

Quarterly Highlights

July--September 1995

- Lawrence C. Mohr, Jr., M.D. named W. Allen Smith, DR., P.H., deputy director of EHAP. Dr. Smith will assist Dr. Mohr's in sharpening the Program's focus on environmental health. He has long been involved in researching various health-care policy matters as well as exploring cooperative agreements between MUSC and other institutes of higher learning. Dr. Smith's project--"Health Services Research"-- focuses on involving more medical doctors and other medical practitioners in the environmental risk assessment and decision-making processes.
- On July 1, MUSC's Department of Family Medicine began a one month mandatory Environmental and Occupation Medicine rotation for third year residents. It is the first residency program in the nation to have a required rotation in Environmental and Occupational Medicine.
- We received a completed copy of "Immunogenetic Risk Assessment in Human Disease: Proceedings of a Symposium," which was edited by EHAP's Dr. Janardan P. Pandey. It contains the proceedings from an EHAP-sponsored conference held March 6-8, 1994, in Charleston, SC. This was the first conference where the role of immunoglobulin allotypes and the role of HLA antigens were discussed simultaneously for their involvement in susceptibility to human diseases.
- EHAP's External Advisory Group met in Charleston July 24-25. Among other charges, the EAG consulted with EHAP project directors and staff members on a wide range of issues. During the second quarter, the EAG will make recommendations to the Principal Investigator on how the Program can best proceed in the future to meet current objectives and new goals.
- MUSC and the City of Charleston began planning "Partners in Community Development," a meeting of various potential partners in Enterprise Community activities. The program will be coordinated by the U.S. Departments of Housing and Urban Development and Health and Human Services and Vice President Al Gore's National Performance Review. Meeting dates are October 29-30.
- MUSC/EHAP sponsored with the Columbia Urban League and the South Carolina Department of Health and Environmental Control the Environmental Justice Future Search Workshop September 7-9 in White Oak, SC. The purpose of this workshop was to focus on the past, present and future of environmental justice in South Carolina especially emphasizing common ground for the future of this issue.

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1.0 Introduction

On June 23, 1992, the U. S. Department of Energy (DOE) signed Assistance Instrument Number DE-FG01-92EW50625 with the Medical University of South Carolina (MUSC) to support the Environmental Hazards Assessment Program (EHAP).

Dr. James B. Edwards, President of the Medical University of South Carolina, suggested, "Good health is not the result of good doctorin' but the result of a healthy society in a healthy, economic, political and biological environment." To further good health, it is appropriate that an educational institution such as MUSC utilize grant funds to help people from all walks of life understand better what truly does affect human health, what does not, and why.

Note

Text enclosed by a dotted border, such as this example, represents an effort funded by other sources in support of the total EHAP mission. Moreover, this border means no grant funds were expended in creating the project.

Grant Objectives

The objectives of EHAP stated in the proposal to DOE are to:

1. Develop a holistic, national basis for risk assessment, risk management, and risk communication that recognizes the direct impact of environmental hazards on the health and well-being of all;
2. Develop a pool of talented scientists and experts in cleanup activities, especially in human health aspects; and
3. Identify needs and develop programs addressing the critical shortage of well-educated, highly-skilled technical and scientific personnel to address the health-oriented aspects of environmental restoration and waste management.

This report describes activities and reports on progress for the first quarter (July-September) of the fourth year of the grant. It reports progress against these grant objectives and the Program Implementation Plan published at the end of the first year of the grant. Questions, comments or requests for further information concerning the activities under this grant can be forwarded to Susan G. Legare in the EHAP office of the Medical University of South Carolina at (803) 792-1666.

2.0 Program Overview

2.1 Program Elements

In April 1995, the Program began a major transition from a Program Management Office to a major academic component of MUSC. To lead EHAP through this change, Dr. Edwards selected Lawrence C. Mohr, Jr., M.D., former White House Physician, to become the new executive director of EHAP. Under Dr. Mohr's leadership, EHAP has become more directly focused on the human health effects of environmental hazards.

Appropriately, Dr. Mohr has drawn up new missions for EHAP. The first is to ensure that EHAP's mission is congruent with the academic mission of the Medical University and the second is to enable the program to expand and diversify with a focus on human health. The new missions are divided into four components:

- Support toxicological and epidemiological investigation into environmental problems that pose a direct risk to human health;
- Develop new methodologies and information systems to translate the results of basic research into risk assessment and preventative medicine applications for primary care physicians and other health care providers;
- Develop and improve educational programs in the environmental health sciences for health care providers and environmental professionals with emphasis on clinical applications risk assessment and risk management; and
- Develop further and apply innovative programs to educate and prepare communities for informed participation in the environmental decision making process.

To increase the focus on human health and integrate the progress from all of the sections, we have added a new element to the Program--the Healthy Community Initiative. Accordingly, the Healthy Community Initiative section is playing a leading role in Charleston, SC's "Neck" area, which the Department of Housing and Urban Development has designated an Enterprise Community.

Thus, the Program consists of six major elements: 1) Public and Professional Outreach; 2) Clinical Science; 3) Biomedical Research; 4) Information Systems; 5) Education; and 6) Healthy Community Initiative. Each element has a specific programmatic function briefly described in more detail in the following sections. In addition to the function, each element has the

responsibility to involve people from outside MUSC faculty, staff, and students.

Elements in Focus

During the fourth year, the Clinical Sciences section continues to focus directly on human health. One project is researching the role of physicians in the environmental health of their communities. Results of this research and other risk assessment studies are woven into the diagnostic backgrounds of established general practitioners; this continuing education program increases the risk assessment capacity of many physicians. In another project, the Occupational and Environmental Medicine Office (OEMO) focuses on a number of clinical issues, responding to inquiries from physicians and supporting the training of SC family practice residents in environmental medicine.

Public and Professional Outreach maintains the momentum in its successful Crossroads of Humanity Series. In this Series, we bring the pool of experts and results developed in our workshops and round table forums to bear on real problems. As during the third year, we focus on actual environmental health issues. Additionally, mid- and upper-level managers are being trained in risk assessment to ensure those decision makers in the environmental cleanup business are better informed.

Biomedical Research projects provide a foundation to enable health care providers and researchers to explore environmental health issues in great detail. The Biomedical Research element continues work on numerous research projects, concentrating on trichloroethylene-related assessments, that are initially providing some of the hard facts needed to assess certain environmental health risks.

In the Education section, the master's program, which is a collaborative effort with the University of Charleston, provides the fundamentals of environmental risk, policy and science with a specialization in one of these areas. The doctoral program in environmental risk assessment is housed within MUSC's Department of Biometry and Epidemiology and offers a multidisciplinary approach combining risk assessment, statistics, epidemiology and modeling with environmental science and policy.

To utilize better the progress made in all the sections during year three, a new element--Healthy Community Initiative--was created during year four. This section will focus on the "Neck" area of Charleston, SC, to empower citizens to take charge of their physical and economic health and the cleanup of hazardous materials in their neighborhoods. The Department of Housing and Urban Development has designated the "Neck" area as an Enterprise Community.

Interwoven throughout EHAP, the Information Systems section provides and maintains the computer and network structure for information handling. Moreover, Information Systems continues to work to refine the data fusion techniques necessary to provide the user with advanced, user-friendly information search and retrieval capabilities.

2.2 Program Expenditures

EHAP Cash Flow Forecast and Actual - Year 4

The table below presents actual cash flow for Year 3 (year ended 6/30/95) and forecasted cash flow for Year 4 (year ended 6/30/96). At the end of the first quarter, actual expenditures were under the forecast by \$25K or approximately one-half of 1%, indicating that program outlays to date are on target with the cash flow forecast.

(Dollars in thousands)

	Actual Year Ended 6/30/95		Forecast Year Ended 6/30/96		Actual Year Ended 6/30/96	Variance (Over) Under Forecast
Qtr 1	996	14%	1,025	14%	1,000	25
Qtr 2	1,265	18%	1,350	18%		
Qtr 3	2,030	28%	2,100	28%		
Qtr 4	2,859	40%	3,014	40%		
	7,150	100%	7,489	100%	1,000	25

EHAP 1st Quarter Year 4 Expenditure Summary

The following presents an overview of expenditures for the First Quarter and year-to-date Year 4

	<u>1st Qtr</u> (Dollars in thousands)	<u>YTD</u>
Public and Professional Outreach	\$158	\$158
Crossroads of Humanity Series		
Publications/Information		
Research and Evaluation		
Professional Training		
Science Programs	180	180
Toxicology		
Risk Assessment		

Education		
Graduate studies	163	163
Summer program		
Clinical Science	117	117
Health Services Research		
Family Medicine		
Information Systems	70	70
Indirect Costs	305	305
Equipment	7	7
Total	\$1,000	\$1,000

3.0 Program Office

The MUSC administration established the Environmental Hazards Assessment Program Office to ensure the management of grant efforts to meet the Program's goals and objectives. The Program Office responsibilities include: development and implementation of the program plan for the DOE grant, development and implementation of major support systems necessary for managing and reporting on all EHAP efforts, developing partnerships for the execution of programs with other universities and research institutions, and the development of joint venture funding of environmental programs.

The Program Office reports to the Office of the President. To support this office, MUSC has made non-federal funds available to the director.

Principal Investigator:	James B. Edwards, D.M.D.
Executive Assistant to Principal Investigator:	Stephen L. Jones, B.S., M.S.W.
Deputy Principal Investigator and Executive Director:	Lawrence C. Mohr, Jr., M.D.
Deputy Director and Assistant to Director for University Programs:	W. Allen Smith, DR., P.H.
Assistant to Director for Administration and Finance:	Susan G. Legare, B.S., C.P.A.
Director of Development:	R. Martin Jones, Ph.D.
Director of Community Development:	David E. Rivers, B.S., M.A.
Assistant to Director for External Programs:	Robert A. Draughn, D.Sc.
Director for Crossroads:	Glenn A. Fleming, Ed.D.
Director for Research, Science and Education:	Rosalie K. Crouch, Ph.D.
Business Manager:	Gail C. Brubaker, B.S.
Assistant Project Administrator:	Marion H. Watson, A.A.
Project Administrator:	Charles W. Waring, III, B.A.
Administrative Specialist:	Mimi C. Gainey
Accounting Technician:	Anita G. Noisette
Administrative Assistant:	Jill Canaday
Administrative Assistant:	Charlene B. Marsh, B.S.

Milestones and Products for First Quarter, Year 4

1. Lawrence C. Mohr, Jr., M.D. named W. Allen Smith, DR., P.H., deputy director of EHAP. Dr. Smith will assist Dr. Mohr's in sharpening the Program's focus on environmental health. He has long been involved in researching various health-care policy matters as well as exploring cooperative agreements between MUSC and other institutes of higher learning. Dr. Smith's project--"Health Services Research"--focuses on

involving more medical doctors and other medical practitioners in the environmental risk assessment and decision-making processes and creating a need-to-know attitude toward environmental medicine.

2. EHAP's External Advisory Group met in Charleston July 24-25. Among other charges, the EAG consulted with EHAP project directors and staff members on a wide range of issues. During the second quarter, the EAG will make recommendations to the Principal Investigator on how the Program can best proceed in the future to meet current objectives and new goals.
3. In collaboration with Coleman Research Corporation (CRC) and the Atomic Energy Authority Technology Consultancy Services (AEA) of the United Kingdom, we continued the planning process for the International Risk Assessment/Risk Management Forum scheduled to take place in March 1996 in Charleston.
4. As a result of the first steering committee meeting of the "Risk Assessment/Risk Management International Symposium Study" held June 15-16 in Charleston, we produced a report of the proceedings.
 - Copy of steering committee meeting notes
5. Steering committee met in Charleston July 25-26 to discuss issues relating to the International RA/RM Forum and produced a report of the proceedings.
 - Copy of steering committee meeting notes
6. Finalized dates and sites for the International RA/RM Forum and planned case studies meeting in the United Kingdom, scheduled to take place October 10-13, in Manchester.
7. To continue the efforts started under the grant, Lawrence C. Mohr, Jr., M.D. continued to coordinate a study on establishing an institution such as an Institute for Environmental Health Studies or a College of Environmental Health Studies at MUSC. To obtain ideas for this transition, Dr. Mohr chaired numerous meetings of a group of MUSC faculty members.
8. We continued to revise the second draft of a program review of EHAP, projecting the activities of each project throughout the life of the grant.
9. We continued final editing of the manuscript on the survey of dental educators regarding environmental issues in dental training, which will be submitted to the *Journal of Dental Education*. This work is a

collaborative effort of MUSC College of Dental Medicine (W. Burton and R. Draughn) and the professional staff of EHAP (D. Holmes, C. Musham and C. Waring).

