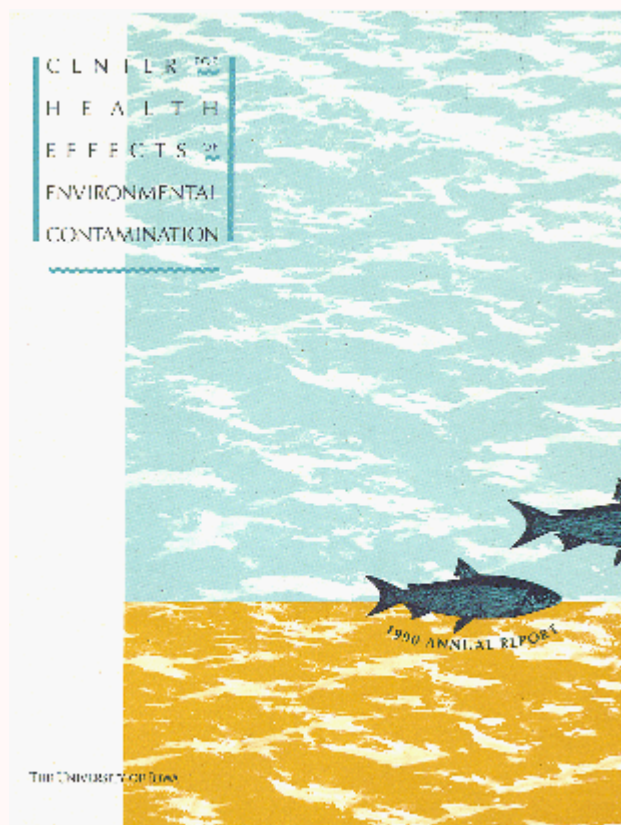


Center for Health Effects of Environmental Contamination | CHEEC

1990 Annual Report





The Center for Health Effects of Environmental Contamination (CHEEC) at The University of Iowa conducts and supports research on determining the levels of environmental contamination which can be specifically associated with human health effects. The Center, established through the Iowa Groundwater Protection act of 1987, has focused its efforts to date on research and service programs involving human exposure to water contaminants.

This annual report for 1990 presents summaries of CHEEC-supported research and an overview of data management and administrative activities during the past year.



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Environmental Data Management Core

The CHEEC Environmental Data Management Core (EDMC) continues to work on assembling a computerized data base of water supply sample analyses, sources, and treatment characteristics for municipal and private drinking water in Iowa. The goal is to establish an environmental data base that can address potential associations between statewide Iowa Health Registry data on cancer and birth defects and various environmental exposures.

The EDMC manages the following data bases on PC-based systems: water supply data for Iowa municipalities above 750 population; a statewide municipal drinking water survey of pesticides and synthetic organic chemicals (1986-87); a statewide rural well water survey (SWRL: 1988-89); and the Iowa rural radon gas survey (1989). During 1990, the EDMC began updating historical municipal drinking water survey data for municipalities over 1,000 population, incorporating Iowa Geological Survey Bureau (IGSB) aquifer data into the EDMC data base, collecting historical water supply and treatment data for municipalities under 750, and developing systems for accessing environmental data for use by the Department of Natural Resource, the IGSB, the University Hygienic Laboratory (UHL) and CHEEC. In addition to providing support to CHEEC researchers for ongoing environmental studies, the EDMC staff responded to requests for data from state and federal agencies, academic institutions and the private sector.

In April, the EDMC published a monograph titled "Historical Community Water Supply and Treatment Data for the State of Iowa" which presents data for municipalities over 1,000 population. In 1991, the EDMC will publish a similar monograph for municipalities between 500 and 1,000, and will also release a report linking aquifer information with municipal water data. A demonstration of the EDMC data bases developed during 1990 was presented at a number of professional meetings and conferences across Iowa.



Administrative Activities

In September, CHEEC was awarded a grant by the Agency for Toxic Substances and Disease Registry to support the *Conference on Water Quality, Agriculture and Public Health*, which will be held on The University of Iowa campus in May of 1991. This conference will highlight research being conducted at the University examining environmental impacts and adverse effects on human health from agrichemicals. In addition, representatives of the agrichemical industry will describe various aspects of industry research and health and safety programs related to crop protection products. Panel discussions with representatives of state and federal regulatory agencies, academic and industrial researchers, environmentalists and state legislators will address public health and environmental programs on water quality, regulatory policy, implications of research and proposed legislative initiatives.

