, Kesner JS, Wilcox AJ [2001]. Assessing human fertility using several markers of ovulation. Stat Med *20*:965–978. (IS I Web of Science: Cited 17 times as of 11/20/06)

Earnest GS, Dunn KH, et al.[2003]. Computational fluid dynamic modeling of carbon monoxide emissions and exposures on a ski boat, U.S. DHHS, CDC, NIOSH.

Earnest GS, Echt A, et al.[2003]. Carbon monoxide emissions and exposures on recreation boats under various operating conditions at Lake Mead, Nevada, and Lake Powell, Arizona, April 22–25, 2002, U.S. DHHS, CDC, NIOSH.

Earnest GS, Echt A, et al. [2004]. Carbon monoxide emissions and exposures on recreational boats, U.S. DHHS, CDC, NIOSH.

Earnest GS, Hall R, et al. [2003]. An evaluation of vertical exhaust stacks and aged production emission control devices to prevent carbon monoxide poisonings from houseboat generator exhaust at Callville Bay Marina, Boulder City, NV, September 30–October 3, 2002, U.S. DHHS, CDC, NIOSH.

Earnest G , Hammond D, et al.[2003]. An update on recreational boating carbon monoxide control work under the NIOSH—Coast Guard IAG, U.S. DHHS, CDC, NIOSH.

Earnest GS, Mickelsen RL, McCammon JB, O'Brien DO [1997]. Carbon monoxide poisoning from small gasoline-powered engines: just what is a well-ventilated area? Am Ind Hyg Assoc J *58*:787–791. (ISI Web of Science: Cited 4 times as of 11/20/06)

Echt A, Earnest GS, et al. [2003]. Carbon monoxide emissions and exposures on recreation boats under various operating conditions at Lake Norman, North Carolina, Arizona, May 13–16, 2002, U.S. DHHS, CDC, NIOSH.

Gao P, Chen BT, Baron PA, Soderholm SC [2002]. A numerical study of the performance of an aerosol sampler with a curved, blunt, multi-orificed inlet. J Aerosol Sci *36*(5):540–553. (ISI Web of Science: Cited 1 time as of 11/20/06)

Garry VF, Burroughs B, Tarone R, Kesner JS [1999] Pesticides and adjuvants: an evolving view. Toxicol Ind Health *15*:159–167. (IS I Web of Science: Cited 13 times as of 11/20/06)

Garry VF, Tarone RE, Kirsch IR, Abdallah JM, Lombardi DP, Long LK, Burroughs BL, Barr DB, Kesner JS [2001]. Biomarker correlations of urinary 2,4-D levels in foresters: genomic instability and endocrine disruption. Environ Health Perspect *109*:495–500. (IS I Web of Science: Cited 16 times as of 11/20/06)

Gardiner JC, Mullan PB, Rosenman KD, Zhu Z, Swanson GM [1995]. Mammography usage and knowledge about breast cancer in a Michigan farm population before and after an educational intervention. J Cancer Educ *10*:155–162. (IS I Web of Science: Cited 15 times as of 11/20/06)

Goldsmith DF, Sisneros GC [1996]. Cancer prevention strategies among California farm workers: preliminary findings. J Rural Health *12*:343–348. (IS I Web of Science: Cited 5 times as of 11/20/06)

Gressel MG, Kovein, RK [2002]. Current methods and future trends in video exposure monitoring, U.S. DHHS, PHS, CDC, NIOSH.

Gressel MG, Kovein RJ, Hentz PA [1994]. Potential problems associated with the rustrack ranger date logger's data storage technique. Am Ind Hyg Assoc J *55*:970.

Hall RM, Heitbrink WA [1996]. Agriculture environmental enclosure project and aerosol complications. U.S. DHHS, PHS, CDC, NIOSH.

Hall RM, Heitbrink WA [1996]. Closeout letter for lift-top cab. Yakima, Washington, February 14, U.S. DHHS, PHS, CDC, NIOSH.

Hall RM, Heitbrink WA [1996]. Protocol for a field evaluation of agricultural enclosures. U.S. DHHS, PHS, CDC, NIOSH.

Hall RM, Heitbrink WA [1996]. In-depth survey report: control technology for agricultural enclosures at John Deere Manufacturing Co., Inc., April 15–19 and August 5–9. (U.S. DHHS, PHS, CDC, NIOSH, July 1997.) Engineering Control Technology Report Number ECTB 223–13a.

Hall RM, Heitbrink WA, et al. [2000]. Evaluation of a tractor cab using real-time aerosol counting instrumentation. Appl Occup Environ Hyg

Hall RM, Heitbrink WA, McGlothlin JD [1997]. In-Depth Survey Report: Control technology for agricultural enclosures at Nelson Manufacturing Co., Inc., Yuba City, CA, October 9–11, 1996. U.S. DHHS, PHS, CDC, NIOSH, July 1997. Engineering Control Technology Report Number ECTB 223–11b.

Hall R M, Earnest G, et al. [2004]. Evaluation of houseboat stack exhaust systems used with gasoline generators, U.S. DHHS, CDC, NIOSH.

Hall R M, Earnest G, et al. [2005]. Evaluation of carbon monoxide emissions from engines on recreational boats equipped with prototype catalysts. Appl Occup Environ Hyg.

Hall RM, Earnest G [2003]. Control of carbon monoxide exposures on houseboats, U.S. DHHS, CDC, NIOSH.

Hall RM, McCammon JB, et al. [2003]. NIOSH efforts to prevent carbon monoxide poisonings on houseboats and other vessels, U.S. DHHS, CDC, NIOSH.