10. We began an EHAP staff seminar series in July and held a total of five hour-long meetings during the past quarter. The series seeks to increase communication between researchers and staff members.
11. We received a completed copy of "Immunogenetic Risk Assessment in Human Disease: Proceedings of a Symposium." This volume was edited by EHAP's Dr. Janardan P. Pandey, and it contains the proceedings from an EHAP-sponsored conference held March 6-8, 1994, in Charleston. This international conference was the first conference where the role of immunoglobulin allotypes and the role of HLA antigens were discussed simultaneously for their involvement in susceptibility to human diseases.

- Copy of book

Milestones and Products Projected for Second Quarter, Year 4

1. Will complete manuscript on the survey of dental educators regarding environmental issues in dental training and will submit it to the *Journal of Dental Education*.
 - Copy of manuscript
2. Will continue the planning process for the International Risk Assessment/Risk Management Forum, scheduled to take place March 5-7, 1996 in Charleston.
3. Will convene case studies meeting in Manchester, UK, to discuss issues relating to the International RA/RM Forum.
 - Case studies meeting notes
4. Will meet in Charleston with representatives of Coleman Research Corporation and South Carolina Educational Television to discuss videotape product of the International RA/RM Forum.
5. Dr. Mohr will continue to chair the faculty committee studying the establishment of an Institute of Environmental Studies or a College of Environmental Health Studies at MUSC.

4.0 Public and Professional Outreach

4.1 Crossroads

Executive Summary

During the first quarter of year four, Public and Professional Outreach built upon the work and planning of preceding quarters in a manner consistent with achievement of EHAP's long-term objective: development of a holistic, national basis for risk assessment, risk management and risk communication, focused on human health.

In the areas of Research and Evaluation, the Crossroads staff continued a public-participation project in the rural-agrarian community of Blackville, SC. The Blackville Project is designed to measure citizens' perceptions of environmental risks to human health in their community, then supplement citizens' knowledge via coordinated, multi-media outreach efforts. We will apply lessons learned from the Blackville Project in partnerships with other communities.

One such "community" is the "Neck" area of Charleston. The U.S. Department of Housing and Urban Development (HUD) designated portions of the "Neck" and contiguous areas as an Enterprise Community (EC). During the first quarter, EHAP staff continued to interface with federal, state and local officials to develop a partnership approach to the EC designation. MUSC/EHAP will serve as a primary partner in development and implementation of a "Healthy Community Initiative," designed to improve the overall environmental health of the Charleston EC.

One portion of the Healthy Community Initiative is the development of a business relationship with industries in the Charleston EC. Crossroads staff continued to work with representatives of Albright & Wilson of the Americas, a chemical-manufacturing company situated in the Charleston "Neck" area. The result of this work may be a multi-disciplinary review and outreach effort, funded by Albright & Wilson and performed in large part by MUSC/EHAP.

Crossroads staff continued publication and information efforts in support of MUSC/EHAP. These include: the quarterly EHAP newsletter; ongoing redesign of the Crossroads Series database; publication support of MUSC's graduate-level programs in Risk Assessment and Environmental Studies; publication and logistical support of Research and Evaluation efforts in Blackville, SC; publication support of EHAP Program Office activities; publication and logistical support of the MUSC-EHAP External Advisory Group, and publication and logistical support of the International Risk Assessment/Risk Management Forum.

Objectives

1. To perform research in areas of risk perception and risk communication.
2. To develop and implement productive partnerships affecting the overall environmental health of real communities, such as Blackville, SC, and the Charleston "Neck" area.
3. To publish printed materials related to EHAP and the Crossroads Series.
4. To publish material and provide information support of the Program Office , Science, Education and Information Systems initiatives.
5. To maintain and develop the Crossroads Series database.

4.1.1 Crossroads of Humanity Series

Director:	Glenn A. Fleming, Ed.D.
Events Coordinator:	Sylvia Rivers
Administrative Assistant:	Percilla Coaxum

Milestones and Products for First Quarter, Year 4

1. Conducted Phase II of the Blackville Speaks Out community intervention project. Began a Speakers Series on various environmental health issues for Blackville organizations.
2. Continued ongoing series of planning meetings with MUSC/Blackville liaison Ms. Mildred Ford and MUSC/EHAP staff Mrs. Sylvia Rivers, Ms. Amy Hovatter and Ms. Cathi Bare.
3. Conducted and/or attended meetings related to development of a partnership between federal, state and local officials and MUSC/EHAP for the purpose of inaugurating a Healthy Community Initiative in the Charleston Enterprise Community (EC).
4. Continued ongoing series of meetings between Mr. David Rivers of MUSC/EHAP and federal, state and local officials, including representatives of HUD and the U.S. Department of Health and Human Services. Contacted and obtained EC application documents from officials in Charlotte, NC; Philadelphia, PA/Camden, NJ; and Birmingham, AL.

5. Conducted and/or attended meetings related to development of a partnership between the Medical University and Albright & Wilson of the Americas. Such a partnership includes scientific review of an environmental risk assessment of Albright & Wilson activities, possibly followed by public outreach activities in potentially affected communities.
6. Continued to overhaul the Crossroads of Humanity database, adding experts as they were identified. This effort continues each quarter so as to provide user-friendly access to the data critical for networking. Database currently contains 3,618 entries.
7. Presented an overview of the Blackville project to an audience of nursing students, nursing faculty and registered nurses at MUSC's College of Nursing on September 27.
8. Sponsored with the Columbia Urban League and the SC Department of Health and Environmental Control the Environmental Justice Future Search Workshop September 7-9 in White Oak, SC.

Milestones and Products Projected for Second Quarter, Year 4

1. Will continue Phase II of the Blackville Project.
2. As part of MUSC/EHAP's leading partnership role, will work toward development of a comprehensive, long-term plan for the Charleston Enterprise Community (EC). Plan will be known as the Healthy Community Initiative and may serve as a model for other communities across the country.
3. Will enter partnership with Albright & Wilson of the Americas for the purpose of review and outreach effort of the company's latest model environmental risk assessment.

4.1.2 Research and Evaluation

Research Director:

Catherine Musham, Ph.D.

Research Associate:

Dylan Holmes

Milestones and Products for First Quarter, Year 4

Research Activities

1. Developed a project proposal describing how videotapes developed by EHAP will be used as a teaching instrument for specific educational levels.
 - Project proposal
2. Finalized a survey instrument with Dr. Janet Temple to examine the current perceptions of state and local administrators about environmental health education funding in school systems.
 - Finalized survey instrument
 - Copy of analysis of raw data results
3. Worked with Dr. Jan Bellack and Dr. David Graber to develop a survey instrument that will measure the perceived changes in medical health education programs nationwide. Ten programs were selected for examination and include: nurse practitioner programs, chiropractic schools, medical schools, family practice residency programs, dental schools, pharmacy schools, pediatric residency programs, obstetrics and gynecological programs, internal medicine and nurse midwifery programs.
 - Survey instrument
4. Conducted focus group pilot testing of the medical health education program study with MUSC administrators and physicians.
5. Continued literary searches and reviews for background literature on environmental health.
6. Began developing a research instrument, in conjunction with Dr. Temple, that will examine the current emphasis of environmental topics in graduate and undergraduate engineering programs.

7. Developed a focus group proposal for a possible Savannah River Site study.

- Copy of proposal

8. Continued to work on stakeholder research project with Dr. Abe Wandersman, University of South Carolina. Initial interviews have been conducted

Dissemination of Research Results

9. Submitted the manuscript, "Perception of Physicians as Environmental Health Information Sources," for publication in *Family Medicine*.

- Copy of manuscript

10. Prepared research paper and co-authored MUSC's *Catalyst* article on consumer perceptions of mercury contamination in freshwater fish in the Georgetown, SC region.

Professional Networking

11. Attended monthly meetings of the South Carolina Family Practice Research Consortium for continued support of environmental risk perception and communication research.

12. Participated in the production of the Blackville Speaks Out videotape.

13. Attended the annual Psychological Association Convention in New York and networked with Dr. Abe Wandersman and other environmental psychologists.

14. Met with personnel at the Savannah River Site to discuss proposal for focus group study and communication program with Dr. Temple.

Milestones and Products Projected for Second Quarter, Year 4

1. Will continue draft of paper, "Blackville SC: A Model for Community Environmental Health Concerns Assessment."

2. Will revise a research paper on physicians' environmental health patient educator practices for submission to *Risk Analysis; An International Journal*.

4.1.3 Publications/Information

Program Information Coordinator:

Cathi Bare

Public Information Specialist:

Amy Hovatter

Public Information Specialist:

Jill Tompkins

Milestones and Products for First Quarter, Year 4

1. Published and mailed fall newsletter.
 - EHAP News & Information
2. Planned publication of winter EHAP newsletter.
3. Continued development and implementation of MUSC/EHAP "home page" on the World Wide Web, a graphical interface to the world's largest computer network. To access: <<http://www.ehap.musc.edu>>.
4. Began designing and publishing monthly internal newsletter for all EHAP faculty and staff.
 - August and September internal newsletters
5. Continued planning and production of MUSC/EHAP video series, which ultimately will include several short videotape programs on various MUSC/EHAP activities. First program will focus on outreach activities in Blackville, SC.
6. Continued design process for a new generation of MUSC/EHAP brochures and information sheets.
7. Provided publication and logistical support for second meeting of EHAP External Advisory Group, July 24-25, in Charleston.
 - External Advisory Group meeting book
8. Provided publication and logistical support for second meeting of International Risk Assessment/Risk Management Forum Steering Committee, July 25-26, in Charleston.
9. Continued in-house newspaper, magazine and publication "clip file."
10. Designed presentations about EHAP-sponsored programs for monthly exhibits at the MUSC Library.

11. Planned publications and exhibit for Blackville Heritage Festival on October 21. This is part of the Blackville Speaks Out project.
12. Planned publication and logistical support for the October 26-27 symposium, "The Environmental Risk Assessment: Does It Work for the Community-Based Family Physician?"
13. Continued publication and presentation material support for the Enterprise Community Project/Healthy Community Initiative.
14. Designed and published student handbook for the Master of Science in Environmental Studies program.
 - Student handbook
15. Designed and published handbook for Environmental Justice Future Search Workshop September 7-9, sponsored by MUSC, the Columbia Urban League and the SC Department of Health and Environmental Control.
 - Workshop handbook
16. Five articles were published in MUSC's weekly newspaper, *The Catalyst*. Articles include: "Research Paves Way for Disease Initiation Discoveries" (July 7); "EHAP Information Support Division Recently Reviewed" (July 21); "Mercury Contamination in Fish: Are South Carolinians Getting the Message?" (July 28); "TCE Data Analysis Project Review Held in Charleston" (August 4); and "Murky Message on Mercury Contamination in Fish" (September 22).
 - Copies of articles
17. Published article on Blackville Speaks Out project's essay contest on July 12 in *Barnwell Sentinel*.
 - Copy of article

Milestones and Products Projected for Second Quarter, Year 4

1. Will plan publication of winter EHAP News & Information newsletter.
2. Will continue development and implementation of MUSC/EHAP "home page" on the World Wide Web.
3. Will continue planning and production of MUSC/EHAP video series, which ultimately will include several short videotape programs on

various MUSC/EHAP activities. First program will focus on outreach activities in Blackville, SC.

4. Will continue design process for a new generation of MUSC/EHAP brochures and information sheets.
5. Will provide publication and logistical support for "The Environmental Risk Assessment: Does It Work for the Community-Based Family Physician?" symposium October 26-27.
6. Will continue in-house newspaper and publication "clip file."
7. Will continue publishing monthly internal newsletters.
 - Copies of newsletters
8. Will continue designing presentations of EHAP-funded projects for monthly MUSC Library exhibits. Presentations will be: Dr. Lackland's Geographic Analysis System for Population Health (October); Dr. Temple's Education and Training Initiative (November); and Dr. Mohr's research on high altitude health issues (December).
9. Will present exhibit and publications at Blackville Heritage Festival on October 21.
 - Blackville newsletter, "Enviromation"
10. Will continue publication and presentation material support for the Healthy Community Initiative.