The administrative and EDMC staffs attended several professional meetings and conferences during the past year to display and discuss CHEEC research and activities:

- Iowa Groundwater Assoc. 1990 Spring Meeting
- Health for a Lifetime Conference, sponsored by Iowa Department of Public Health Division of Family and Community Health, Iowa Public Health Assoc, Iowa Environmental Health Assoc., Region VII Cardiovascular Risk Reduction Conference Planning Group
- Region VII Conference for Implementaion of Surgeon General's Agenda for Children with Special Health Care Needs and their Families, sponsored by Division of Maternal and Child Health, U.S. Public Health Service
- 1990 Farm Progress Show
- Iowa Groundwater Assoc./Iowa Water Well Assoc. 1990 Fall Meeting
- Centers for Disease Control/ATSDR Site Visit of Iowa Birth Defects Registry
- 2nd Annual Leopold Center Conference, Iowa State University



The following seminars were sponsored by CHEEC at The University of Iowa during the 1990 academic year:

- Fate and Transport of Alachlor and Atrazine in the Subsurface Environment: Laboratory and Fields Studies; Dr. Gene Parkin, Professor of Civil and Environmental Engineering, The University of Iowa
- The Statewide Rural Well Water Survey; Dr. Burton Kross, Assistant Professor of Preventive Medicine and Environmental Health, The University of Iowa
- The National Alachlor Well-Water Survey: An Overview; Drs. Larry Holden and Andrew Klein, Monsanto Agricultural Company, St. Louis



Seed Grants

In the summer of 1988, CHEEC instituted a Seed Grant Program to support pilot research in environmental exposure and risk assessments. Qualified environmental researchers affiliated with public or private colleges or universities in Iowa were encouraged to submit proposals. Since that time, CHEEC has awarded twenty grants totally almost \$250,000.

"Pilot" research refers to small-scale, relatively inexpensive projects which are designed to test new and unusual hypotheses, develop innovative methodologies in both laboratory and field settings, or perform initial statistical analyses to support efforts to acquire federal or private grants for larger studies.

Thus, CHEEC support for pilot projects can be considered economic development capital for environmental research. To that end, the CHEEC Seed Grant Program has been very successful in helping to acquire funds for environmental research which impacts all Iowans. Of five completed CHEEC pilot projects, four have provided results which were used in applications resulting in large federal grants for University of Iowa researchers.

The following section contains summaries of projects funded by the Seed Grant Program. While the emphasis to date has been on water quality issues, CHEEC is also supporting research on air, soil, and food contaminants.

Collection of Historical Municipal Drinking Water Data in Iowa

Investigators

C. Lynch, M. Gleaves, M. Finn, Preventive Medicine and Environmental Health, The University of Iowa

Background

A major activity of the CHEEC Environmental Data Management Core (EMDC) has been the computerization of historical water



supply and treatment data for Iowa municipalities with a population over 1,000. In relating health effects data to drinking water quality, questions arise concerning years of use, type of water source and treatments, and amount obtained from specific supplies. The data are used to evaluate relationships between drinking water contamination and adverse health outcomes. For example, this information is applied in analyzing data from birth and death certificate tapes obtained from the Iowa Department of Public Health as well as birth defect and cancer data obtained from the State Health Registry of Iowa. Since the historical municipal water supply data have wide applicability, CHEEC collected similar information from municipalities with populations under 1,000.

Project Goals

- Identify the types of drinking water sources and methods of treatment historically utilized in the municipalities in Iowa with a population between 750-1,000.
- Evaluate the completeness of data and response rate that could be obtained from these municipalities through a mailout questionnaire and follow-up telephone survey of water operators.
- Evaluate the accuracy and completeness of existing data that are currently available to CHEEC for these municipalities.

Methods

Five data sources contained historical water supply and treatment data for the 75 study municipalities:

- information on historical water supply sources at the IGSB
- an IGSB file of finished and raw water sample analyses performed by the UHL
- records from the Statewide Pesticide and Volatile Organic Survey of 1986-87
- Iowa Public Water Supply data from a mid 1960s State Dept. of Health publication
- records of treatment practices for two points in time: the early 1960s and the mid 1970s.

Initially, the project involved obtaining, collating, and computer-entering these data as well as data for the 117 municipal water supplies serving towns with a population between 500-749. A computer-generated form of the data was developed and mailed to 10



municipal water operators as a pilot test. The water operators were then contacted by telephone and surveyed to verify and update the information.

Results

Pilot test results showed the data collection process was efficient. Any questions the water operators had about the form were answered during the telephone interview. New information provided by the water operators was added to the existing data. The remaining 65 communities were then contacted in the same manner. Completed interviews were transferred to the data entry forms and any inconsistencies or problems were corrected. Minor changes were made in the data entry form for future use.

The overall response rate for the study was excellent. Of the 75 municipal water operators contacted, 72, or 96%, agreed to be interviewed so that the data could be verified and updated; 3 interviews are still outstanding. Currently, the CHEEC EDMC is collecting similar information for communities with a population between 250-749.

Modeling Dissolved Oxygen, Nitrate and Pesticide Concentrations in the Subsurface Environment

Investigators

J. Schnoor, D. Nair, Civil and Environmental Engineering, The University of Iowa

Background

Previous UHL studies have determined that the concentration of pesticides and other toxic agricultural chemicals in shallow wells in Iowa is increasing. The UHL has detected nitrate in levels above the EPA MCL (maximum contaminant level) in about 25% of well samples analyzed. The herbicides alachlor and atrazine are two commonly used pesticides that have been detected in Iowa groundwaters. In recent animal studies, alachlor was found to be carcinogenic at very low doses and the proposed RMCL (recommended maximum contaminant level) in drinking water is zero.