Hammond D, Earnest G, et al. [2003]. An evaluation of issues related to the performance of dry exhaust stacks to prevent carbon monoxide poisonings on houseboats, U.S. DHHS, CDC, NIOSH.

Hammond D, Earnest G, et al. [2004]. an evaluation of factors that might influence exhaust stack performance to prevent carbon monoxide poisonings from houseboat generator exhaust at Lee's Ford Marina, Somerset, Kentucky, August 4–7, 2003, U.S. DHHS, CDC, NIOSH.

Hammond D, Marlow DA [2004]. Follow up evaluation of design changes to a houseboat generator exhaust stack system, at Sumerset Acquisitions LLC, Somerset, Kentucky, August 27, 2003, U.S. DHHS, CDC, NIOSH.

Hanrahan LP, Anderson HA, Haskins LK, Olson J, Lappe K, Reding D. 1996. Wisconsin farmer cancer mortality, 1981 to 1990: selected malignancies. J Rural Health 12: 273-7. (IS I Web of Science: Cited 2 times as of 11/20/06)

Heitbrink WA [1998]. Practical Air Contaminant Control Lessons Learned by NIOSH's Engineering Control Technology Branch. U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Earnest GS, et al. [1999]. Evaluation of leakage from a metal machining center using tracer gas methods: a case study. Am Ind Hyg Assoc J *60*(6):785–788.

Heitbrink WA, Hall RM [1998]. Closeout letter for Griffith Farms, Exeter, California, September 24–25, U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Hall RM, et al. [1999]. Review of ambient aerosol test procedures at ASAE Standard S525. J Agric Safety Health *4*(4):255–266.

Heitbrink WA, Hall RM, et al. [1999]. Use of ambient aerosol for testing agricultural cabs for protection against pesticide aerosol. Am J Ind Med *1*(Suppl):75–76.

Heitbrink WA, Moyer E [2000]. In-Depth Survey Report: Control Technology for Environmental Enclosures: An Evaluation of In-Use Enclosures at San Joaquin Helicopter Company, Delano, CA, September 20–22 and October 26–28, U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Moyer E [2000]. In-Depth Survey Report: Control Technology for Environmental Enclosures: An Evaluation of In-Use Enclosures at Sun Pacific, Bakersfield, CA, October 27, U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Moyer E, et al. [2001]. Environmental agricultural tractor cab filter efficiency and field evaluation. Am Ind Hyg Assoc J.

Heitbrink WA, Moyer E, et al. [2002]. Environmental Tractor Cab(s), Filter Efficiency, and Field Evaluation. University of Iowa/U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Thimons E [1999]. In-Depth Survey Report: Control Technology for Environmental Enclosures—The Effect of Wind Speed Upon Aerosol Penetration into an Enclosure at Clean Air Filter, Defiance, Iowa, August 3–7 and October 19–23, 1998, U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Thimons ED, et al. [2000]. Static Pressure Requirements for Ventilated Enclosures. Ventilation 2000, 6th International Symposium on Ventilation for Contaminant Control, Helsinki, Finland, Finnish Institute of Occupational Health.

Hines CJ, Deddens JA [2001]. Determinants of chlorpyrifos exposure and urinary 3,5,6-trichloro-2-pyridinol among termiticide applicators. Ann Occup Hyg *45*:309–321. (IS I Web of Science: Cited 14 times as of 11/20/06)

Hines CJ, Deddens JA, Striley CAF, Biagini RE, Shoemaker DA, Brown KK, Mackenzie BA, Hull RD [2003]. Biological monitoring for selected herbicide biomarkers in the urine of exposed custom applicators: application of mixed-effect models. Ann Occup Hyg *47*(6):503–517,  (ISI Web of Science: Cited 6 times as of 11/20/06) NN: 20023365.

Hines CJ, Deddens JA, Lu CS, Fenske R, Striley CAF [2006]. Mixed-effect models for evaluating multiple measures of atrazine exposure among custom applicators. J Occup Environ Hyg *3*(5):274–283; NN: 20030196.

Holland SE, Garry VF, Schrader SM, Kesner JS, Knecht EA [2002]. testosterone levels in male pesticide applicators and the sex of their children. 27th Annual Meeting of the American Society of Andrology, Seattle, Washington, April 24–27, Journal of Andrology Suppl.

Hooks C, Ugarte C, Silsby J, Brown R, Weinman J, Fernandez G, Foxwell J, Newton N, Connally, LB [1996]. Obstacles and opportunities in designing cancer control communication research for farm workers on the Delmarva Peninsula. J Rural Health *12*:332–342.  (IS I Web of Science: Cited 4 times as of 11/20/06)

Huang K, Whelan EA, Ruder AM, Deddens J, Davis-King KE, Carreón T,  Waters MA, Butler MA, Calvert GM, Schulte P, Zivkovich Z, Heineman E, Mandel J, Morton R, Reding D, Rosenman K, Brain Cancer Collaborative Study Group [2003]. Reproductive factors and risk of glioma in women. Proc Am Assn Cancer Res 44:1365.