4.2 Department of Environmental Health Sciences (DEHS) - Education and Training Initiative

Project Director:	Janet Z. Temple, Ph.D.
Consultant:	Susan Nelson, M.S.
Administrative Specialist:	Gerri Hollis

Executive Summary

The primary objective of this task is to address workforce management training needs in a rapidly changing environment. One of the environmental industry's missions is to ensure that resources are available to assure the current and future workforce has the skills, knowledge and abilities to carry out its mission today and in the future. It is also a priority to ensure that all groups within our society participate in the successful cleanup activities of environmentally hazardous sites. Adequate training to address

the health risks to the public, the workers and the environment is essential for those executives, managers and workers who will be involved with environmental cleanup and restoration issues within government, business and industry.

The Department of Environmental Health Sciences (DEHS) is involved in the outreach initiative with a focus on education and training. We established a Risk Management Advisory Committee to render guidance to this task. It includes representatives from EPA, OSHA, DOE, DOD, labor unions, educators, public interest groups and the health-care community.

A modification to the Risk Communication text included an additional chapter addressing the use of risk perception research (rpr). The chapter defines rpr and addresses the benefits associated with its use. Qualitative and quantitative methods are introduced with a case study presented.

A second pilot of the Executive Overview of Risk Analysis course was conducted and final changes including an extensive case study are to be completed in October.

A focus of this year's activities include course demonstrations that are scheduled for WSRC, SC School Board Association, SC Municipal Association and for the Citizens Advisory Board of Albright & Wilson, a local business in the "Neck" area of Charleston.

Milestones and Products for First Quarter, Year 4

Planning/Administration/Networking

1. Continued networking to examine risk-related training needs of government and industry facilities.
2. Planned WSRC Executive Risk Training for October 1995. Training for the Citizens Advisory Board of Albright & Wilson will be held in late October and early November.
3. Initiated a discussion with Jim Caper, Director of Education in Governor Beasley's office, to incorporate risk education and training into math and science reforms for South Carolina. Working with Charleston Hub (one of 13 in SC) for math and science on a risk education and training initiative for K-16.
4. Continued to maintain an off-site library housing environmental management and communication information.

Risk Management Advisory Committee

5. Received input from Risk Management Advisory Committee members.

Risk Program Design and Development

6. Finalized course development for the third Professional Development Seminar, "Risk Communication," by adding the chapter, "Risk Perception Research."
7. Continued course development for the fourth Professional Development Seminar, "Executive Overview of Risk Analysis." A second pilot was delivered emphasizing an in-depth case study.
8. Submitted risk texts for external review in collaboration with private sector.

Research/Publications/Presentations

9. Received preliminary data from a "Survey of Environmental Risk Management Practices in Schools." With a 38 percent response rate, preliminary data reflects a need for an information clearinghouse for environmental health risks. Dr. Catherine Musham and Mr. Dylan Holmes assisted in this effort. We initiated a second mailing in August with responses still being returned.
10. Received letter of acceptance from Society for Risk Analysis for December 3-6 conference in Honolulu, Hawaii.
 - Copy of letter of acceptance
11. Continued survey development with Dr. Musham for a study in environmental health topics in undergraduate engineering schools.

Outreach/Speaking Engagements

12. Presented preliminary findings of "Environmental Health Risk Management Practices in Public Schools," September 21 at the NC/SC Environmental Information Association in Myrtle Beach, SC.

Milestones and Products Projected for Second Quarter, Year 4

Planning/Administration/Networking

1. Will continue networking and meeting with a wide range of colleagues and potential partners and clients.
2. Will work with the Citizen Risk Management Advisory Board at an industrial site in Charleston. This effort will further enhance efforts with the Enterprise Community initiative.

Program Design and Development

3. Will demonstrate and finalize "Executive Overview of Risk Analysis."
4. Will finalize the "Risk Perception Research" chapter for the "Risk Communication" course.
5. Training will be provided for the DOE/WSRC, Risk Management Advisory Board at a local industrial facility and training will be provided to the SC Municipal Association.
6. Will refine proposed Risk Leadership Initiative with Charleston Hub (one of 13 in SC) for math and science teachers K-16.
7. Will compile and review feedback from private business in their review of risk courses.

Research/Publications/Presentations

8. Will submit abstracts to the National Association of Environmental Professionals and the Environmental Information Association in response to their call for papers.
9. Will finalize the risk survey of public schools.
10. Will finalize survey instrument to be sent to engineering schools.
11. Will design and disseminate risk management survey instrument to SC School Board Association.

Outreach - Other

12. Will continue to be involved in Charleston's "Neck" Area/Enterprise Community initiative, meeting with local industry and local Citizen Risk Management Advisory Board.

13. Will continue to serve on conference planning committee for National Association of Environmental Professionals; will have responsibility to oversee risk analysis session presentations, selection of session chairs, and abstract reviews for the 1996 annual conference scheduled June 1-6 in Houston.

4.3 Healthy Community Initiative

Director, Community Development:	David E. Rivers
Director, Public and Professional Outreach:	Glenn A. Fleming, Ed.D.
Research Associate:	Richard C. Jablonski
Special Events Coordinator:	Sylvia Rivers
Program Information Coordinator:	Cathi Bare
Public Information Specialist:	Amy Hovatter
Public Information Specialist:	Jill Tompkins

Executive Summary

The Medical University, through EHAP, is exploring a broader definition of "community environmental health." The Medical University recognizes that its primary mission as a health sciences institution is the understanding (through education and research) and delivery of human health care. At the same time, human health is not just a matter of delivery, but a reflection of a community's physical, economic and environmental well-being. We seek a better understanding of what it takes to develop healthy communities on every scale--local, national and global.

With the establishment of EHAP in 1992 and its Crossroads Series of forums and workshops in 1993, the Medical University began this process. Initially, the Crossroads programs convened multi-disciplinary panels to examine hypothetical scenarios. Over time, at the suggestion of Crossroads Series panelists, EHAP's Public and Professional Outreach programs developed a narrower, "real-world" focus. Through the Crossroads Series initiative, the Medical University and EHAP are identifying and addressing environmental health issues in Blackville, SC (the latter project is ongoing as part of the Crossroads Series effort).

Currently, MUSC/EHAP is playing a leadership role in Charleston (SC) Enterprise Community activities, and is developing a long-term partnership with Albright & Wilson Americas, a chemical manufacturer located in Charleston, SC. As these latter projects grow and lead to other opportunities, it appears that now is an appropriate time to introduce a new EHAP initiative--Community Environmental Health.

Objectives

1. To develop a better understanding of the interrelated nature of the many elements of a community's "environmental health."
2. To develop and implement productive partnerships affecting the overall environmental health of real communities, such as the Charleston, SC, Enterprise Community.
3. To envision and facilitate effective programs and projects as part of these efforts.
4. To perform research in areas of risk perception and risk communication, as these disciplines relate to environmental health.
5. To publish printed materials related to EHAP's Community Environmental Health activities.
6. To maintain and develop a Community Environmental Health database as part of the larger Crossroads Series database.

Introduction

In December 1994, the U.S. Department of Housing and Urban Development designated portions of the Charleston, SC, peninsula an Enterprise Community (EC). The EC designation empowers chronically underserved communities to develop unique "partnerships" for the purpose of community betterment. The Medical University, through EHAP, is playing a major role in EC activities by assisting in--among other things--amendment and expansion of EC benchmark documents.

This role is consistent with the Medical University's broad definition of the term *environmental health*. In part through EHAP initiatives, the Medical University believes that a community's environmental health consists of many interrelated elements: its economic health, the physical health of its residents, and the condition of their surroundings (housing, environment, public safety). These related "healths" mirror the stated concerns of Enterprise Community residents.

In partnership with the City of Charleston and EC residents, the Medical University is developing programmatic themes (and projects) to address these concerns. The partners' collective vision is the driving force behind the Charleston Healthy Enterprise Community Initiative. This is the basis of future EC activities, and may evolve into a foundation for the Medical

University's involvement in other Community Environmental Health initiatives.

One portion of the Healthy Enterprise Community Initiative is development of a business relationship with industries in the Charleston EC. During the first quarter, Crossroads staff met with representatives of Albright & Wilson Americas, a chemical-manufacturing company situated in the Charleston Neck area. The result of these meetings is a multi-disciplinary review and outreach effort, funded by Albright & Wilson and performed in large part by MUSC/EHAP. This effort is projected to continue through the second and third quarters of year four.

Milestones and Products for First Quarter, Year 4

1. Continued ongoing development of Charleston Healthy Enterprise Community Initiative, in coordination with the City of Charleston and the EC's residents.
 - Greater Charleston Healthy Community Initiative document
2. Inaugurated and continued planning process for Primary Healthcare Resource Center in the Charleston Enterprise Community.
 - Primary Healthcare Resource Center document
3. Met on August 11 in Atlanta, GA, with representatives of U.S. Department of Health and Human Services (HHS), U.S. Congressman James Clyburn's office and Franklin C. Fetter Health Center of Charleston to discuss planning grant for Primary Healthcare Resource Center in Charleston Enterprise Community.
4. Met on August 23 with City of Charleston representatives (Pat Crawford, Ginny Stroud and Eric Loewe) and Congressman Clyburn's representative Davis Marshall to discuss Charleston Enterprise Community initiative.
5. Met August 24-25 with representatives of General Services Administration (GSA), National Performance Review (NPR), City of Charleston, SC, and MUSC, to discuss proposed "Partners in Community Development" meeting in Charleston.
6. Met on September 1 with HHS officials in Atlanta, GA.
7. Met on September 1 with regional representatives of various U.S. government agencies to discuss proposed "Partners in Community Development" meeting in Charleston. Represented offices/agencies

included Housing and Urban Development (HUD), Education, Labor, General Services Administration (GSA), National Performance Review (NPR), and Congressman Clyburn's office. Meeting was hosted by HUD Regional Administrator Davey Gibson.

8. Met on September 15 with Dr. Charles Young, Chairman of EC Advisory Board, regarding the board's role in EC activities. Briefed Dr. Young on Charleston Healthy Enterprise Community Initiative and planned meeting for October 30.
9. Met on September 19 and 26 with Dr. Carolyn Jenkins (MUSC College of Nursing, EC grantee) for the purpose of discussing Enterprise Community activities.
10. Met on September 28 with regional representatives of U.S. EPA in Atlanta, GA, regarding that agency's potential involvement as a partner in Charleston Enterprise Community activities.
11. Planned partnership activities with Albright & Wilson Americas for the purpose of review and outreach effort of the company's latest model environmental risk assessment.
12. Met on July 13 with representatives of Albright & Wilson, including Bill Helfenstein and John Stoney, at MUSC.
13. Attended July 18 meeting of Albright & Wilson's Community Advisory Board.
14. Hosted July 20 meeting in which John Stoney and Bill Helfenstein of Albright & Wilson briefed Dr. David Hoel of MUSC on A&W's Risk Management Plan.
15. Richard Jablonski and Dr. Robert Draughn of MUSC met with John Stoney of Albright & Wilson on August 15 to discuss review of Risk Management Plan.
16. Attended September 12 meeting of Albright & Wilson's Community Advisory Board. Agreed that Mr. Jablonski will represent MUSC on A&W's Risk Management Committee.
17. Began process of adding an Enterprise Community section to the existing Crossroads of Humanity database, adding potential partners, meeting attendees and others as they were identified.

Milestones and Products Projected for Second Quarter, Year 4

1. As part of MUSC/EHAP's leading partnership role, will work toward development of a comprehensive, long-term plan for the Charleston Enterprise Community (EC). Plan will be known as the Charleston Healthy Enterprise Community Initiative and may serve as a model for other communities across the country.
 2. David Rivers will continue briefing process for Charleston-area participants in Enterprise Community activities. These participants include, but are not limited to, EC Advisory Board members and neighborhood association representatives.
 3. MUSC and City of Charleston will plan and host "Partners in Community Development," a meeting of various potential partners in EC activities. Program will be coordinated by the U.S. Departments of Housing and Urban Development and Health and Human Services and Vice President Al Gore's National Performance Review. Meeting dates are October 29-30.
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| <ol style="list-style-type: none">4. Will formalize partnership with Albright & Wilson of the Americas for the purpose of review and outreach effort of the company's Risk Management Plan.5. Will complete and present review of Albright & Wilson's Risk Management Plan. Review will be a combined effort by Dr. David Hoel and Dr. Bobby Kennedy of MUSC and Dr. Thomas Overcamp of Clemson University.6. Will attend meetings of Albright & Wilson's Community Advisory Board and Risk Management Committee.7. Will begin formal process of developing format for Albright & Wilson's proposed Risk Management outreach activities. These meetings will include involvement of South Carolina Educational Television personnel. |
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8. Will continue process of adding an Enterprise Community section to the existing Crossroads of Humanity database, adding potential partners, meeting attendees and others as they were identified.