Dissolved oxygen and nitrate concentrations are critical as electron acceptors in the transformation that pesticides and other toxic chemicals undergo in the subsurface environment. Scientists are currently unable to predict the concentration of pesticides and nitrate



reaching the groundwater vertically through the unsaturated zone as a function of application rates, hydrogeologic setting, or agricultural management practices. In this study, scientists hope to develop a mathematical groundwater model that would allow State and Federal regulatory personnel to determine the exposure concentration of pesticides and nitrate in surficial groundwater for risk assessment procedures and risk management decisions.

Project Goals

- Develop a one dimensional (vertical) time-variable mathematical model for the transport and reactions of pesticides and nitrate through the unsaturated zone to surficial aquifers.
- Test and validate the model with data from laboratory column studies and field studies on alachlor, atrazine and nitrate.
- Use the model to provide a better understanding of the processes which affect pesticide and nitrate fate in the subsurface and provide qualitative predictions of pesticide and nitrate concentrations under varied application rates, soil types, climatic conditions and electron acceptor conditions.

Methods

A literature review of related research was completed. A fortran code of the PRZM (Pesticide Root Zone Model: U.S. EPA) was obtained and modified to run on an Apollo mini-supercomputer. The PRZM was used as the base from which to develop a more process-oriented mathematical model, to reduce model development time and to take advantage of progress in this field to date. Salient features included in the model were pesticide processes like volatilization, chemical hydrolysis, redox reactions, macropore flow and biotransformation under different electron acceptor conditions. Dissolved oxygen and nitrate fate and transport were also included. A laboratory batch study was performed using radio-labelled atrazine to determine kinetic parameters for model input.

A field study was conducted near Lily Lake (Amana, Iowa) in the summer of 1989 utilizing three plots: one with small poplar trees, another with corn plants and a third was left barren. Atrazine, alachlor and nitrate were applied at the end of July and the site was monitored until mid-October. Due to drought conditions it was difficult to obtain adequate unsaturated zone water samples for pesticide and nitrate analyses. Although the scarcity of data made it difficult to calibrate and test the model, an attempt was made.



Preliminary simulations indicated that the model predicted the concentrations of alachlor and atrazine fairly well at various depths. The model was also run using data obtained from a published field study done in Tipton, GA (1986-87). Again, the model accurately predicted pesticide concentrations.

Results

Data sets from two different regions and soil types were used to test the model. Problems were encountered obtaining sufficient and uniform pesticide data from the unsaturated zone, the most important soil compartment both from the standpoint of the pesticides' primary utility to the farmer and protecting the environment. The model performed well and will continue to be tested. It is being modified with a number of enhancements and will be compared to the PRZM using similar data to determine if it performs better than the existing model with the addition of more processes describing pesticide fate. A search for additional data sets to test the model is underway. If successful, the model can be used to predict pesticide concentrations in surficial groundwater for different soil types, application rates, farming practices, soil microbiology/ chemistry, site hydrology and climatic conditions.

Discussion

Utilizing data obtained from this pilot project, University researchers have obtained grants from the EPA Hazardous Substances Research Center (Regions 7 & 8) at Kansas State University for two related research projects.

Pesticide Oxidation by Ozone for Point-of-Use Point-of-Entry Treatment Systems

Investigators

B. Kross, M. Selim, J. Hwang, L. Odell, Preventive Medicine and Environmental Health, The University of Iowa

Background

Rural well water supplies serving farm families have become increasingly vulnerable to contamination from agrichemical applications. Recent surveys in Iowa have documented the presence of nitrate and common pesticides in a large percent of rural wells. Previous studies have identified several nitrogenous pesticides in shallow wells. Ongoing research by Kross and Odell has determined that



concentrations of these pesticides are reduced by an ozonation point-of-use water treatment system. However, the identity and toxicity of resulting decomposition products are not known.

Concern over chlorination by-products (trihalomethanes) and their link to cancer has focused national research efforts on alternative disinfection processes. Ozonation methods are widely used in Europe and are receiving more research and process design attention in the U.S. In addition, groundwater contamination in rural areas has sparked interest in the development of point of use water treatment systems; ozonation processes are being explored for these applications.

Project Goals

- Develop test procedures for reacting ozone with individual pesticides to determine reaction kinetics and to predict steady-state conditions.
- Develop methods to isolate or synthesize decomposition products of pesticides for further investigation.

Methods

The feasibility of oxidizing six common pesticides (atrazine, alachlor, cyanazine, metalachlor, metribuzin and propachlor) for point-of-use/ point-of-entry drinking water treatment was examined. Water samples were spiked with 10ppb of pesticide and were then treated with a commercially-available ozone generator system at a rate of 1 gram per hour. Jar test procedures were developed for reacting ozone with atrazine, alachlor, and propachlor. Jar test procedures utilized in this study were modified to generate steady-state concentrations of target decomposition products.

Results

Project results showed that pesticide oxidation by ozone using a point of entry/ point of use system is feasible. Percent of oxidation was dependent upon the concentration of ozone and the time of exposure. Reductions of 80-95% were achieved for all pesticides except propachlor (about 50%) during the four hour test periods. Examination of chromatographs of samples following ozonation



indicated that refractory organics were present. Toxicity testing of decomposition products was not accomplished due to technical difficulties in the laboratory.