Huang K, Whelan EA, Ruder AM, Deddens J, Davis-King KE, Carreón T, Waters MA, Butler MA, Calvert GM, Schulte P, Zivkovich Z, Heineman E, Mandel J, Morton R, Reding D, Rosenman K, Brain Cancer Collaborative Study Group [2004]. Reproductive factors and risk of glioma in women. Cancer Epidem Biomark Prevent 13:1583–1588.  (ISI Web of Science: Cited 3 times as of 11/20/06)

Kesner JS, Knecht EA, Krieg EF Jr, Wilcox AJ, O'Connor JF [1998]. Detecting preovulatory luteinizing hormone surges in urine. Human Reprod *13*:15–21.  (IS I Web of Science: Cited 13 times as of 11/20/06)

Kesner JS, Knecht EA, Krieg EF Jr [1999]. Measuring endocrine profiles of women in field studies. Scand J Work Environ Health *25*(Suppl 1):17–19.  (IS I Web of Science: Cited 3 times as of 11/20/06)

Kesner JS, Knecht EA, Krieg EF Jr [2003]. Assessing the endocrine effects of occupational exposures on menstrual cycle function. In: Izmerov NF, Zaitseva NV, May IV, Shur PZ, Brazhkin AV, Khoroshavin VA, eds. Environmental Health. Russian Health Ministry Scientific & Development Centre for Environmental Safety, Perm, Russia, pp. 194–197 [85–88].

Kesner JS, Lynch DW, Schnorr TM, Schrader SM, Wess JA [1999]. The effects of workplace hazards on female reproductive health. DHHS (NIOSH) Publication No. 99–104.

Krieg EF Jr, Kesner JS, Knecht EA [1999]. An algorithm for detecting features of the hormone profiles of the human menstrual cycle. Computers Biol Med *29*:229–242.
Kristal AR, Goldenhar L, Muldoon J, Morton RF [1997]. Evaluation of a supermarket intervention to increase consumption of fruits and vegetables. Am J Health Promot *11*:422–425. (IS I Web of Science: Cited 12 times as of 11/20/06)

Key-Schwartz R J, Baron PA, Bartley DL, Rice FL, Schlecht PC [2004]. Determination of airborne crystalline silica. In: NIOSH Manual of Analytical Methods. Cincinnati, NIOSH.

Ku B-K, Maynard AD, Baron PA, Deye GJ [2005]. Anomalous responses (arcing electrical discharge) in a differential mobility analyzer caused by ultrafine fibrous carbon aerosols. Presented at the American Association for Aerosol Research Conference, Oct. 17–21, Austin, TX.

Lawson CC, Schnorr TM, Daston GP, Grawjeski B, Marcus M, McDiarmind M, Murono E, Perreault SD, Shelby M, Schrader SM [2003]. An occupational reproductive research agenda for the third millennium. Environ Hlth Perspec *111*:584–591. (ISI Web of Science: Cited 2 times as of 11/20/06)

Lipscomb JC, Barton HA, Tornero Velez R, Evans MV, Alcasey S, Snawder JE, Laskey J [2004]. The metabolic rate constants and specific activity of human and rat hepatic cytochrome P-450 2E1 toward toluene and chloroform. J Toxicol Environ Health, *67*(7):537–553, (ISI Web of Science: Cited 2 times as of 11/20/06)
NN: 20024735..

MacKenzie BA, Striley CAF, Biagini RE, Stettler LE, Hines CJ [2000]. Improved rapid analytical method for the urinary determination of 3,5,6 trichloro-2-pyridinol, a metabolite of chlorpyrifos. Bull Environ Contam Toxicol *65*:1–7. (ISI Web of Science: Cited 10 times as of 11/20/06)

MacKenzie BA, Biagini RE, Sammons DL, Smith JP, Snawder JE, Striley CAF [2003]. Is it really doses and responses instead of dose response? Applying Biomarkers to Occupational Health Practice, Santa Fe, NM, March 24–25, Atlanta, GA: Centers for Disease Control, NN: 20027213.

Mainelis G, Gorny RL, Reponen T, Trunov M, Grinshpun S, Baron P, Yadav J, Willeke K [2002]. Effect of electrical charges and fields on injury and viability of airborne bacteria. Biotechnol Bioeng *79*(2):229–241. (IS I Web of Science: Cited 11 times as of 11/20/06)

Mainelis G, Willeke K, Baron P, Reponen T, Grinshpun S, Gorny RL, Trakumas S [2001]. Electrical charges on airborne microorganisms. J Aerosol Sci *32*(9):1087–1110. (IS I Web of Science: Cited 17 times as of 11/20/06)

Mainelis G, Willeke K, Baron P, Grinshpun S, Reponen T [2002]. Induction charging and electrostatic classification of micrometer-size particles for investigating the electrobiological properties of airborne microorganisms. Aerosol Sci. Technol *36*(4) 479–491. (ISI Web of Science: Cited 5 times as of 11/20/06)

Mainelis B, Willeke K, Baron P, Grinshpun S, Reponen T [2002]. Classification of micrometer-size particles for investigating the electrobiological properties of airborne microorganisms. Aerosol Sci Technol *36*(4):1–13. (ISI Web of Science: Cited 5 times as of 11/20/06)

Mandel JH, Carr WP, Hillmer T, Leonard PR, Halberg JU, Sanderson WT et al. [1996]. Factors associated with safe use of agricultural pesticides in Minnesota. J Rural Health *12*:301–310. (ISI Web of Science: Cited 6 times as of 11/20/06)
Mandel JH, Carr WP, Hillmer T, Leonard PR, Halberg JU, Sanderson WT et al. [2000]. Safe handling of agricultural pesticides in Minnesota: results of a county-wide educational intervention. J Rural Health *16*:148–54. (ISI Web of Science: Cited 2 times as of 11/20/06)

Marlow DA, Guishard C, et al. [2004]. Evaluation of the "fresh air exhausttm" system to reduce carbon monoxide exposure during motor boating and wake surfing at Lake Austin, Texas, May 24–25, U.S. DHHS, CDC, NIOSH.