5.0 Biomedical Research

5.1 Biomedical Research Projects

5.1.1 Identification of Trichloroethylene-Hemoglobin Adducts for Use in the Development of an Immunological Assay to Assess Trichloroethylene (TCE) Exposure in Humans

Project Director:

David C. McMillan, Ph.D.

Executive Summary

Trichloroethylene (TCE) is a commonly used industrial solvent and has become a common environmental contaminant. At many hazardous waste sites, it is the most abundant chlorinated hydrocarbon contaminant, being present in ground water and soils and sediment in some areas at levels thousands of times to millions of times higher, respectively, than EPA's regulatory maximum level for drinking water.

During this first quarter, we have completed a manuscript entitled, "Immunochemical Detection of Protein Adducts in Mice Treated with Trichloroethylene." This manuscript has been submitted for publication to *Chemical Research in Toxicology*. We have begun work on a second manuscript, which describes the appearance of TCE-protein adducts in the serum of rats treated with TCE. The serum adducts appear to have come from the liver and are probably protein fragments of the major liver adduct (a 50 kDa protein immunochemically reactive with anti-cytochrome P-450 2E1). To detect TCE adducts in the serum, serum protein from TCE-treated rats had to be purified by immunoaffinity chromatography. Of interest, no other adducts were detected under the described experimental conditions.

Objectives

1. To identify and structurally characterize human hemoglobin adducts derived from exposure to TCE.
2. To prepare immunogens and generate antisera to these biomarkers for development and application of immunoassays for the biomarkers.
3. To characterize protein adduct biomarkers of exposure to additional chemicals of relevance to DOE sites and develop antisera to these biomarkers.

Milestones and Products for First Quarter, Year 4

1. Completed first TCE manuscript and submitted it to *Chemical Research in Toxicology*.
 - Copy of submitted manuscript
2. Completed experiments on serum TCE-protein adducts. Began preparation of the manuscript.

Milestones and Products Projected for Second Quarter, Year 4

1. Will develop experimental procedures to enzymatically digest purified proteins to amino acids and develop chromatographic methods to isolate amino acids from digested proteins for structural analysis.
2. Will identify amino acid adducts recognized by the anti-TCE antibody in mice.
3. Will examine whether human serum samples from scleroderma patients (obtained from Dr. Richard Silver) have antibodies that recognized TCE-protein adducts.

5.1.2 Species Comparison of Trichloroethylene-Induced Peroxisome Proliferation and Induction of DNA Syntheses

Project Director:

JoEllyn M. McMillan, Ph.D.

Technical Support:

Stacey Allen, B.S.

Executive Summary

Trichloroethylene (TCE) is a commonly used industrial solvent and has become a common environmental contaminant. At many hazardous waste sites, it is the most abundant chlorinated hydrocarbon contaminant, being present in ground water and soils and sediment in some areas at levels thousands of times to millions of times higher, respectively, than EPA's regulatory maximum level for drinking water.

The main target organ for TCE toxicity is the liver. Chronic exposure to TCE has been shown to cause hepatic carcinomas in B6C3F₁ mice, but not in Osborne-Mendel rats. In addition, TCE exposure has produced lymphomas in hamsters, lung tumors in ICR rats and renal tumors in Fischer 344 rats. These tumors, however, have not been consistently observed in other rodent species and strains.

TCE falls into a category of compounds known as peroxisome proliferators, for example, they induce an increase in the number of peroxisomes in a cell. Peroxisome proliferators also induce a characteristic pattern of biochemical responses in the liver. Hepatocarcinogenesis is a common property of all peroxisome proliferators tested thus far; however, this response is not usually associated with direct DNA damage by the compound. Increased production of hydrogen peroxide, which may cause indirect DNA damage, and the propensity of these compounds to induce hepatocyte replication have been argued to contribute to their ability to cause hepatic cancer in certain laboratory animal species.

TCE-induced peroxisome proliferation has been demonstrated in rats and mice and in cultures of mouse hepatocytes. We propose to examine the ability of TCE and its proposed hepatotoxic metabolites, trichloroacetic acid (TCA) and dichloroacetic acid (DCA), to induce peroxisome proliferate and DNA synthesis and/or cell replication by utilizing hepatocyte cultures from B6C3F₁ mice and rats. Further, we propose to compare the response in these cultured cells to that in a human liver cell line and/or cultured human hepatocytes. The results from these studies would provide information on the relative susceptibility of human, rat and mouse liver cells to the potential hepatocarcinogenic activity of TCE.

This project should provide useful information in assessing the risk TCE poses as a human health hazard, both at DOE sites and in surrounding areas where there is ground water contamination.

Objectives

1. To determine the dose/response relationship of TCE and its toxic metabolites to induce peroxisome proliferation and DNA synthesis in rat and mouse hepatocyte cultures.
2. To determine the ability of TCE and its toxic metabolites to induce peroxisome proliferation and DNA synthesis in human liver cell lines and/or human hepatocyte cultures.

Milestones and Products for First Quarter, Year 4

1. Examined the ability of DCA to induce peroxisome proliferation (using both enzymatic and molecular markers) and to enhance DNA synthesis in both B6C3F₁ mouse and rat hepatocyte cultures.
2. Compared responsiveness of HepG2 and Hep3B human hepatoma cell lines, with respect to DCA induction of peroxisomes, to the response observed in mouse and rat hepatocyte cultures.

- Copies of figure 1 and results summary (for both of above milestones)
- 3. Compared the ability of DCA to induce peroxisome proliferation (using both enzymatic and molecular markers) with that of clofibrate and TCA.
- Copies of figures 1 and 2 and results summary
- 4. Attended International Congress of Toxicology VII Meeting in Seattle, WA, July 2-5 to present results on TCA induction of peroxisomal enzymes in rat and mouse hepatocyte cultures and human hepatoma cell lines.
- Poster

Milestones and Products Projected for Second Quarter, Year 4

1. Will continue studies on TCA- and DCA- induced peroxisome proliferation (using both enzymatic and molecular markers) in rat and mouse hepatocyte cultures and in the HepG2 and Hep 3B human hepatoma cell lines.
2. Will compare the ability of TCA and DCA to induce peroxisome proliferation (using both enzymatic and molecular markers) with that of clofibrate and other known peroxisome proliferators.

5.1.3 Molecular Dosimetry in Reactive-Oxygen Species (ROS)--Mediated Toxicity of Environmental Chemicals.

Project Director:	James S. Norris, Ph.D.
Co-Investigators:	David Jollow, Ph.D.
	JoEllyn M. McMillan, Ph. D.
	David Kurtz, Ph.D.
	Steven Frawley, Ph.D.
	Inderjit Singh, Ph.D.

Executive Summary

Trichloroethylene (TCE) is a widely used industrial solvent that has pervasively contaminated the environment. At some hazardous waste sites, it is so concentrated that it has entered the ground water, soils and sediments to levels, thousands to millions of times higher than EPA regular maxims allow.

TCE toxicity is mainly targeted toward the liver. It has been shown in the B-6C3F1 mouse model to be a hepatic carcinogen. TCE exposure also induces lymphomas in hamsters, lung tumors in ICR rats and renal tumors in fisher 344 rats. However, there is some discrepancy between the consistency with which these tumors are observed among other rodent species and strains suggesting that there is a genetic element underlying susceptibility.

TCE is believed to function as a peroxisome proliferator. This has been demonstrated in rodent models but remains to be determined in humans. Peroxisome proliferators are typically able to act as hepatic carcinogens by mechanisms that are not well defined. For example, direct DNA damage by the compound has not been observed. However, the sensitivity of the assays used are not always sufficient to detect rare but predicted DNA damage that would be induced by this type of carcinogen via its ability to induce hydrogen peroxide in peroxisomes. Because peroxisome proliferators interact with their cognate receptors that interact with other receptors, it is also quite possible that TCE may act to alter transcription of important control elements in the cell. This latter activity, for example, induction of the oncogene might lead to chromosome instability and hepatic cancer.

In the proposed project, TCE will be evaluated for its peroxisome proliferation activity as well as for its ability to generate oxygen free radicals and corollary DNA damage. The system that we have available for doing these assays is state-of-the-art and will allow the assay to be carried out in a continuum in a single cell, providing the first direct functional information relative to oxygen free radical induction versus DNA damage. This project is groundbreaking in this respect, and its future potential for analyzing mechanistic responses to environmental chemical exposure is considered highly significant.

Note on terms

An oncogene is a hypothetical viral genetic material carrying the potential of cancer.

Objective

To determine whether TCE or its metabolites induce free radical generation in the peroxisomes of established and primary human liver cells as primary cultures.

Milestones and Products for First Quarter, Year 4

1. Hired Dr. Christina Johnson as a post-doctoral fellow. Training of Dr. Johnson is in progress.
2. Tested the fos-luc vector that is ready for Dr. Frawley to analyze.

3. Tested the fos-luciferase (fos-luc) reporters for their functionality by transient expression approaches following stimulation with phorbol esters (control) and TCE metabolites (test).
4. Continued to establish conditions for photon counting that will later be analyzed for suitability in the comet assay.
5. Continued all of the above experiments in established cell lines. Once conditions are worked out, experiments will be repeated in primary rat hepatocyte cultures obtained from Dr. JoEllyn McMillan.

Milestones and Products Projected for Second Quarter, Year 4

1. We expect to have created our first transgenic mice by the end of 1995. Publication of this data will not be possible until 1996 because of the length of time necessary to assay the animals.
2. Will develop functional knockout vectors for the following peroxisomal enzymes: catalase, Acyl-CoA oxidase and Acyl-CoA synthetase. We will also develop vectors (to be decided) to perturb the PPAR system. These functional knockout vectors are based on the triple ribozyme * vector that Drs. Norris and Clawson (Penn State) are developing. These vectors are designed to determine the role of peroxisomes in TCE-induced hepatocellular carcinoma in B6 mice.

* This vector (patent applied for) is based upon a ribozyme construct targeted to inactivate the gene of interest flanked by two autocatalytic ribozymes that cleave to produce a short RNA molecule available to act in the nuclear environment.

5.1.4 Immunogenetic Epidemiology of Scleroderma

Project Director:	Janardan P. Pandey, Ph.D.
Co-Investigators:	Richard M. Silver, M.D. Susan Sutherland, Ph.D
Graduate Student:	Paul Nietert
Laboratory Technician:	Phillip Werner

Executive Summary

Scleroderma (SSc) is an autoimmune disease characterized by inflammation and fibrosis of the skin and visceral organs. A number of occupational and environmental exposures have been related to the occurrence of SSc and SSc-like illnesses. Exposure to trichloroethylene (TCE), perchlorethylene, methylene chloride, trichlorethane, and other organic solvents has been

reported in association with SSc. Thus far, there has been no epidemiological study conducted to investigate any relationship between SSc and environmental exposure to agents such as TCE.

According to the Agency for Toxic Substances and Disease Registry (ATSDR), about 400,000 workers are exposed to TCE in the United States during an average 40-hour work week. Moreover, TCE is widely used as a solvent and is used to make other chemicals and is found in typewriter fluid, paint removers, adhesives, and spot removers. We are conducting a case-control study which will quantify the association between TCE exposure and SSc. A questionnaire has been developed and is being utilized to collect information on demographic characteristics, occupational histories and environmental factors from each SSc patient and control subject. Data collected through this questionnaire will help determine the relative risk of SSc due to TCE exposure.

Segregation analysis of several autoimmune families has shown that autoimmunity is controlled by a single autosomal dominant gene. The resultant autoimmune disease, if any, is probably determined by epistatic interactions of this primary gene with other secondary autoimmune genes and environmental factors. HLA class II, $TNF\alpha$, $IL-1\alpha$ and β , GM, and KM loci are excellent candidates for the postulated secondary autoimmune genes, which could trigger the autoimmune disease state such as scleroderma. HLA class II alleles have been shown to be associated with susceptibility to several autoimmune diseases, including scleroderma. $TNF\alpha$, $IL-1\alpha$ and β are important in several immunological activities and are mediators of inflammatory responses. $TNF\alpha$ has been shown to be a risk factor in some autoimmune diseases, e.g. SLE. Similarly, GM and KM loci have been implicated in a number of autoimmune disorders. In addition to these genes of the immune system, we will also study polymorphic loci that encode the major P450 (2E1,2B1/2,2C11/6) enzymes involved in the bioactivation of TCE.