Discussion

Methods developed for this study were utilized in developing a grant application for further ozonation research. The EPA Hazardous Substances Research Center for Region 7 & 8 is supporting a project being conducted by Dr. Kross and John Hwang entitled *Destruction of Nitrogenous Pesticides by Combined Ozone/H₂O₂ and Enzymatic Polymerization Process*.

Development of Methods for Epidemiologic Studies of Birth Defects and Environmental Exposures in Iowa

Investigators

R. Munger, P. Isacson, C. Lynch, Preventive Medicine and Environmental Health; J. Hanson, Pediatrics; D. Schwartz, Internal Medicine, The University of Iowa

Background

The Iowa Birth Defects Registry, established in 1983, has proven successful in identifying children with birth defects. However, the Registry has not been utilized to investigate possible relationships between environmental exposures and development of defects. Epidemiologists recognized the need to develop methods for use in population surveys to assess environmental exposures, lifestyle factors and genetic factors that may increase the risk of birth defects. The main goal of this project was to develop these methods.

A previous study in the Midwest reported an increased risk of facial clefts among individuals with "high" vs. "low" exposures to agricultural chemicals. Individual exposures were calculated based on county of residence and county-wide averages of the use of fertilizers, insecticides, and herbicides. The CHEEC study questionnaire will be used to assess several environmental exposures in parents of children with facial clefts, including occupation, rural or urban residence, agricultural practices, diet, water quality, smoking and drug and alcohol use.

Project Goals



- Develop telephone-administered and mailed questionnaires to evaluate the relationship between various environmental exposures, lifestyle factors, and the development of facial clefts.
- Determine if response rates of mothers vary by interval between birth and contact by staff, age of the mother, and the outcome of the child (birth defect vs. normal birth).
- Measure validity of the responses to the questionnaire compared to information collected from the mother's medical record.
- Determine if specific environmental exposures are associated with facial clefts. For example, are exposures to selected agricultural practices or water contaminants related to the risk of facial clefts independent of other known causes?

Methods

Children with facial clefts were identified through the Iowa Birth Defects Registry. A comparison group of children without birth defects was obtained from a sample of all normal births in Iowa as listed on the data file provided by the Iowa Department of Public Health. An extensive review was conducted of the literature on assessment of exposures that may be relevant to birth defects. Initial questions were formulated by staff members and tested informally on acquaintances and other staff members.

More formal drafts of the telephone-administered and mailed questionnaires were reviewed by the staff of the Statistical Laboratory at Iowa State University, then tested in 21 pilot interviews with mothers of children with facial clefts born during 1983-86. The questionnaire was then revised further based on the results of the pilot interviews.

Results

Because of the extensive amount of data collected from each family, the data collection was broken down into two telephone-administered questionnaires and a mailed questionnaire, and the focus of the project was narrowed to the development of methods of subject contact and tracking as well as development of questionnaires. Previously tested and accepted methods of data collection were used whenever possible. Examples of the methods selected include the Willett semi-quantitative food frequency questionnaire for dietary assessment, the CAGE questionnaire on symptoms of alcohol abuse, a medication questionnaire based on symptom prompts, and standard occupational questions that include employer's name, description of what employer does, job title, and description of



specific job duties. As resources to conduct validation studies of these questions were not available, "state of the art" questions based on a review of the relevant literature were used.

Discussion

Questionnaires developed in this pilot project have enhanced the usefulness of the Registry in etiologic studies of birth defects. Questions on residency history and source of drinking water will be used in the analyses of linked data sets including water quality and other environmental data.

The questionnaires are now being used in a project titled *Epidemiologic Characterization of Genetic and Environmental Risk Factors for Human Clefts*, funded by the National Institute for Dental Research (NIDR). This five-year statewide case-control study is being conducted by the Craniofacial Anomalies Research Center at The University of Iowa. The analyses of data from the CHEEC funded pilot study and the NIDR study will be delayed until the accrual of more cases and controls (through birth year 1991).

Development of a Model Rural Injury Surveillance Program

Investigators

J. Merchant, K. Donham, Preventive Medicine and Environmental Health, The University of Iowa

Background

Farming is now generally considered the most hazardous occupation in America. This finding is based largely on available epidemiological data on farm injuries, which suggest that there are some 1,600 farm-related deaths among farmers, another 300 related deaths among children, and some 170,000 farm injuries (many of which are serious) in America each year. Epidemiological studies in New York and recent surveillance data in Iowa indicate that these figures may be significantly underestimated (deaths might be underestimated by as much as 100%). Additionally, farmers have high rates of occupationally-related morbidity from toxic exposure to farm chemicals, noise induced hearing loss, acute and chronic lung disease and sunlight and probable farm chemical-related cancers. Some studies suggest that farm families are at an increased risk to the development of certain birth defects.



Obviously there is a pressing need to develop population-based surveillance programs for high incidence farm morbidity and mortality. There are no national or state data collection systems to document far-related health and safety problems. Development of surveillance models for agriculture will provide representative and reliable information on environmental exposures and related morbidity and mortality.