Mastin JP, Striley CAF, Biagini RE, Hines CJ, Hull RD, MacKenzie BA, Robertson SK [1998]. Use of immunoassays for biomonitoring of herbicide metabolites in urine. Anal Chim Acta *376*(1):119–124, NN: 20027943. (ISI Web of Science: Cited 9 times as of 11/20/06)

Maynard AD, Baron PA [2005]. Aerosols in the industrial environment. In: Ruzer L, Harley N, eds. Aerosols Handbook: Measurement Dosimetry and Health Effects. CRC Press.

Maynard AD, Baron PA, Foley M, Shvedova AA, Kisin ER, Castranova V [2004]. Exposure to carbon nanotube material. I: aerosol release during the handling of unrefined single walled carbon nanotube material. J Tox Environ Health *67*(1):87–107. (IS I Web of Science: Cited 47 times as of 11/20/06)

Moline JM, AL Golden, N Bar-Chama, E Smith, ME Rauch, RE Chapin, SD Perreault, SM Schrader, WA Suk, Landrigan PJ [2000]. Exposure to hazardous substances and male reproductive health: a research framework. Env Health Persp *108*:803–813. (IS I Web of Science: Cited 18 times as of 11/20/06)

Moorman WJ, Ahlers HW, Chapin RE, Daston GP, Foster PMD, Kavlock RJ, Morawetz JS, Schnorr TM, Schrader SM [2000]. Prioritization of NTP reproductive toxicants for field studies. Reprod Toxicol *14*:293–301. (ISI Web of Science: Cited 8 times as of 11/20/06)

MoormanWJ, Cheever KL, Skaggs SR, Clark JC, Turner TW, Marlow KL, Schrader SM [2000]. Male adolescent exposure to endocrine disrupting pesticides: vinclozolin exposure in peripubertal rabbits. Andrologia *32*:285–293. (ISI Web of Science: Cited 5 times as of 11/20/06)

Muldoon JT, Schootman M, Morton RF [1996]. Utilization of cancer early detection services among farm and rural nonfarm adults in Iowa. J Rural Health *12*: 21–31. (IS I Web of Science: Cited 7 times as of 11/20/06)

NIOSH [1993]. Update: NIOSH warns of deadly carbon monoxide hazard from using pressure washers indoors. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 93–117.

NIOSH [1996]. ALERT: Preventing carbon monoxide poisoning from small gasoline-powered engines and tools. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 96–118.

NIOSH/CDPHE/CPSC/OSHA/EPA [1996]. Alert: Preventing Carbon Monoxide Poisoning from Small Gasoline-Powered Engines. National Institute for Occupational Safety and Health, Colorado Department of Public Health and Environment, Consumer Product Safety Commission, Occupational Safety and Health Administration, Environmental Protection Agency, USDHHS, PHS, CDC, NIOSH, Cincinnati, Ohio.

Organiscak JA, Cecala AB, et al. [2002]. NIOSH/Industry collaborative efforts show improved mining equipment cab dust protection. SME 2003 Conference.

Page S, Volkwein JJ, Baron PA, Deye GJ [2000]. Particulate penetration of porous foam used as a low flow rate respirable dust size classifier. Appl Occup Environ Hyg *15*(7):561–568. (IS I Web of Science: Cited 3 times as of 11/20/06)

Peters TM, Evans DE, et al. [2005]. Ultrafine particles in an engine machining and assembly center. Ann Occup Hyg.

Peters TM, Heitbrink WA, et al. [2005]. Particle Concentration Mapping in a Diesel Engine Machining and Assembly Center, U.S. DHHS, CDC, NIOSH/University of Iowa.

Reding D, Anderson H, Lappe K, Hanrahan L, Haskins L [1991]. The Wisconsin Farmers' Cancer Control Project. Wis Med J *90*:443–445. (IS I Web of Science: Cited 3 times as of 11/20/06)

Ruder AM, Waters MA, Butler MA, Carreón T, Calvert GM, Davis-King KE, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2003]. Farm exposure to individual pesticides and glioma in men. Proc Am Assn Cancer Res 44:1466.

Ruder AM, Waters MA, Butler MA, Carreón T, Calvert GM, Davis-King KE, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2006]. Gliomas and farm pesticide exposure in men. Arch Environ Health 2004 *59*: 650–657 (published June 2006).

Ruder AM, Waters MA, Carreón T, Butler MA, Davis-King KE, Calvert GM, Schulte PA, Ward EM, Connally LB, Lu J, Wall D, Zivkovich Z, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Brain Cancer Collaborative Study Group [2006]. The upper midwest health study, a case-control study of primary intracranial gliomas in farm and rural residents. J Agric Safe Health 2006; 12(4).

Ruder AM, Waters MA, Carreón T, Butler MA, Davis-King KE, Calvert GM, Schulte PA, Ward EM, Connally LB, Lu J, Wall D, Zivkovich Z, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2003]. The Upper Midwest Health Study: A case-control study of primary intracranial gliomas among rural residents: demographics. Am J Epidemiol 157:S14.

Ryan TJ, Burroughs GE, et al. [2002]. Video exposure assessments demonstrate excessive laboratory formaldehyde exposures." Applied Occupational and Environmental Hygiene. Analyzing Workplace Exposures Using Direct Reading Instruments and Video Exposure Monitoring Techniques, NIOSH Publication No. 92–104.

Sanderson WT, Talaska G, Zaebst D, Davis-King K, Calvert G [1997]. Pesticide prioritization for a brain cancer case-control study. *Environ Res 74*:133–144. (ISI Web of Science: Cited 7 times as of 11/20/06)

Schrader SM [2003]. Man and the workplace: assessing his reproductive health. Chem Hlth Safety *10*:11–16.

Schrader SM, Arbuckle T, Turner L, Ritter L [1997]. The use of silastic condoms in an exposure assessment occupational field study. J Androl *17*:P–31

Schrader SM, Kesner JS [2002]. Reproductive health: developing partnerships in the study of reproductive hazards in the workplace. DHHS (NIOSH) Publication No. 2002–152.