Unlike some other autoimmune diseases, autoantibodies in scleroderma appear to be specific to this disease. Moreover, different autoantibodies are associated with different subsets of the disease. For example, autoantibodies to topoisomerase I (Scl-70) are found in patients with diffuse cutaneous SSc with a propensity to develop rapid and significant visceral disease. The limited cutaneous form of SSc (also known as the CREST syndrome) is associated with anti-centromere antibody (ACA) production. The significance of these autoantibodies in the pathogenesis of the disease is not understood.

We hypothesize that exposure to TCE increases the risk of SSc, and the host genetic factors--either through their effect on the immune system and/or by mediating the bioactivation of TCE--modify this risk.

Whereas the Medical University of South Carolina has: 1) 400 scleroderma patients and 52 percent thereof are SC residents; 2) MUSC survey research center; and, 3) immunogenetic markers currently determined by MUSC immunologists and consultants, particularly within EHAP, MUSC is the proper place to conduct this project.

Objectives

1. To determine the prevalence of TCE exposure among scleroderma patients; to estimate the magnitude of the association between TCE-exposure and scleroderma; and to quantify the risk of scleroderma attributable to TCE.
2. To compare the distribution of immunogenetic markers (HLA, TNF α , GM, KM, IL-1 α and β) among TCE exposed scleroderma patients with (a) non-exposed (idiopathic) scleroderma patients and (b) non-scleroderma controls.
3. To compare the distribution of the genetic markers of the major P450 (2E1,2B1/2,2C11/6) enzymes involved in the bioactivation of TCE among TCE exposed scleroderma patients with (a) non-exposed (idiopathic) scleroderma patients and (b) non-scleroderma controls.
4. To determine the gene-environment interaction effects of the genes of the immune system, genes regulating the bioactivation of TCE, and TCE exposure in scleroderma.
5. To determine the prevalence of scleroderma specific antibodies: anti-topoisomerase I (anti-Scl-70), anticentromere, and anti-RNA polymerase I, in idiopathic versus TCE -exposed patients.
6. To compare the association of autoantibodies with the genetic markers among TCE-exposed and nonexposed scleroderma patients.

Milestones and Products for First Quarter, Year 4

1. Collected data and blood from over 155 patients and controls.
2. Completed a preliminary statistical analysis of the available data that indicates the involvement of TNF α and GM loci in susceptibility to scleroderma.
3. Consulted with Dr. David Flockhart of Georgetown University who is an expert on the P450IIE1 gene. Dr. Flockhart also gave a presentation

on the human predisposition to environmental toxicity: the role of hepatic metabolism. He suggested that we should explore the possibility of studying two more polymorphic loci in our subjects — glutathione-S-transferase 1 and N-acetyltransferase 2.

4. Continued to determine the role of immunogenetic markers in autoimmune diseases, resulting in a manuscript submitted to *Clinical and Experimental Immunology*. Authors of text include: Enz, L.A.; Love, L.A.; Targoff, I.N.; Pandey, J.P.; and Miller, F.W.; for manuscript entitled, "Genes Linked to Gm and MHC Loci Control Susceptibility for Developing Myositis and Myositis-Specific Autoantibodies."

- Copy of manuscript

Milestones and Products Projected for Second Quarter, Year 4

1. Will continue to analyze that association of scleroderma with occupational and environmental exposures, leading to a characterization and prevalence of TCE exposure among a subset of scleroderma patients and controls.
2. Will add three more items to the repertoire of variables determined in our patients and controls — autoantibodies to calpastatin and the polymorphic determinants of glutathione-S-transferase1 and N-acetyltransferase2 loci.
3. Will consult and explore collaborative arrangements with Dr. Kim Dietrich of the University of Cincinnati, an expert in path-coefficient analysis.

5.1.5 <u>Anaerobic Dechlorination of Polychlorinated Biphenyls (PCBs) and the Biodegradation of Ether-Containing Gasoline Additives and Ether Solvents</u>

Project Director:	Harold D. May, Ph.D.
Laboratory Technician:	Mary Berkaw

Executive Summary

Investigations continue on the reductive dechlorination of polychlorinated biphenyls (PCBs) under anaerobic (no oxygen) conditions. The long-term goal of this work is the destruction of PCBs *in situ* (where they exist) in anaerobic soils and sediments. The project will also deliver information on reductive dechlorination in general and on the microbial communities that are operating in these environments. A second project targets the microbial destruction (aerobic or anaerobic) of ether compounds that are used as

solvents, are by-products of plastics production (1,4-dioxane), or are used as octane-enhancing additives to gasoline (methyl *t*-butyl ether, MTBE, and ethyl *t*-butyl ether, ETBE).

PCBs

Polychlorinated biphenyls (PCBs) have been used in a wide variety of industrial applications worldwide. Due to their stability and potential toxicity, PCBs in soils and sediments have been an environmental concern for several decades. Up until about 15 years ago, PCBs were considered to be resistant to biological degradation; however, since then, the dechlorination and biodegradation of these compounds has been documented in both the laboratory and in the environment.

The reductive dechlorination of PCBs by anaerobes is considered an important step in the destruction of these compounds in the environment because: 1) many of these environments are anaerobic; 2) more heavily chlorinated PCBs are more easily attacked under anaerobic conditions; and, 3) some of the more heavily chlorinated PCBs are considered to be more toxic. However, no PCB-dechlorinating anaerobes have been isolated, and the physiology and ecology of the organisms responsible for this activity have not been determined. This makes construction of bioremediation schemes difficult.

Anaerobic dechlorination of PCBs in essence detoxifies a contaminated site. To completely dechlorinate PCBs in anaerobic environments, several dechlorinating activities will be required. This is because there are potentially 209 forms of PCBs and no one organism is capable of attacking them. Also, the number and position of the chlorines on the biphenyl rings is another element of this problem. Attack of the *ortho* positioned chlorines is rare, and hence, the characterization and development of such activity (action by organisms) could be of use in future remediation efforts.

Gasoline Additives (MTBE and ETBE)

These compounds are resistant to degradation and can accumulate in groundwater following a gasoline spill. Some gasolines are now 15 percent MTBE. The health hazard that this may pose is not clear and is being hotly debated. Identification and characterization of microorganisms that can degrade these compounds would be very useful in the remediation of a spill site. Thus far six aerobic strains that degrade ETBE have been isolated in this laboratory. The degradation products have not yet been determined because of delays in the renovation of the lab. Whereas we are now equipped, analysis of these and future strains can proceed.

Objectives for Anaerobic Dechlorination of PCBs

1. To enrich, isolate, and characterize the microorganisms involved in the anaerobic dechlorination of PCBs, which is needed as a first step toward understanding the microbiology of the process of bioremediation of PCBs.
2. Long-term: To achieve bioremediation of soils and sediments contaminated with PCBs.

Objectives for Biodegradation of Ethers

1. To isolate and characterize microorganisms that are capable of degrading cyclic ethers and ether-containing gasoline additives.
2. Long-term: To achieve bioremediation of ground waters contaminated with the aforementioned ethers.

Education

An undergraduate student, Aliyah Spruill, joined the laboratory for ten weeks this summer. Aliyah was trained in the cultivation of environmental isolates and assisted in the analysis of the organisms that degrade the gasoline additives (ETBE). Aliyah has now moved on to graduate course work at MUSC.

A new student, Leah Cutter, joined the laboratory in September and is working on the *ortho* PCB-dechlorinating project. This is a rotation project for her, however, she has expressed a long-term interest in the project.

Milestones and Products for First Quarter, Year 4

1. Presented the results of the *ortho*-PCB dechlorination project at a Gordon Conference on applied and environmental microbiology.
2. Submitted a manuscript describing the *ortho* -PCB dechlorination observed with Baltimore Harbor sediment for publication.
 - Copy of manuscript
3. Screened sediments of Charleston Harbor for activity similar to that seen with Baltimore Harbor sediments. Thus far activity has been detected (including *ortho* dechlorination), however some subtle differences exist in the specificity of the activity and the acclimation time preceding the onset of activity.

Milestones and Products Projected for Second Quarter, Year 4

1. Will further define dechlorination of commercial mixtures of PCBs (Aroclors) in marine sediments.
2. Will develop for publication a manuscript describing the isolation of DNA from sediments heavily contaminated with coal-based humic acids and PCBs.
3. Will initiate a new exploratory project on the concentration of tritium (tritiated water) in biomass and fermentation products by anaerobic microorganisms.
4. Will develop course work for Environmental Microbiology course (30-772) for the spring semester.
5. Will investigate the substrate range of CB1190, a 1,4-dioxane degrading aerobic organism.
6. Baltimore Harbor sediments are dechlorinating commercial mixtures of PCBs (Aroclor 1242), but a significant amount of work is still needed in order to define this activity.

5.1.6 Biodegradation of Hydrophobic Contaminants (PCBs and Fossil Fuels)

Project Director:

Pamela J. Morris, Ph.D.

Laboratory Technician:

Louise Weston

Executive Summary

The long-term goal of this research investigation is to better understand the biodegradation of hydrophobic contaminants (e.g., fossil fuels, polychlorinated biphenyls) in soils and sediments.

The strong sorption of polychlorinated biphenyls (PCBs) onto soils and sediments limits their availability to PCB-degrading microorganisms. This availability to the biotic community, referred to as bioavailability, is an increasingly important component in the bioremediation of hydrophobic compounds. In addition, co-contaminants, such as fossil fuels, may substantially contribute to the organic component of the soil matrix, and result in a change in the sorptive behavior of PCBs. Researchers have demonstrated that both natural organic matter and residual oil components of soil act as a partition media for organic solutes such as PCBs, with the latter being roughly ten times more effective as a sorptive phase. In addition, studies have demonstrated the inhibition of degradation in the presence of a mineral oil component.

Our studies are focusing on environmental sites that are contaminated with both PCBs and fossil fuels. We have begun to enrich for microorganisms capable of biodegrading the fossil fuel fraction from several of these sites. In addition, we are isolating and characterizing pure cultures from these enrichments and assessing their individual contributions to fossil fuel biodegradation.

Milestones and Products for First Quarter, Year 4

1. Prepared "Extensive Biodegradation of Fossil Fuels Extracted from Soil and Sediment" by Morris, P.J.; Shelton, M.E.; McDonald, T.J.; and Chapman, P.J.; for publication in *Environmental Science and Technology*.
2. Taught as small group leader in a Problem-Based Learning (PBL) course in Immunology, Microbiology and Infectious Disease.
3. Roberto Frontera-Suau, Ph.D. student, conducted research on the microbial characterization and population dynamics of a crude oil-degrading enrichment culture.
4. Samuel Rawlin, Ph.D. student, studied the hydrophobicity of bacterial cells, and the biosorption of hydrophobic contaminants (e.g., PCBs) to bacteria and how biosorption influences contaminant mobility.
5. Romish Stanislaus, Ph.D. student, conducted research on methods to enhance desorption of PCBs from an aged soil in order to increase contaminant availability and biodegradation.
6. Allison Stack, Ph.D. student (rotation student), studied biosurfactant production by fossil fuel-degrading microorganisms.
7. Dan Bost, Ph.D. student (rotation student), studied the cometabolism of hydrocarbons by *Phyllobacterium rubiacearum* during growth on ammonia.
8. Co-sponsored two undergraduates with Dr. L. London for ten weeks this summer as part of MUSC's Undergraduate Research Program.
9. Conducted preliminary studies on the effect of biodegradation of complex contaminant mixtures on immune response.
10. Served as co-coordinator for EHAP's Seminar Series.