Project Goals

- Review and evaluate available mortality and morbidity data for farm health and safety as input for the rural injury surveillance model.
- Develop a plan for a population-based model surveillance program, data management system, and surveillance network that could be replicated in any agricultural state or region.
- Prepare an implementation plan which will provide a system for piloting the surveillance system, for testing it in several rural hospitals, and a plan for extension of the system to other state hospitals.
- Utilize the model developed in this pilot study to prepare a proposal which will be submitted to one or more potential funding agencies for ongoing support.

Methods

A literature search for farm-related morbidity and mortality data was performed, focusing on epidemiological and surveillance approaches to assessment of farm-related injuries. Meetings were held with researchers from the National Institute for Occupational Safety and Health, the Center for Environmental Health and Injury Control, the Iowa Department of Public Health (IDPH) and the State Health Registry of Iowa. Colleagues affiliated with The University of Iowa Departments of Surgery, Physical Therapy, Preventive Medicine and Environmental Health, Internal Medicine and Pediatrics were consulted on development of program methods. Contacts were made with several national injury epidemiologists and occupational physicians concerned with farm safety and health. It became clear that the most pressing health and safety surveillance need involved traumatic injuries. As the IDPH had in place a voluntary farm injury monitoring system (SPRAINS) for Iowa health providers, it was decided that the surveillance system being



developed should be confined to hospitals. Therefore, a system that would capture the farm injury data and meet the IDPH injury reporting regulations became a priority for Iowa hospitals.

Results

A proposal was written to develop an electronic hospital-based rural injury surveillance system targeting inpatient and outpatient traumatic injuries. This system would contain essential data items already collected through emergency room logs and inpatient medical records. The data items include name, address, phone number, date of birth, employer (Standard Industrial Code), cause of injury, injury type, EMT run number and disposition of injury. For farm injuries and head and neck trauma (covered by state reporting regulation), additional information required by the IDPH would be collected.

Following development and testing of this system, it was proposed that the data would be collected by individual hospitals for transmission to the State Health Registry of Iowa, which would assure confidentiality of the data and build the rural injury surveillance data base. This data base would then be available for the development of case-control studies on a wide variety of rural injuries, including those from farm machinery, farm chemical burns, chemical pneumonitis, etc.

Discussion

This proposal was made as a project within an application for an Injury Prevention Research Center to the Center for Environmental Health and Injury Control of the Centers for Disease Control. In September, 1990, The University of Iowa was notified that this Center and project had been approved, but with reduced funding. Nevertheless, the award has allowed this project to move forward. Meetings with several of the individuals and organizations contacted in developing this grant have now been held, and the project is on schedule for full development over a period of three years.

Feasibility Study of DNA Flow Cytometry in Renal Cell and Colorectal Carcinoma Among Iowa Residents

Investigators

C. Lynch, Preventive Medicine and Environmental Health; R. Robinson, Pathology, The University of Iowa *Background*

A recent study conducted by researchers in Preventive Medicine & Environmental Health looked at whether characteristics and



components of drinking water could be identified as risk factors for the development of cancer of the bladder, colon, rectum, brain, pancreas, or kidney. In other studies, DNA flow cytometry has been studied as a possible predictor of outcome for Stage 1 renal cell carcinoma. While DNA ploidy pattern (degree of repetition of the basic number of chromosomes) did predict patient outcome, it was not an independent predictive variable.

The Lynch & Robinson study is evaluating the DNA ploidy pattern's relationship to known risk factors for renal cell and colorectal carcinoma. This is the first CHEEC project where flow cytometry (i.e., DNA ploidy pattern determination) is being utilized in an epidemiologic study design. This linking of flow cytometry and epidemiology may assist future evaluations of relationships between environmental contamination and adverse health outcomes.

Project Goals

- Develop computer data forms that will permit efficient linkage of study data and data for both pathologic predictors of outcome and DNA ploidy analyses results.
- Evaluate the DNA ploidy pattern as predictor of outcome for renal cell and colorectal carcinomas.
- Evaluate known risk factors for renal cell and colorectal carcinomas as predictors of DNA ploidy pattern.

Methods

Initially, tumorous tissue was obtained for 30 colorectal cancer patients treated at The University of Iowa Hospitals & Clinics. A data collection form was developed and DNA ploidy analyses were run; the data were computer-entered and edited. Statistical analyses were performed on dietary and other factors to test associations between ploidy status (normal vs. other) and these factors. These factors included patient age, sex, weight, chlorinated drinking water exposure, cigarette smoking, alcohol consumption, dietary fat and fiber, occupational exposures and genetic susceptibility (positive family history, bilateral disease, early age at diagnosis). Tissue was obtained for renal cell cases and a data collection form was developed. DNA ploidy analyses were completed, statistical analyses are underway.



Results & Discussion

Preliminary results from analyses of the colorectal cases indicate that there may be an association between some dietary factors (essentially fats), health history factors (colitis) and abnormal ploidy status. Results of analyses of drinking water factors are inconclusive. However, the small sample size of the colorectal cases (n=30) must be taken into account in any interpretation of these results. Study investigators will compare analytical results of renal cell cancer DNA ploidy and various exposure factors with the colorectal results to determine the strength of potential associations.