Schrader SM, Schnorr TM, Wess JA [1996]. The effects of workplace hazards on male reproductive health. DHHS (NIOSH) Publication No. 96–132.
Schrader SM, Turner TW, Shaw PB, Erickson LL, Holland S, Garry VF [2000]. Semen quality of men applying pesticides in Northwest Minnesota. J Androl Suppl 21:50.

Scialli AR, Swan SH, Amler RW, Baird DD, Eskenazi B, Gist G, Hatch MC, Kesner JS, Lemasters GK, Marcus M, Paul ME, Schulte P, Taylor Z, Wilcox AJ, Zahniser C [1997]. Assessment of reproductive disorders and birth defects in communities near hazardous chemical sites. II. Female reproductive disorders. Reprod Toxicol *11*:231–242. (IS I Web of Science: Cited 10 times as of 11/20/06)

Shulte PA, Rice FL, Key-Schwartz RJ, Bartley DL, Baron PA, Schlecht PC, Gressel MG, Echt A [2002]. NIOSH Hazard Review: Health effects of occupational exposure to respirable crystalline silica. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002–129.

Shvedova AA, Kisin ER, Murray AR, Gandelsman VA, Maynard AD, Baron PA, Castranova V [2003]. Exposure to carbon nanotube material ii: assessment of the biological effects of nanotube materials using human keratinocyte. Cells J Toxicol Environ Health *66*(20):1909–1926. (IS I Web of Science: Cited 66 times as of 11/20/06)

Shvedova A, Kisin A, Murray ER, Schwegler-Berry AR, Gandelsman A, Baron P, Maynard A, , Gunther M, Castranova V [2004]. Exposure of human bronchial epithelial cells to carbon nanotubes caused oxidative stress and cytotoxicity. Meeting of the Society for Free Radical Research, European Section. Ioannina, Greece. June 26–29, 2003. ISBN 88–7587–002.

Smith J, Sammons D, Biagini R, Robertson S, Striley C, MacKenzie B, Snawder J [2005]. The use of fluorescence covalent microbead immunosorbent assays (FCMIAS) for multiplexed pesticide biomonitoring. 2005 Toxicology and Risk Assessment Conference, April 25–28, Holiday Inn Conference Center, Fairborn, OH, April, NN: 20030189.

Snawder JE, Lipscomb JC [2000]. Interindividual variance of cytochrome P450 forms in human hepatic microsomes: correlation of individual forms with xenobiotic metabolism and implications in risk assessment. Regul Toxicol Pharmacol *32*(2):200–209, NN: 20020814. (ISI Web of Science: Cited 25 times as of 11/20/06)

Snawder JE, MacKenzie BA, Biagini RE, Sammons DL, Smith JP, Striley CAF [2003]. Development and application of new and existing biological monitoring methods to assess workers exposure to toxic chemicals and their role in hazard identification, evaluation and control. Applying Biomarkers to Occupational Health Practice, Santa Fe, NM, March 24–25, Atlanta, GA: Centers for Disease Control, NN: 20027215.

Steenland K, Dick RB, Howell RJ, Chrislip DW, Hines CJ, Reid TM, Lehman E, Laber P, Krieg EF, Knott C [2000]. Neurologic function among termiticide applicators exposed to chlorpyrifos. Environ Health Perspect *108*:293–300. (IS I Web of Science: Cited 30 times as of 11/20/06)

Steenland K, Jenkins B, Ames RG, O'Malley M, Chrislip DW, Russo JR [1994]. Chronic neurologic sequelae to acute organophosphate pesticide poisoning. Am J Public Health *84*(5):731–736. (IS I Web of Science: Cited 127 times as of 11/20/06)
Strauss S, Wasil JR, et al. [2004]. Carbon monoxide emissions from marine outboard engines. Society of Automotive Engineers, Technical Paper: 1–11. (ISI Web of Science: Cited 7 times as of 11/20/06)

Striley CAF, Biagini RE, Snawder JE, Hines CJ, MacKenzie BA [2000]. Clinical biological monitoring using immunobiochemical methods. Abstracts of the 8th Annual USEPA/NERL Immunochemistry Summit VIII/219th American Chemical Society National Meeting. Part 1, San Francisco, CA: American Chemical Society, p.106, NN: 20021075.

Turner TW, Schrader SM [2006]. Sperm migration assay as measure of recently ejaculated sperm motility in specimens shipped overnight. J Andrology 27 (supplement).

Wang Z, Hopke PK, Baron PA, Deye JG, Cheng Y-S, Su W-C [2005]. Investigation of glass fiber deposition onto inner walls of straight brass tubing. Presented at the American Association for Aerosol Research Conference, Oct. 17–21. Austin, TX.

Wang Z, Hopke PK, Baron PA, Ahmadi G, Cheng Y-S, Deye GJ, Su W-C [2005]. Fiber classification and the influence of average air humidity. Aerosol Sci Technol *39*(11):1056–1063.