11. Assisted in writing article, "Co-contaminated Sites: The Biodegradation of Fossil Fuels in the Presence of Polychlorinated Biphenyls."
12. Presented "Extensive Biodegradation of Weathered Fossil Fuels Extracted from Soil and Sediment" at Gordon Conference, Applied and Environmental Microbiology Abstracts, July 2-7 in New Hampton, NH.
13. Submitted the Following Abstracts for MUSC Student Research Day (November 3, 1995):

- | |
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| <ul style="list-style-type: none"> • Bost, F. D.; Frontera-Suau, R.; and Morris, P.J.; "Identification of <i>Phyllobacterium rubiacearum</i> in a Crude Oil-degrading Culture." • Samuel, R. R.; and Morris, P.J.; "Bacterial Cell Hydrophobicity." • Frontera-Suau, R.; and Morris, P.J.; "An Antibiotic Selection Strategy for the Study of Microbial Population Dynamics During Crude Oil Biodegradation." • Stack, A. S.; and Morris, P.J.; "Biosurfactant Production by Crude Oil-degrading microorganisms." • Stanislaus, R. C.; and Morris, P.J.; "The Effect of Methanol on PCB Degradation by <i>Alcaligenes eutrophus</i> H850." |
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Milestones and Products Projected for Second Quarter, Year 4

1. Will submit the following manuscript for publication: Morris, P.J.; Shelton, M.E.; McDonald, T.J.; and Chapman, P.J.; "Extensive Biodegradation of Fossil Fuels Extracted from Soil and Sediment."
2. Will submit abstracts for the American Society of Microbiology Annual Meeting.
3. Will present poster presentations for MUSC's Student Research Day on November 3.
4. Will continue to teach the PBL course, to assist in coordinating the EHAP Seminar Series and to act as a mentor to students.

5.2 Risk Assessment Projects

5.2.1 Low Dose-Rate Radiation Health Effects

Project Director:	David G. Hoel, Ph.D.
Research Associate:	Zhen Zhang, Ph.D.
Research Associate:	Ping Li, Ph.D.
Graduate Student:	Tomas Radivoyevitch

Executive Summary

In the evaluation of external ionizing radiation exposure to man, all of the health risk assessments are based on acute exposures. It has been known from animal studies that often times for the same total dose, the toxic effects of radiation are less if the exposure is given continually at a low dose-rate. Estimates of the reduction in risks have ranged from a factor of two to ten. Obviously, this would greatly impact the strategies for cleanup of radioactive materials and the level of permissible exposure to workers. This is particularly important because of the recent comparisons being made between A-bomb survivors and nuclear worker populations. The shape of the cancer dose-response function is also important to study in light of the discussion concerning hormesis.

In studying exposure to workers, methods of physiologically based pharmacokinetic (PBPK) modeling and simulation are often used in dose-response evaluations of human health effects. Specifically, the project will utilize PBPK modeling and simulation to measure the effects of radiation in the body over time. Fate-transport models are used to estimate the distribution of radioactive materials in the environment including living and working places. In both cases, models are often highly nonlinear in nature and of a large number of variables and parameters. These models are usually developed with very limited information on the precision of the estimated input variables and the model parameters.

Objectives

1. To determine dose-rate effectiveness factors for various cancers in rodent studies after gamma or neutron exposure and to examine the low-end of the dose-response function.
2. To determine relative biological effectiveness of neutrons in rodent cancer studies and relate the rodent models to human epidemiological data.

3. To incorporate the analytical tools of systems science and engineering to the theoretical and methodological research of PBPK models.
4. To understand through basic biological models the effects of radiation induction of misrepaired double strand breaks at the cellular level.

Strategy

To study this question, it is necessary to bring together large amounts of animals studies that have been conducted through the years by DOE and compare chronic versus acute exposures using statistical cancer models for the analysis. One would then be able to project the effects of estimated human cancer risk at low dose-rate exposure. Connected with this analysis, it is also possible to work out risk assessments for neutron exposure for which there is little or no human data. This work would again depend upon DOE experimental information. This research is being carried out collaboratively with scientists at the Argonne National Laboratory.

To examine the low-end of the dose-response function, cell cultures will be irradiated and mutations measured in real time through the use of the luciferase gene.

Monte Carlo techniques and other methods such as calculation of sensitive indices are currently used for the evaluation of precision in human exposure estimation and dose-response analyses. We would like to develop a new method for the analysis of sensitivity based on global optimization search algorithms. The new method will be more suitable for nonlinear models of large number of estimated input variables and/or parameters.

Milestones and Products for First Quarter Year 4

1. Reviewed two mathematical models for measuring DNA double strand breaks. These breaks are the key to understanding the genetic lesions caused by ionizing radiation. The models focus on using Pulse Field Gel Electrophoresis as the experimental technique for measuring double stand breaks.
 - Report (Radivoyevitch)
2. Continued to use rodent tumor data as a measure of dose-response and dose-rate effects of radiation. Variability of the estimates is being studied. Human data is also being assessed with regard to leukemia. Both vital statistics and A-bomb incidence data is being analyzed.

3. Completed majority of program coding work for PBPK modeling on the Intel Paragon supercomputer at USC-Columbia. A user can now use our PC/Windows based PBPK program to design and specify a model and then send the system description to the Paragon for actual simulation. It has been shown with our test data that the parallel program has a considerable advantage in computational time with PBPK models of a large number of organs or tissue regions. Enough program components have been finished that we are ready to start testing with real data.

- Abstracts to be presented at the Annual Society for Risk Analysis meeting

Milestones and Products Projected for Second Quarter Year 4

1. Will continue modeling at the biological level. Will begin simulation studies of existing models.
2. Expect to have developed a method for assessing the precision of estimated dose-rate effectiveness factors using rodent data. Will continue models of radiation induced human leukemia risk, especially at low doses.
3. Will further perfect the program system and work toward providing a more detailed performance analysis.

5.2.2 Environmental Risk Perception in Defined Populations

Project Leaders:

Daniel T. Lackland, Ph.D.
John B. Dunbar, Dr. P.H.
David G. Hoel, Ph.D.

Executive Summary

Risk perception is an important consideration in environmental restoration and cleanup standards, as well as being a key component of risk assessment. The quantification of perceived risks, risk awareness and knowledge of health hazards is critical to the determination of public-acceptable levels of environmental contamination. The development and implementation of methodologies are necessary preludes to any comprehensive environmental hazard and risk assessment program.

This program is designed to be a major resource for decision makers involved in environmental remediation and restoration of hazardous waste sites. Furthermore, the project will provide timely feedback of community and

population-based findings to concerned parties, in particular the risk assessment programs.

Objectives

1. To build and maintain a comprehensive survey research center for conducting population health, awareness, knowledge and perception assessments.
2. To develop methodology and implement the measurement of knowledge, awareness and attitudes with regards to environmental hazards risks to human health.
3. To quantify these measures and construct a perceived risk index.
4. To estimate levels of acceptable risk in the population.

Milestones and Products for First Quarter, Year 4

1. Implemented the second population risk perception survey with the Computer Assisted Telephone Interview system (CATI). Two hundred interviews will be completed in population proximal to the facilities at the Savannah River Site (SC) DOE, Rocky Flats (CO) DOE, Hanford (WA) DOE, Oak Ridge (TN) DOE, Pinewood (SC) Hazardous Waste, and Spartanburg (SC) Control.

Notes

The populations are being interviewed as a group, thus reducing interviewer's bias resulting from interviewing sites separately. However, the length of the survey and complexity of the protocol have slowed the progress of the survey. The total survey is 1/3 complete with interviews completed at each site.

2. Completed first draft of report of risk perception and geographic variation.
 - Copy of report

Milestones and Products Projected for Second Quarter, Year 4

1. Will complete final draft of manuscript on geographic variation of risk perception.
2. Will complete the multi-site survey.

5.2.3 The Development and Implementation of a Geographic Analysis System for Population Health and Environmental Risk Assessment

Project Leaders:

Daniel T. Lackland, Ph.D.

John B. Dunbar, Dr. P.H.

David G. Hoel, Ph.D.

Executive Summary

Traditional approaches for the assessment of environmental exposure evaluation have employed the usual screening methodologies. In a typical assessment, investigation will select a population believed to be at risk, collect data and tissue samples, and determine cases of exposure and potential adverse health outcomes. Although this approach is useful, numerous limitations exist. First, only individuals who are selected and agree to participate are used in the investigation. Risk assessment of specific geographic areas is very difficult as surrounding areas are not identified or assessed and geographic clusters of events are often missed with one hundred percent participation. A second limitation involves the difficulty in obtaining often missing information on confounders in a high-risk population. Use of computerized data bases, such as census demographic files, water quality, tax records and health records is extremely laborious to quantify and is typically completed variable by variable. In summary, the traditional assessment methodology is useful for the study of a single household, only cursory investigations are possible for large regions and populations.

An alternate and progressive approach is proposed that will utilize a geographic information system (GIS) to be used in the defining of geographic study areas and the analysis of multiple data sets. The proposed system will consist of computerized data bases structured to a defined geographic area combined with analytic tools including thematic map generation, proximity analysis, buffer zone identification and map overlay comparisons.

Objectives

1. To complete and assess comprehensive geo-coding of all addresses and areas in a specific geo-political area.
2. To merge health, demographic and environmental data sets based on location in the geographic analysis system.
3. To complete a health and risk assessment on a defined geographic area.

Milestones and Products for First Quarter, Year 4

1. The Office of Research and Statistics have continued to be successful in geo-coding and address matching.
 - Copy of report
2. Constructed maps for Beaufort County in response to concerns regarding the drinking water. The maps were a result of successful mapping with the SRRHIS cancer registry data.
 - Copy of map
3. The geo-coding process and maps will be an important component in the health status assessment in the Charleston "Neck" area and the area around the Savannah River Site. Data and map will be used for future studies.
 - Copy of maps

Milestones and Products Projected for Second Quarter, Year 4

1. Will work on details of geo-coding assessment of Charleston "Neck" area.
 - Copy of maps
2. Will assess the barrier islands of South Carolina.
 - Copy of map
3. Will present project for EHAP exhibit in MUSC Library during October.

5.2.4 Risk Assessment of Trichloroethylene

Project Director:	David G. Hoel, Ph.D.
Research Associate:	Zhen Zhang, Ph.D.
Research Associate:	Ping Li, Ph.D.

Executive Summary

We propose to work towards developing a risk model for low-dose exposures to TCE. This work will begin with a follow-up of the results of the physiologically based pharmacokinetic (PBPK) work of ChemRisk and the Peer Review Panel. We shall execute the following detailed evaluation of the use of the PBPK findings in a risk assessment followed by a linkage of these

results to toxicological outcome data and model as well as any human health data.

Uncertainty Analysis of PBPK models of TRI

There is a considerable amount of knowledge available on the major metabolic pathways of TRI for a number of species. This facilitates the development of PBPK models of TRI for animals. However, the lack of adequate human data in many of the critical aspects of the modeling process will undoubtedly introduce uncertainty in the model end-point results of PBPK models of TRI for humans. In this project, we propose to utilize 1) a computational method based on "importance sampling"; and 2) systems analysis methods to identify potential sources to the overall model output uncertainty.

1) A Genetic Algorithm Based Importance Sampling Method for Sensitivity Analysis

Recently, there has been an increasing effort in applying Monte Carlo simulation methods for model sensitivity analysis. However, for non-linear models with a large number of input parameters, the limited number of simulation runs do not always adequately reflect the true properties of the underlying sample space. Improved sampling techniques may help to distribute the sample points more evenly over the entire space. They do not, however, solve the problem of having too few sample points in areas of importance. What is often of concern is the tail portion of the model end-point output distribution. However, for complicated nonlinear systems such as PBPK models, it is often an impossible task to identify regions in the high dimensional sample space that contribute to the tail portion of the output distribution.

In our research, we have developed a computational method based on the genetic algorithm (GA) optimization technique. In this approach, a user-specified evaluation function defines what is "important" in term of the Monte Carlo simulation results. In some case, it may be defined as having output close to the extreme end of the output distribution. The genetic algorithm then searches for points in the input parameter space (sample space) that minimized the evaluation function (e.g. distance to the theoretically possible extreme output value). During the process, a collection of sample points that are of "importance" in our sensitivity analysis are identified with a limited number of simulation runs. Statistical analyses are then performed to evaluate the relative sensitivity of input parameters.

2) System Analysis Methods

Systems analysis methods can be used to verify model stability and hence, to identify possible intrinsic or structural sources that might cause high model sensitivity. PBPK models are essentially a set of non-linear differential equations with parameters that are of physiological and/or anatomical interpretations. We should still be able to analyze such models with the traditional systems analysis methods. As an example, in our previous research, we have proved a set of conditions under which some of the organs or tissue regions may be "lumped" together without affecting the computation of concentrations in the remaining tissue regions. This can significantly simplify the analysis of model output sensitivity to parameter changes since the number of parameters is reduced.