Ultraviolet Phototoxicity of Some Non-Steroidal Anti-Inflammatory Agents (NSAIDs) on the Retina of the Eye

Investigators

J. Pulido, Ophthalmology; T. Shires, Pharmacology, The University of Iowa

Background

Progressive global stratospheric ozone thinning and consequent elevation in ultraviolet (UV) irradiance of the Earth's surface presents the prospect of a significant human health hazard. In the eye, the cornea, lens and retina have well established UV radiation pathologies. Outdoor workers such as farmers and commercial fishermen are especially susceptible; retinal damage by UV irradiance is especially serious because of its irreversibility.

Stratospheric ozone depletion and enhanced UV exposures may also intensify the UV-phototoxicity inherent in some therapeutic agents widely used by workers and the general population. Phototoxic agents apparently benign for the retina under subdued lighting may become more problematic under increased radiation. This study will examine some anti-inflammatory analgesics known to be UV-phototoxic in skin but with as yet unreported effects in the eye. Responses of cultured retinal epithelium will be examined to affirm UV-phototoxicity in eye tissue for these drugs and to determine the toxic dosages. The investigators hypothesize that these widely used drugs compound the risk of retinal damage in people who have outdoor occupations and are thus exposed to high sunlight levels.

Project Goals



- Develop a laboratory system for examining drugs and toxic substances in general for possible retinal damage.
- Determine if the widely used NSAIDs ketoprofen, naproxen, and piroxicam are UV-photosensitizing agents for retinal cells.
- Determine the dose-response for each NSAID at fixed UV-A irradiance levels in order to estimate the likelihood of retinal phototoxic responses in laboratory rats.
- Initiate studies of NSAID retinal phototoxicity to better understanding the risks of these drugs in environmental conditions in which ultraviolet exposure is increased.

Project Status

An initial goal was to develop a laboratory system for measuring in vitro the toxicity of drugs and xenobiotics for the retina. Rat pup retinal cells in culture were exposed to a known retinotoxic agent (gentamycin: an antibiotic used clinically to treat patients with severe intraocular infections) to determine whether a dose-dependent decline in amounts of evoked-neurotransmitter release per cell would result. A series of cell cultures were exposed to graded concentrations of agent, amounts of neurotransmitters (glutamate (the principal retinal transmitter), glycine and taurine) released by depolarization of each culture were measured, and the percent decline from control levels in untreated cultures for each dose of agent determined. Analysis of the retinotoxicity of gentamycin with the retinal culture system supports the validity of this in vitro approach. Plots were constructed of the percent decline in neurotransmitter release as a function of log-dose. Results of regression analyses suggest that (1) gentamycin has significantly inhibited glutamate release but not taurine or glycine, (2) that gentamycin is selectively toxic to glutamate-releasing neurons and not to taurine or glycine-releasing neurons, and (3) that the half maximal toxicity in vitro (TD-50%) of 410 micrograms/ml calculated from the regression slope for glutamate approximates the estimated TD-50% for the antibiotic in the human eye. The performance of the in vitro retinal system for measuring retinotoxicity, based on these results, appears very promising.

The next phase of the project involves determining drug dose-response curves for a known phototoxic drug, a non-phototoxic drug, and the study drugs. Families of dose-response curves will be constructed for each drug at four irradiance levels. Comparison of drug ED50s at each level will indicate whether drug-UV irradiation synergy occurs in the retinal cultures, synergy being evidence that UV-phototoxicity occurs. Change in any neurotransmitter release or of cell viability is indicative of UV-phototoxicity.



Following are short descriptions of research projects which were awarded CHEEC seed grants during 1990. These studies demonstrate the scope of environmental research supported by CHEEC.

Teratogenic potential of *Fusarium moniliforme* mycotoxins

Investigators: S. Hendrich, Food & Nutrition; P. Murphy, Food Technology; G. Osweiler, Veterinary Diagnostic Laboratory, Iowa State University; F. Ross, T. Wilson, National Veterinary Services Laboratory, Ames

Summary: Fumonisin is a newly-recognized tumor-promoting agent produced by *Fusarium moniliforme*, a common contaminant of corn. A dose of 0.1% fumonisin in the diet fed for four weeks promotes the development of hepatic preneoplasia in rats, and hepatic carcinomas develop within six months. Fumonisin levels in corn ranges up to 15 g/kg in *Fusarium*-infected corn in laboratory cultures and 2-3 g/kg in the field. Exposure to fumonisin may represent a risk to humans, as *F. moniliforme* is a more common contaminant of corn than is aflatoxin-producing *A. flavus*. The consumption of infected corn, corn-based products or products from animals fed contaminated corn may lead to currently uncharacterized health problems. Birth defects are a crucial concern because even a single dose at the wrong time may have disastrous effects. This project will establish a basis for fumonisin risk assessment in humans.

Development of an immunoassay for the detection of glyphosate in water

Investigators: G. Breuer, S. Berberich, University Hygienic Laboratory

Summary: Glyphosate, a broad-spectrum herbicide sold by Monsanto under the trade name Roundup, is a water-soluble product of increasing use. It was included on the "list of 83" compounds for which Congress required EPA to adopt regulations under the SDWA amendments (1986). EPA is proposing special monitoring for glyphosate during periods of highest vulnerability for drinking water supplies which may be contaminated by this compound. The goal of this project is to create a monoclonal antibody that is specific for glyphosate and develop an immunoassay system, using this antibody, for the rapid detection of glyphosate in water samples at a cost considerably less than current analytical procedures.