Wyrobek AJ, Schrader SM, Perreault SD, Fenster L, Huszar G, Katz DF, Osorio AM, Sublet V, Evenson D [1997]. Guidelines for field studies of male reproductive disorders. Reproduc Toxicol *11*:243–259. (IS I Web of Science: Cited 22 times as of 11/20/06)

Ye J, Shi X, Jones W, Rojanasakul Y, Cheng N, Schwegler-Berry D, Baron PA, Deye JG Li, C, Castronova V [1999]. critical production and transcription factor□role of glass fiber length in tnf- activation in macrophages. Am J Physiol (Lung, Cellular and Molecular Physiology) *276* (Mar (3 Pt 1):L426–L434. (IS I Web of Science: Cited 1 time as of 11/20/06)

Ye J, Zeidler P, Young S-H, Martinez A, Robinson VA, Jones W, Baron P, Shi X, Castranova V [2001]. Activation of mitogen-activated protein kinase p38 and extracellular signal-regulated kinase is involved in  production in macrophages. J Biol glass fiber-induced tumor necrosis factor– Chem *276*(7):5360–5367.  (IS I Web of Science: Cited 13 times as of 11/20/06)

Zeidler PC, Calhoun WJ, Ameredes BT, Deye GJ, Baron PA, Blake T, Castranova V [2003]. Cytotoxicity of size-selected manville code 100 (jm-100) glass fibers on human alveoloar macrophages. Society of Toxicology Annual Meeting, March 9–13, Salt Lake City, UT.

Zeidler PC, Ye J, Jones J, Baron P, Martinez, A, Robinson VA, Landsittel DP, Castranova V [2001] Use of size-selected fibers to evaluate the contribution of length versus chemistry in fiber cytotoxicity. The Toxicol *60*(1):A942.

Zeidler PC, Ye J, Jones W, Baron P, Martinez A, Robinson VA, Landsittel DP, Castranova V [2001]. Use of size-selected fibers to evaluate the contribution of length versus chemistry in fiber cytotoxicity. Society of Toxicology Meeting, March 25–29, San FranciscoCA.

Zeidler-Erdely P, Calhoun WJ, Ameredes BT, Clark MP, Deye GJ, Baron P, Jones W, Blake T, Castranova V [2006]. In vitro cytotoxicity of Manville Code 100 glass fibers: effect of fiber length on human alveolar macrophages. Part. Fibre Toxicol *3*:5.

Zimmer A, Biswas P, Baron P [2001]. The influence of operating parameters on number-weighted aerosol size distribution generated from a gas metal arc welding process. J Aerosol Sci. *33*(3):519–532.

Zimmer AT, Baron PA, Biswas P [2001]. Exhaust recirculation and the control of submicrometer aerosols generated from gas metal arc welding processes. Presented at the American Association for Aerosol Research Meeting, October 15-19, Tacoma, WA.

Zimmer AT, Earnest GS, et al. [2005]. An evaluation of catalytic emission controls and vertical exhaust stacks to prevent carbon monoxide poisonings from houseboat generator exhaust at Callville Bay Marina, Boulder City, Nevada, March 7–9, U.S. DHHS, CDC, NIOSH.

**Thesis**

Cragin LA [in progress]. Menstrual cycle characteristics and reproductive patterns in women exposed to atrazine in drinking water. Thesis for the Degree of Ph.D. from Colorado State University.

## 5.10 References Cited

Arbuckle TE, Schrader SM, Cole D, Hall JC, Bancej CM, Turner LA, Claman P [1999]. 2,4-D Residues in Semen of Ontario Farmers. Reproductive Toxicology 13:421-429.

Baird DD, Weinberg CR, Zhou H, Kamel F, McConnaughey DR, Kesner JS, Wilcox AJ [1999]. Preimplantation urinary hormone profiles and the probability of conception in healthy women. Fertil Steril 71:40-49.

Biagini RE, Murphy DM, Sammons DL, Smith JP, Striley CA, MacKenzie BA [2002]. Development of multiplexed fluorescence microbead covalent assays (FMCAs) for pesticide biomonitoring. Bull Environ Contam Toxicol *68*(4):470–477.

Biagini RE, Smith JP, Sammons DL, MacKenzie BA, Striley CA, Robertson SK, Snawder JE [2004]. Development of a sensitivity enhanced multiplexed fluorescence covalent microbead immunosorbent assay (FCMIA) for the measurement of glyphosate, atrazine and metolachlor mercapturate in water and urine. Anal Bioanal Chem *379*(3):368–374.

Butler M, Ruder A, Carreon T, Waters M, Yeager M, Welch R, Chanock S, Schulte P [2005]. Polymorphisms in DNA repair genes and susceptibility to primary intracranial brain gliomas Neuro-Oncology Jul; 7(3):283.

Calvert GM, Mueller CA, Fajen JM, Chrislip DW, Russo J, Briggle T, Fleming LE, Suruda AJ, Steenland K [1998]. Health effects associated with sulfuryl fluoride and methyl bromide exposure among structural fumigation workers. Am J Public Health 88, 1774-80.

Carreón T, Butler MA, Ruder AM, Waters MA, Davis-King KE, Calvert GM, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2005]. Gliomas and farm pesticide exposure in women. Environ Health Perspect *113*(5):546–551.

Curwin BD, Hein MJ, Sanderson WT, Striley C, Heederick D, Reynolds SJ, Alavanja M, Kromhout H [submitted]. Pesticide dose estimates for children of Iowa farmers. Environmental Health Perspectives

Curwin BD, Sanderson W, Reynolds S, Hein M, Alavanja M [2002]. Pesticide use and practices in an Iowa farm family pesticide exposure study. J Agric Saf Health 8: 423-33.

Curwin BD, Hein MJ, Sanderson WT, Barr DB, Heederik D, Reynolds SJ et al [2005]. Urinary and hand wipe pesticide levels among farmers and nonfarmers in Iowa. J Expo Anal Environ Epidemiol 15: 500-8.

Curwin BD, Hein MJ, Sanderson WT, Nishioka M, Reynolds SJ, Ward E, Alavanja M [2005]. Pesticide contamination inside farm and non-farm homes. Journal of Occupational and Environmental Hygiene 2(7):357-367.