Objective

To use new and advanced scientific methods to evaluate and improve current approaches to risk assessment of low-dose exposure to TCE for both carcinogenic and non-carcinogenic effects.

Milestones and Products for First Quarter Year 4

1. Collected current literature on sensitivity analysis for TCE PBPK models.
2. Completed the basic programming work for simulation to TCE PBPK models for sensitivity analysis using advanced processing algorithm. This is one of the core computational components in the important sampling/genetic algorithm based method for sensitivity analysis. We are ready to test with some currently used TCE models with real data.

Milestones and Products Projected for Second Quarter Year 4

1. Will implement the currently used TCE PBPK model.

6.0 Education

6.1 Graduate Education in Risk Assessment

Project Director:	Dr. Rosalie Crouch, Dean, College of Graduate Studies
Assistant Director:	Dr. Eberhard Voit, Assistant Dean for Environmental Studies

Executive Summary

The educational component is an essential part of the environmental risk assessment program. This task concerns establishing strong academic graduate programs at the master's and doctoral levels addressing the needs of governmental agencies, private industry and public concerns. These programs address the void of graduates who have the combination of some understanding of science, risk analysis and the policy process. Graduates at the doctoral level have, in addition, considerable expertise in a defined area that they select for their dissertation. In future years of the project, attention will be given to undergraduate environmental studies programs. These topics will also be introduced at the primary and secondary school levels.

Objective

To develop outstanding academic programs at the master's and doctoral levels that educate the student in the fundamentals of environmental risk, policy and science with a specialization in one of these areas.

Milestones and Products for First Quarter, Year 4

1. Processed additional applications to MES program. Received a total of 42 applications for fall. From these 42 applications, 33 applicants have been accepted to the program. Four additional students were admitted to the Ph.D. program in Biometry and Epidemiology with Emphasis in Environmental Risk Assessment.
 - Lists of MES applicants accepted
 - Status sheet
 - List of Ph.D. students
2. Received 1,588 requests for information since September 1994. 891 are from recruitment posters, 271 are from telephone inquiries, 27 from brochure return cards, 33 written requests and 366 were forwarded from

the University of Charleston. Applications requested from all sources were 902.

- Breakdown of requests from posters broken down by state and scientific background
- 3. Developed new course, Environmental Immunology, which started this fall and is instructed by Dr. Karen Burnett and Dr. Robert Galbraith.
 - List of students enrolled in course
- 4. Curriculum committee provisionally approved case studies course for fall.
 - List of students enrolled in course
- 5. Initiated Seminar Series in Environmental Studies for fall.
 - List of invitees
- 6. Initiated contact with Dr. W. H. Breazeale, Jr. of Francis Marion College as feeder program to MES program.

Milestones and Product Projected for Second Quarter, Year 4

1. Will continue recruitment efforts for MES students.
2. Will finalize draft for Capstone Seminar course.
3. Will offer continuing Seminar Series in Environmental Studies.

6.2 Department of Health Administration and Policy

Project Director:	David R. Graber, Ph.D.
Chairman and Professor, Department of Health Administration and Policy:	James Johnson, Ph.D.

Executive Summary

Continuing responsibilities were in three major areas: environmental health policy, environmental health education and international environmental issues. Research efforts will also focus on social and economic considerations in environmental decision-making, as well as citizen participation issues. A major thrust of the Policy Studies Journal symposium, the hazardous waste

study and future planned projects is the relation of social and economic issues to environmental policy.

Objectives

1. To analyze and assess the current status of environmental medicine and education in American medical schools.
2. To assess the interrelation to the environment of agricultural activities in Third World countries.

Milestones and Products for First Quarter, Year 4

1. Published "Environmental Health in Medical School Curricula: Views of Academic Deans" by Graber, D.; Musham, C.; Bellack, J., Holmes, D.; in July in the *Journal of Occupational and Environmental Medicine*.
2. Published "Human and Ecosystem Health: The Environment-Agriculture Connection in Developing Countries" by Graber, D.; Johnson, J.; and Jones, W.; in August in the *Journal of Agromedicine*.
3. Submitted proposal to Nelson-Hall, MacMillan, and Greenwood Press for a proposed text on environmental health policy entitled, "Environmental Health Policy: The Interplay of Social, Economic, and Human Health Issues."
4. Secured seven environmental professionals and academics as chapter authors for "Environmental Health Policy: The Interplay of Social, Economic, and Human Health Issues."
5. Completed and submitted abstract of paper, "The Network Model in Agromedicine: Implications for International Program Development," to be presented at the 25th Congress of Occupational Health 1996 in Stockholm, Sweden.
6. Prepared two paper presentations and one poster presentation for the November American Public Health Association Meeting.
7. Paper entitled, "Hazardous Waste Management," accepted for Winter 1996 Issue of *New Solutions*.
8. Established research committee with Dr. Jan Bellack and Dr. Catherine Musham for national study to compare environmental content in health professions educational programs with other subject areas. Developed survey instrument, cover letter and initial research methods.

Milestones and Products Projected for Second Quarter, Year 4

1. Will deliver two paper presentations and one poster presentation at the American Public Health Association Meeting in November.

7.0 Clinical Science

7.1 Health Services Research

Project Director:

W. Allen Smith, Dr., P.H.

Executive Summary

Health Services Research has been involved with EHAP and risk assessment since the grant was initiated, but before the first quarter of year three, the project's mission was carried out under Program Management. In accordance with the new emphasis placed on involving medical doctors and other medical practitioners in the environmental risk assessment and decision-making process, Health Services Research continues to be a separate project.

Through personal networking, I have met with numerous MUSC faculty members to explain in detail the concept of risk assessment in medicine. As a result, many departments and individual physicians have taken an interest in the project with many being recruited into health risk associated projects.

Other plans include an industrial medicine clinic and a referral system, both of which would further institutionalize risk assessment in the practice of medicine. As the various elements of the project develop, more physicians, other medical practitioners, and assorted professionals will be better educated in environmental health issues.

Objectives

1. To involve more medical doctors and other medical practitioners in the environmental risk assessment and decision-making processes.
2. To create a need-to-know attitude toward environmental medicine.

Milestones and Products for First Quarter, Year 4

1. Continued to plan the October 25-26 symposium, "The Environmental Risk Assessment: Does it Work for the Community-Based Family Physician?" This meeting of nationally recognized (practicing) family physicians will take place in Charleston and may stimulate interest and encourage greater participation among the primary care medical community in the discussion and resolution of environmental risk issues. Attendees will evaluate the utility of the current risk assessment processes to the family practice physician in his/her role as

a community health advocate. They will also explore things that can be done to improve this utility.

Milestones and Products Projected for Second Quarter, Year 4

1. Will continue to work toward hosting a meeting of nationally recognized (practicing) family physicians.
2. Will continue to look for opportunities for the Medical University to take a leadership role in addressing the health hazards created by the departing military at the Charleston Naval Base and Shipyard.
3. Will continue to work closely with the Occupational and Environmental Medicine (EOM) effort (project #7.2 below) to determine how the core and elective curriculum modules should be disseminated.

7.2	<u>Environmental Medicine and Risk Communication: Curriculum and a Professional Support Network--Department of Family Medicine</u>
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Director:	Stanley H. Schuman, M.D., Dr. P.H.
Associate Director:	William M. Simpson, Jr., M.D.
Project Administrator:	Samuel T. Caldwell, M.A.
Staff Dev. & Training Coordinator:	Larry H. Spell, M.S.
Staff Dev. & Training Specialist:	Jan A. Lay, M.S.
Administrative Assistant:	JoAnn Retter
Administrative Assistant:	Kay Minson

Executive Summary

Historically there has been little or no environmental and occupational medicine (EOM) training in the curriculum of family practitioners even though this group of physicians see more EOM patients than any other medical specialty. In addition, patients expect their family physician to be knowledgeable about environmental risks in their community. Family medicine residents and practitioners who receive training in EOM will be able to better serve their patients and community in the risk assessment process.

Such needs have led to the project goal of developing and implementing graduate and continuing medical education curriculum in EOM for family physicians. To achieve this goal, an Environmental Medicine Curriculum Committee (EMCC) comprised of at least one faculty member from each of the seven teaching sites of the South Carolina Statewide Family Practice Residency Program (SFPRP) was formed to advise the OEMO on curriculum development. The OEMO also developed an EOM resource to support the

faculty, residents and staff of the SFPRP with consultations on patients with EOM complaints. The work of the committee and EOM consultative resource are ongoing. Activities this project year will focus on the implementation of the EOM core and elective curriculum at the seven SFPRP sites and determining the need for EOM self-study programs for the busy practitioner.

Accomplishments during the past quarter include: 1) 93 EOM consultations; 2) 11 EOM lectures presented; 3) project staff finalized plans with Dr. Smith for a meeting of national leaders in family medicine to discuss the environmental risk assessment process; and 4) core curriculum interactive computer programs were updated.

Objectives

1. To provide continued support to the EMCC faculty including EOM consultative and research services to the Statewide Family Practice Residency Program.
2. To adapt the core and elective curriculum to other disciplines.
3. To determine the need and desire for EOM continuing medical education among SC practitioners.
4. To contact directors of family medicine residency programs in other states and determine their interest for incorporating SC designed EOM curriculum in their programs.
5. To implement the core and elective EOM curriculum at the seven SFPRP teaching sites and update the curriculum as needed.

Milestones and Products for First Quarter, Year 4

1. Provided continued support to the EMCC faculty including EOM consultative and research services to the Statewide Family Practice Residency Program (SFPRP).
2. Continued monthly EOM literature review for pertinent articles to be added to the project's computerized data base.
3. Consulted on 93 EOM cases.
 - Cases described in July - September Monthly Summary Reports
4. Published the monthly newsletter, Environmental Medicine Update, July-September. The objectives of the newsletter are to report on the

activities of the EMCC and to stimulate committee members concerning recent developments in EOM.

- Environmental Medicine Update - Volume 2 No. 12 and Volume 3 Nos. 1-2
5. Presented 11 EOM lectures. "Quality of the American Food Supply," was presented on September 26 in Blackville in support of EHAP's Blackville Speaks Out Community Project. Lectures are described in July-September Monthly Summary Reports
 6. Due to the poor response of the initial survey of alumni of the SFPRP, a follow-up survey of the Greenwood and Columbia graduates was initiated during the last quarter and completed on June 30. A draft report on this project has been completed. A final report will be issued in the next quarter. The objectives of this study are to determine: 1) the extent of EOM in their practice; 2) suggestions for EOM curriculum improvements in residency training; and, 3) the need for EOM continuing medical education.
 7. Adapted the core and elective curriculum to other disciplines.
 8. Held EMCC meeting September 28-29. The focus of the meeting was to discuss strategies and resources for implementing the core and elective EOM curriculum at the seven family medicine training sites.
 - Copy of agenda
 9. On July 1, MUSC's Department of Family Medicine began a one month mandatory EOM rotation for third year residents.
 - Description of required EOM rotation
 10. Updated the five EOM core curriculum interactive computer programs (Version 2.0). These were delivered to the EMCC on September 28 and are as follows:
 - Module 1 - Environmental and Occupational Medicine History for Family Physicians (Version 2.0)
 - Copy of module
 - Module 2 - Communicating Environmental and Occupational Risks to Patients: A Guide for the Family Physician (Version 2.0)
 - Copy of module

Module 3 - Environmental and Occupational Medicine Resources for the Family Physician (Version 2.0)

- Copy of module

Module 4 - Environmental and Occupational Medicine in Private Practice: Choices for the Family Physician (Version 2.0)

- Copy of module

Module 5 - Using Hospital Site Visits for Teaching Environmental and Occupational Medicine (Version 2.0)

- Copy of module

11. During the last project year a Letter to the Editor of the *Journal of Family Medicine* was published. The letter summarized the EMCC's survey of family medicine residents for their interest in EOM training.