Biotransformation and transport of monoaromatic hydrocarbons under stimulated denitrifying conditions in soil columns



Investigators: G. Parkin, M. Vermace, Civil and Environmental Engineering, The University of Iowa

Summary: Perhaps the largest contributors to point source contamination of groundwater are leaking underground storage tanks and pipelines used to store and transport petroleum products such as gasoline, diesel fuel and waste oils. These products are composed primarily of the monoaromatic hydrocarbons xylene, toluene, and benzene (BTX). The U.S. EPA has designated each of these hydrocarbons as a priority pollutant. The goal of this project is to examine the role of nitrate (a common groundwater contaminant) as an alternate electron acceptor for biologically-mediated reactions important to in-situ bioremediation. The presence of nitrate may facilitate the biotransformation of other contaminants such as BTXs under denitrifying conditions.

Investigation of the feasibility of adapting immunoassay tests for detection of minute amounts of pesticides in water

Investigators: J. Cowan, S. Berberich, University Hygienic Laboratory

Summary: At present there is no routine, effective and rapid way to detect modern herbicides reliably at concentrations much below 0.1 part per billion (ppb). The UHL can detect several pesticides at 0.1 ppb by extracting 1000 ml of a water sample with organic solvents, concentrating the sample to a final volume of 1 ml, and using gas chromatography with nitrogen/phosphorous detectors. This project's goal is to develop a protocol, using immunochemistry, to detect minute amounts (<.01 ppb) of pesticides present in water samples. The investigators propose to expand on UHL methods to detect and identify pesticides using commercially available immunoassay kits. Identifying a trend of increased pesticide contamination before there is a real health risk problem allows more options in addressing and correcting the causes of contamination.

Analysis of aflatoxins in grain dust

Investigator: M. Selim, Preventive Medicine and Environmental Health, The University of Iowa

Summary: Aflatoxins, particularly B1, are recognized as highly potent chemical carcinogens with acute toxic effects documented in animal species and humans. International studies have shown an association between the incidence of lung cancer and exposure to aflatoxins in contaminated grain dust. In the U.S., limited exposure data are available to assess the potential risk of lung cancer in farmers and agricultural workers, who are exposed to grain dust during harvesting, grain storage, animal feeding and bin clean-up



operations. Adverse health effects could result from a combination of repeated low level exposures to toxins which may be below the detection limits of current analytical methods. Therefore, a more sensitive and highly reliable method is needed. The goal of this project is to develop and validate an analysis technique for the separation and quantitative determination of low levels of aflatoxins in airborne grain dust samples.

An assessment of infant exposure to nitrate/nitrite in breast milk and rural well water

Investigators: C. Dungy, L. Dusdieker, Pediatrics; B. Kross, Preventive Medicine and Environmental Health, The University of Iowa

Summary: The Statewide Rural Well Water Survey documented that about 18.3% of all private rural well water samples tested in Iowa exceeded the EPA MCL for nitrate. Infants are particularly vulnerable to high concentrations of nitrate in water. In recent years few cases of infant methemoglobinemia have been reported in Iowa. However, the condition may be misdiagnosed and its affect on State and national infant morbidity/mortality data underestimated. The purpose of this project is to determine the relationship between maternal infant feeding practices and infant exposure to nitrate/nitrite contamination in rural weel water. Mothers of infants less than 6 months of age will be surveyed regarding maternal and infant nitrate exposure and personal infant feeding practices. Breast milk and well water samples will be evaluated using standard analytical methods at the Analytical Toxicology Laboratory.

Birth defects in Iowa: effects of surface water pollution in southern Iowa

Investigators: J. Hanson, Pediatrics; R. Munger, Preventive Medicine and Environmental Health, The University of Iowa

Summary: Recent aggregate analyses of risk for low birth weight (LBW) in rural areas of Iowa have shown an association with source of drinking water supply: higher risk of LBW was found for rural residents supplied by shallow wells or surface water in contrast to those supplied by water from bedrock aquifers. This association was particularly apparent in rates for small towns and rural areas served by a surface rural water system in southern Iowa. Following up these findings, a more detailed examination of adverse pregnancy outcomes in this area is planned. This study will examine the relationship between exposure to specific contaminants in water and a particular category of birth defect outcomes, severe cardiac anomalies. Results of previous studies looking at a relationship between cardiac anomalies and water quality have been inconsistent.



Urban vs. rural differences in cancer incidence and mortality among residents of Iowa

Investigators: C. Lynch, L. Burmeister, Preventive Medicine and Environmental Health, The University of Iowa

Summary: Past studies have indicated that Iowa farmers have significantly higher mortality rates from certain cancers than do Iowa males who do not farm. Conversely, mortality from some cancer types, primarily smoking-related cancers, is significantly lower in farmers compared to nonfarmers. This project will evaluate differences in cancer incidence and mortality by rural vs. urban residence and differences in cancer incidence by farmers vs. nonfarmers. For cancer sites significantly higher in rural residents, rates will be computed for each of the six hydrogeologic regions in Iowa. SWRL reported the highest nitrate levels in rural wells in NW Iowa, also the area with the highest stomach cancer incidence rates. Such ecological associations may provide clues to environmental factors associated with cancer rates.