Curwin BD, Hein MJ, Sanderson WT, Striley C, Heederick D, Reynolds SJ, Alavanja M, Kromhout H [2006]. Urinary pesticide concentrations among children, mothers, and fathers living in farm and non-farm households in Iowa. Annals of Occupational Hygiene doi:10.1093/annhyg/mel062 [online September 19, 2006].

Dick RB, Steenland K, Krieg EF, Hines CJ [2001]. Evaluation of acute sensory--motor effects and test sensitivity using termiticide workers exposed to chlorpyrifos. Neurotoxicol Teratol 23: 381-93.

EPA [2002]. Interim Reregistration Eigibility Decision for Chlorpyrifos (Case No. 0100) EPA 738-R-01-007. Washington, DC: U.S. Environmental Protection Agency, Office of Pesticide Programs, Health Effects Division.

EPA [2006]. Organophosphate Cumulative Risk Assessment; Notice of Availability", Federal Register: August 2, 2006 (Volume 71, Number 148), [Notices] [Page 43740-43742] From the Federal Register Online via GPO Access [wais.access.gpo.gov].

Frazer DG, Jones WG, Petsonk EL, Kullman GJ, Barger MW, Afshari A, Jones T, Castranova V [1993]. Organic dust exposure from compost handling: response of an animal model. AJIM *24*:375–385.

Gardiner JC, Mullan PB, Rosenman KD, Zhu Z, Swanson GM [1995]. Mammography usage and knowledge about breast cancer in a Michigan farm population before and after an educational intervention. J Cancer Educ 10: 155-62.

Garry VF, Burroughs B, Tarone R, Kesner JS [1999]. Herbicides and adjuvants: an evolving view. Toxicol and Ind Health 15: 159-167.

Garry VF, Tarone RE, Kirsch IR, Abdallah JM, Lombardi DP, Long LK, Burroughs BL, Barr DB, Kesner JS [2001]. Biomarker correlations of urinary 2,4-D levels in foresters: genomic instability and endocrine disruption. Environ Health Perspect 109:495-500.

Goldsmith DF, Sisneros GC [1996]. Cancer prevention strategies among California farmworkers: preliminary findings. J Rural Health 12: 343-8.

Hanrahan LP, Anderson HA, Haskins LK, Olson J, Lappe K, Reding D [1996]. Wisconsin farmer cancer mortality, 1981 to 1990: selected malignancies. J Rural Health 12: 273-7.

Heederik D [2006]. Personal communication, May, 2006.

Heitbrink WA, Thimons ED, Organiscak JA, Cecala AB, Schmitz M, Ahrenholtz E [2000]. Static Pressure Requirements for Ventilated Enclosures. Ventilation 2000, 6th International Symposium on Ventilation for Contaminant Control [2] pp.97-99.

Heitbrink WA, Moyer ES, Jensen PA, Watkins DS, Martin SB Jr [2003]. Environmental agricultural tractor cab filter efficiency and field evaluation. Am. Ind. Hyg. Assoc. J. 64:394-400.

Hines CJ, Deddens JA [2001]. Determinants of chlorpyrifos exposures and urinary 3,5,6-trichloro-2-pyridinol levels among termiticide applicators. Ann Occup Hyg 45: 309-21.

Hooks C, Ugarte C, Silsby J, Brown R, Weinman J, Fernandez G et al [1996]. Obstacles and opportunities in designing cancer control communication research for farmworkers on the Delmarva Peninsula. J Rural Health 12: 332-42.

Hoppin JA, Umbach DM, Henneberger PK, Kullman GJ, London SJ, Alavanja MCR. Sandler DP [accepted]. Agricultural factors associated with Farmers Lung among Farm Residents in the Agricultural Health Study, accepted by *OEM*.

Hoppin JA, Umbach DM, London SJ, Henneberger PK, Kullman GJ, Alavanja MCR. Sandler DP [2006]. Pesticide Exposure and Allergic and Non-Allergic Asthma in the Agricultural Health Study. 2nd North American Congress of Epidemiology, 2006 Society for Epidemiologic Research, Seattle,Washington, June 21–24.

Kesner JS, Knecht EA, Krieg EF Jr, Wilcox AJ, O'Connor JF [1998]. Detecting preovulatory luteinizing hormone surges in urine. Human Reprod 13: 15-21.

Knecht EA, Krieg EF Jr, Clark JC, Kesner JS [2002]. Urinary creatinine measurement using a Vitros 250 chemistry analyzer compared with the Jaffe method. 54th Annual Meeting of the American Association for Clinical Chemistry, July 30, Orlando, FL, Clin Chem 48:A55, 2002.

Krieg EF Jr, Kesner JS, Knecht EA [1999]. An algorithm for detecting features of the hormone profiles of the human menstrual cycle. Computers in Biol Med 29:229-242.

Kristal AR, Goldenhar L, Muldoon J, Morton RF [1997]. Evaluation of a supermarket intervention to increase consumption of fruits and vegetables. Am J Health Promot 11: 422-5.

Lipscomb JC, Barton HA, Tornero-Velez R, Evans MV, Alcasey S, Snawder JE, Laskey J [2004]. The metabolic rate constants and specific activity of human and rat hepatic cytochrome P-450 2E1 toward toluene and chloroform. J Toxicol Environ Health, A Apr; 67(7):537-553.

MacKenzie BA, Striley CA, Biagini RE, Stettler LE, Hines CJ [2000]. Improved rapid analytical method for the urinary determination of 3, 5,6 trichloro-2-pyridinol, a metabolite of chlorpyrifos. Bull Environ Contam Toxicol 65: 1-7.