Development of a water quality data base to assess the factors associated with low birth weight and intrauterine growth retardation

Investigators: K. Cherryholmes, W. Hausler, Jr., University Hygienic Laboratory; P. Isacson, Preventive Medicine and Environmental Health, The University of Iowa

Summary: The 1987 survey of Iowa's regulated drinking water supplies (HF 2303) documented the presence of pesticides in 125 finished water supplies with atrazine observed most frequently. Atrazine was found in both raw and finished water in one Rural Water Association (RWA) in southern Iowa. Preliminary studies report a greater than expected incidence of LBW infants were born to mothers of communities served by this RWA. A positive statistical association was found between LBW rates and alluvial, drift or surface sources of drinking water supply. A subsequent EPA-funded study looked at intrauterine growth retardation (IUGR), low weight for gestational age, as a dependent variable. Initial results indicate that IUGR is associated with the use of surface water. Again, this was found in relation to the RWA system. The goals of this project are to analyze water samples from this RWA area for common herbicides, nitrogen series and total coliform bacteria; to assess the seasonal fluctuation of these contaminants; and to utilize this water quality data base to continue the assessment of factors affecting LBW and IUGR.



A preliminary survey of radon-222, radium-226 and radium-228 in private well-water supplies in Iowa

Investigators: R.W. Field, Preventive Medicine and Environmental Health; K. Cherryholmes, University Hygienic Laboratory

Summary: A large data base exists on agrichemical pollutants in municipal water supplies and private rural wells in Iowa; limited data are available on radioactive contaminants in those supplies. Health risks from airborne radon are well documented; recent studies indicate that ingested radon and radium may also represent a major pathway of exposure. ²²⁶Ra and ²²⁸Ra occur naturally in deep aquifers supplying municipalities in southern and northwestern Iowa. Glacially-deposited granitic aquifers may be a source of high levels of ²²⁶Ra and ²²⁸Ra in well-water. The purpose of this study is to determine the levels of ²²²Rn, ²²⁶Ra and ²²⁸Ra in a sample of private wells in Iowa to address the following questions: 1) what percentage of private well sites sampled have levels of ²²²Rn, ²²⁶Ra or ²²⁸Ra that exceed current or proposed MCLs? 2) Do the levels or distribution of ²²²Rn, ²²⁶Ra or ²²⁸Ra found in this pilot study support further studies? 3) Do private well-water supplies have higher levels of ²²²Rn, ²²⁶Ra or ²²⁸Ra relative to public ground water supplies? and 4) Can aquifer age or type, well depth or water quality characteristics be used to predict the occurrence of ²²²Rn, ²²⁶Ra or ²²⁸Ra in private well-water supplies?

Regional radon exposure index model and epidemiological test of the model

Investigator: L. Fuortes, Preventive Medicine and Environmental Health, The University of Iowa

Summary: A recent EPA survey showed Iowa having one of the highest average in-home air radon concentrations in the nation. Considerations of this exposure becomes important in epidemiologic studies of health effects of environmental contaminants. Most of the data currently available for Iowa are aggregate and their use value in health studies has yet to be determined. The goal of this project is to develop a regional radon exposure index based on a geological model of radon distribution in Iowa using results from the Iowa Rural Radon Survey (IRRS). IRRS data suggest there is a statistically discernible difference in the proportion of homes within geological landform regions which exceed the EPA action level of 4 pCi/L radon in the air. Within regions there is a great deal of variability in the levels of concentration of radon found in individual homes. This project will use factor analysis to evaluate relationships between home construction, geological setting and radon concentration. Controlling for significant factors, regional associations will be evaluated to establish a geologically-based regional exposure index for Iowa. An epidemiologic test of this index



will re-evaluate the relationship found between increased incidence of lung cancer and higher levels of radium-226 in Iowa municipal drinking water supplies controlling for radon exposure.

Assessment of exposures to bioaerosols in "sick" and "healthy" buildings

Investigator: P. Thorne, Preventive Medicine and Environmental Health, The University of Iowa

Summary: Sick building syndrome and building-related illness are familiar terms to most Americans. Well publicized sick buildings and major outbreaks of building-related illness have increased awareness of the hazards of indoor air pollution. While there have been many studies of chemical contaminants of indoor air, microbiological contaminants have not been systematically studied. In particular, baseline levels for fungi, bacteria, or other aeroallergens and bioaerosols have not been determined. Goals of this project include 1) characterizing the levels of bioaerosol contamination in problematic and non-problematic buildings; 2) determining the relationship between indoor and outdoor bioaerosol concentrations and species; 3) testing for relationships among and between various microbial and gaseous indoor air pollutants, ventilation parameters, heating or air conditioning seasons, types of construction and other relevant parameters; 4) using health questionnaire data, estimate the prevalence of various health complaints and study the actions taken by the occupants to address these health concerns; 5) continuing efforts to refine the methodologies for bioaerosol sampling and indoor air quality evaluation; and 6) providing public education services through visits to evaluation sites and by dissemination of study results to Iowa DNR and others through CHEEC.



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