Mandel JH, Carr WP, Hillmer T, Leonard PR, Halberg JU, Sanderson WT et al [1996]. Factors associated with safe use of agricultural pesticides in Minnesota. J Rural Health 12: 301-10.

Moorman WJ, Ahlers HW, Chapin RE, Daston GP, Foster PMD, Kavlock RJ, Morawetz JS, Schnorr TM, Schrader SM [2000a]. Prioritization of NTP Reproductive Toxicants for Field Studies. Reproductive Toxicology 14:293-301.

Moorman WJ, Cheever KL, Skaggs SR, Clark JC, Turner TW, Marlow KL, Schrader SM [2000b]. Male Adolescent Exposure to Endocrine Disrupting Pesticides: Vinclozolin Exposure in Peripubertal Rabbits. Andrologia 32:285-293.

Moyer ES, Heitbrink WA, Jensen PA [2005]. Test for the Integrity of Environmental Tractor Cab Filtration Systems. J Occup Environ Hyg 2:516-523.

Muldoon JT, Schootman M, Morton RF [1996]. Utilization of cancer early detection services among farm and rural nonfarm adults in Iowa. J Rural Health 12: 321-31.

NIOSH [1994]. Alert. Request for assistance in preventing organic dust toxic syndrome. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational lSafety and Health, DHHS (NIOSH) Publication No. 94–102.

Popendorf WJ, Spear RC, Leffingwell JT, Yager J, Kahn E [1979]. Harvester Exposure to Zolone (Phosalone) Residues in Peach Orchards. *J Occup Med*. 21(3):189-194.

Ruder AM, Waters MA, Butler MA, Carreón T, Calvert GM, Davis-King KE, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2006]. Gliomas and farm pesticide exposure in men. Arch Environ Health *59*:650–657.

Ruder AM, Waters MA, Carreón T, Butler MA, Davis-King KE, Calvert GM, Schulte PA, Ward EM, Connally LB, Lu J, Wall D, Zivkovich Z, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Brain Cancer Collaborative Study Group [2006]. The upper midwest health study, a case-control study of primary intracranial gliomas in farm and rural residents. J Agric Safe Health *12*:255-274.

Sanderson WT, Talaska G, Zaebst D, Davis-King K, Calvert G [1997]. Pesticide prioritization for a brain cancer case-control study. Environ Res *74*:133–144.

Schrader SM, Turner TW, Shaw PB, Erickson LL, Holland S, Garry VF [2000]. Semen Quality of Men Applying Pesticides in Northwest Minnesota. Journal of Andrology Suppl 21:50

Schrader SM, Arbuckle T, Turner L, Ritter L [1997]. The Use of Silastic Condoms in an Exposure Assessment Occupational Field Study. Journal of Andrology 17:P-31.

Snawder JE, Lipscomb JC [2000] . Interindividual variance of cytochrome P450 forms in human hepatic microsomes: correlation of individual forms with xenobiotic metabolism and implications in risk assessment Regul Toxicol Pharmacol Oct; 32(2):200-209.

Steenland K, Jenkins B, Ames RG, O'Malley M, Chrislip D, Russo J [1994]. Chronic neurological sequelae to organophosphate pesticide poisoning. Am J Public Health 84: 731-6.

Steenland K, Dick RB, Howell RJ, Chrislip DW, Hines CJ, Reid TM et al [2000]. Neurologic function among termiticide applicators exposed to chlorpyrifos. Environ Health Perspect 108: 293-300.

Turner TW, Schrader SM [2006]. Sperm Migration Assay As Measure Of Recently Ejaculated Sperm Motility In Specimens Shipped Overnight. J Andrology 27 (supplement).

Valcin M, Henneberger PK, Kullman GJ, Umbach DM, London SJ, Alavanja MCR, Sandler DP, Hoppin JA [2006]. Risk Factors for Chronic Bronchitis Among Non-Smoking Farm Women in the Agricultural Health Study. 2nd North American Congress of Epidemiology, 2006 Society for Epidemiologic Research, Seattle, Washington, June 21 – 24.

Wainman B, Tsuji L, Nieboer E, Kesner J, Weber J-P, Vasquez R [2004]. The effects of persistent organic pollutants (POPs) and toxic metals (TMs) on menstrual cycle function in the Cree of Western James Bay, Canada. International Federation of Fertility Societies 18th World Congress on Fertility & Sterility. May 23-28 Montreal, Canada. Abstract.

Washington State Department of Labor and Industries [2005]. Cholinesterase Monitoring in Agriculture, WAC 296-307-148. Washington State Department of Labor and Industries, January 6, 2005. Cholinesterase Monitoring of Pesticide Handlers in Agriculture Report to the Legislature, 26 pages.

Washington State Department of Labor and Industries [2006]. Safety Standards for Agriculture; Chapter 296-307 WAC, Part J-1, Cholinesterase Monitoring, 17 pages. Rule effective Feb [http://www.lni.wa.gov/WISHA/Rules/agriculture/HTML/part-j-1.htm] Accessed Nov. 20, 2006.

Weber S, Petsonk, E, Kullman GJ, Jones W, Olenchock S, Sorenson W, and Parker J Marcelo-Baciu R, Frazer D, Castranova V [1993]. Organic dust exposures from compost handling: case presentation and respiratory exposure assessment. AJIM *24*:365–374.

Winterlin WL, Kilgore WW, Mourer C, Schoen SR. Worker reentry studies for Captan Applied to Strawberries in California [1984]. *J. Agric. Food Chem*. 32:664-672

Zwieg G, Gao R, Popendorf WJ. Simultaneous Dermal Exposure to Captan and Benomyl by Strawberry Harvesters [1983]. *J. Agric Food. Chem*. 31:1109-1113