- Godenick, M.T.: Letter to the editor: Learning Environmental and Occupational Medicine. *Family Medicine* 1995; 27(4):226-227

Milestones and Products Projected for Second Quarter, Year 4

1. Will provide continued support to the EMCC including EOM consultative and research services to the SFPRP.
2. Will complete final report on the EOM survey of alumni of the SFPRP.
3. Will conduct the October 26-27 symposium, "The Environmental Risk Assessment: Does it Work for the Community-Based Family Physician?"
4. Will determine the need and desire for EOM continuing medical education among SC practitioners. Survey planned for third quarter.
5. Will contact directors of family medicine residency programs in other states and determine their interest for incorporating SC designed EOM curriculum in their programs. Survey planned for third quarter.
6. Will implement the core and elective EOM curriculum at the seven SFPRP teaching sites and will update the curriculum as needed.

8.0 Information Systems

8.1 Information Support and Access Systems

Director:	Thomas G. Basler, Ph.D.
Systems Analysis:	Richard Gadsden, CCIT
Biomolecular Computing:	Starr Hazard, Ph.D.
Word Processing Specialist:	Carol Savage

Executive Summary

This project supports the information, communication, and computational needs of the outreach, education and research tasks encompassed by EHAP. The basic strategy involves two primary components. First, the Information Systems Design Group built the specifications and architecture for computer systems that are capable, generally, of the computation and communication necessary to achieve EHAP goals. During the first year of the program, core equipment, based on the design architecture was purchased. Installation of this equipment continued through the second year. The major focus during the second year of the grant was to generate preliminary designs of an information access system which will serve researchers, health practitioners, and other environmental professionals. To achieve this, we completed extensive surveys of needs and available information sources, and developed the first prototype systems. Two basic tenets provide focus for the information access system design. First, no new databases or other information systems are being created--the system's function is to provide easy, user-friendly access to a broad range of data sources that already exist. Second, we will be developing data integration techniques to assist the user in identifying and retrieving as much relevant data as is possible from a wide range of sources.

During the third year of the grant we expanded our access to existing databases and incorporated new capabilities into our One Door Access System (ODAS). To broaden ODAS's information access we are working with existing commercial database vendors to develop integrated access methods for their products via the ODAS. We completed the development of an access module that provide ODAS with the capability of accessing Silver Platter databases. Silver Platter, a commercial database vendor, provides over 200 databases to its clients. In addition, two new database access methods were implemented and integrated with the ODAS prototype, ODBC--to access X-based databases (e.g., Paradox, Foxpro, Dbase) and DXP--to access databases provided on CD-ROM by Silver Platter.

We have demonstrated the prototype to people from the DOE, Waste Policy Institute, Silver Platter, The National Library of Medicine (NIH), the University of Maryland, Washington University at St. Louis, the University

of Washington, the University of Illinois at Chicago and the Ames Laboratory. Based on our working ODAS prototype, we have shown that a single system can be built that can access a large number of commercial and proprietary databases based on a single query. This is the first system we know of providing such broad capability. Next, we are moving to build an ODAS based system that will support MUSC's Occupational and Environmental Medicine Office (OEMO). This will be the first implementation that will result in a "real" product. This system will be built based on the needs of MUSC physicians and should be applicable to the needs of physicians in these specialties across the country. We will continue to coordinate our development efforts with the National Library of Medicine--working with their Unified Medical Language System (UMLS) products into the ODAS.

In the third year of the project we continued development of our "gopher" server as well as implementation of a World Wide Web (WWW) server. During the first quarter, we have expanded the functionality of our WWW server; modifications and upgrades will continue into next year.

There are four main thrusts of the Information Support Project:

- build and maintain the basic computer and network structure for information handling;
- support of the Education Initiative;
- support of the Seminars, Science, and Risk Assessment; and
- support of the Clinical Initiative.

There is one operational responsibility:

- operational support of EHAP overall internal computing and communications

Milestones and Products for First Quarter, Year 4

1. Continued design of an ODAS-based system for the MUSC Occupational and Environmental Medicine Office (OEMO) as an initial "beta-site" system. We worked with OEMO to understand their unique information access requirements.
2. Continued development of the EHAP World Wide Web (WWW) home pages by connecting to other DOE sites, allowing interactive requests and forms and setting up e-mail connections.
3. Broadcasted the EHAP WWW home pages to other health centers and environmental agencies and Web search engines.

4. Continued the development of the capability to access Z39.50-compliant databases via the ODAS. We implemented communications between the Stanford Z39.50 client and a Wide Area Information Server (WAIS).
5. Continued development of a PC-based ODAS client using the PowerBuilder application development tool.
6. Continued the design of a distributed processing architecture for ODAS. The purpose of this initiative is to migrate the ODAS to a distributed client-server architecture in order to increase data access time. In addition, this architecture will be entirely PC-based, which will make it a viable information access solution for a larger user community.
7. Continued to coordinate our efforts with related research efforts throughout the U.S.

Milestones and Products Projected for Second Quarter, Year 4

1. Will continue to establish a complete working ODAS at MUSC, previously the versions in Charleston have been demonstration systems only.
2. Will continue to work with MUSC's OEMO and modify the ODAS technologies to meet their needs.
3. Will continue to work with Dr. Barry Weissglass (a South Carolina occupational medicine doctor) to modify the ODAS at MUSC to meet his needs.
4. Will connect to a Z39.50 database.
5. Will move all efforts in support of this project to our Charleston base by the end of November 1995.
6. Will continue to develop EHAP's World Wide Web (WWW) home pages, integrating the latest enhancements of Hyper Text Mark-Up Language (HTML).
7. Will begin preparation for the mounting of interactive educational materials on the EHAP Web.
8. Will support the Crossroads Database with new enhancements including report generation.

9. Will demonstrate Information Systems (ODAS, WWW, and Crossroads database) to other corporations developing similar systems including the MUSC HIIT thrust. Will attempt to establish collaborative agreement.

8.2 Physicians Research Network

Director: Lawrence B. Afrin, M.D.

Executive Summary

The Physicians Research Network (PRN) project (Phase I) is largely on track. We report below a summary of progress in the areas of production system development, database development, internal deployment and external deployment. A more detailed progress diary can be found online in the PRN database at <<http://prn.musc.edu/research/whatsnew.htm>>.

The core of the production system consists of two identically configured server-class IBM-compatible computers (Dell Computer Corp. PowerEdge XE5100-2 system units). Key components in each computer include one Intel Pentium 100 MHz processor (with expansion capability to two processors), redundant power supplies, redundant cooling units, 64 megabytes of random access memory, 2 gigabytes of hard disk storage space, a high-capacity/high-performance digital linear tape backup drive, a 10 megabit/second interface to the MUSC campus network (which provides access to the Internet) and a backup power supply capable of powering the system during a power outage lasting more than one hour. Key software loaded on each system includes the Microsoft Windows NT Server 3.51 operating system, O'Reilly and Associates, Inc.'s WebSite 1.0 World Wide Web server package and Octopus Technologies, Inc.'s Octopus ClientPRO 1.42 multisystem file synchronization package.

One system is identified as the primary system and the other serves as a backup system. The two systems are configured so that the PRN user sees only one system. Further, all software and data specific to the PRN project are mirrored between the two systems. If the primary system "goes down" for any reason, the backup system is activated and users continue to enjoy access to PRN without being aware of the failure. Currently, the process of switching from primary to backup requires manual intervention; once the expected upgrade to the Octopus software is installed in the next quarter, switching will be automatic.

Milestones and Products for First Quarter, Year 4

Production System Development

1. Proceeded with the transition from the prototype system to the production system. Following an extensive technology assessment that focused chiefly on the issue of system reliability, specifications were developed and the production system components were acquired in accordance with these specifications.
2. Procured a 16-port Xylogics MicroAnnex 2000 to act as the communications server for our extramural users. An extramural user's computer will be configured to establish a connection by modem to the communications server, thereby gaining direct access to the Internet (including the World Wide Web and, thus, PRN).

Notes

An intramural user operating a computer from an off-campus location can also enjoy similar access privileges. The MUSC Center for Computing and Information Technology (CCIT) has been very helpful in the installation and maintenance of the MicroAnnex. (In particular, we would like to acknowledge the assistance of Melissa Forinash, Steve Burns, and Kevin Moore.) CCIT has provided space for the device in its main computer room and handled all the arrangements for installation of modems and phone lines, including the incoming WATS lines. CCIT had been experimenting with other vendors' solutions to this access problem for a considerable length of time with unsatisfactory results. When the network systems engineers at CCIT saw the ease of installation, ease of use, and reliability of the MicroAnnex, they immediately moved to acquire several additional units. Installation and testing of these units is almost complete. In October CCIT expects to announce the availability of these units for providing Internet access to MUSC staff from off-campus locations.

Since PRN will contain information vital to the treatment of patients and that information will not be easily available through other means, we feel it is appropriate to view the PRN system as a "mission-critical" system; i.e., the goal is to provide users with what appears to be a system that is never "down" or unavailable.

We are pleased to report that since the production system "went live" on June 1, it indeed has never been down. Not only has the hardware been 100 percent failure-free, but we have been quite pleased with the stability of all the key software components, none of which has ever malfunctioned or "crashed." Although the PRN system itself has never been down, we do note it has been inaccessible twice, each time a 24-hour weekend incident

involving a failure of a particular segment of the campus network. When the Octopus upgrade is installed in the next quarter (to provide for automatic switching from primary to backup system when the primary is down or inaccessible), we plan to investigate the possibility of relocating the backup system to a different segment of the campus network so that only a catastrophic failure of the entire campus network would prevent users from accessing PRN.

Though less important than reliability and stability, system performance (i.e., speed, or apparent responsiveness) has been more than adequate.

PRN access statistics (culled from the access log maintained by WebSite) for the first quarter show an increasing number of accesses, most recently approximately 800 per week. While the majority of these accesses are still being made by the PRN team for testing purposes, their access rate has been steady; most of the increase in accesses has been due to actual PRN users, who now are making almost 50 percent of all accesses. Informal surveys of these users reveal them to be very satisfied with PRN. They uniformly indicate they are able to retrieve information via PRN in a much more efficient manner than previously; some are able to access information never accessible to them previously.

Database Development

3. The project's part-time employee, Ms. Valerie Kuppúswamy, completed the initial loading of the PRN database in July. At that point the database was current with the complete text and graphical material contained in all MUSC, CALGB, ECOG, NSABP and POA adult oncology protocols serviced by the Hollings Cancer Center's Clinical Trials Program (HCC CTP). Database loading is a straightforward but time-consuming process involving optical scanning of the printed protocol documents, optical character recognition (OCR), OCR error correction and HTML coding (i.e., the process of inserting special coding in the documents so that they can be displayed on the World Wide Web). Access to protocol documents in electronic form would greatly simplify and speed this process, but our earlier requests for such assistance were denied, forcing us to develop our current method, which we continue to use at present.
4. Ms. Kuppúswamy has concentrated on maintaining the currency of the database, processing protocol updates and adding newly activated protocols. In August the CTP has also taken on the servicing of RTOG and GOG protocols. Ms. Kuppúswamy loaded the few RTOG protocols into the PRN database, but the library of GOG protocols is extensive and will require another 1.0 FTE in order to load it into the PRN database. This additional FTE has been planned from project inception.

Currently, the PRN database contains more than 110 adult oncology protocols.

5. Dr. Afrin has concentrated on adding new types of information and services to the PRN database. A few of the new features include: 1) links to the NCI PDQ database containing physician- and layman-oriented articles on diagnosis and treatment of most malignancies; 2) links to Usenet oncology-related newsgroups; 3) links to other Internet resources of oncology information; 4) remote web management services; 5) further enhancement of security in the PRN interface to the MUSC OACIS clinical data repository; 6) non-protocol chemotherapy consent forms; 7) chemotherapy pharmaceutical information; and, 8) guidelines for physicians on the treatment of sickle hemoglobinopathies.

Internal Deployment

6. Reconfigured key workstations in the adult medical oncology clinic in the HCC to provide access to the World Wide Web (and, thus, PRN) with the assistance of CCIT and Lisa Lemon (Data Analyst and Network Manager, HCC). All Hematology/Oncology fellows, CTP staff, and HCC adult medical oncology clinic nurses were trained in the use of PRN. Two fellows also requested configuration of their home personal computers for access to PRN, and access log statistics show them to be routinely using PRN by this route.
7. Made offers for one-on-one or small group training to the Hematology/Oncology attending physicians and to the nurses on MUSC's 8-West and 10-East inpatient units (where protocol treatments are administered).

External Deployment

8. Identified large oncology practices in Charleston, Greenville, Spartanburg and Florence as ideal for pilot testbed purposes. These practices agreed months ago to participate, but, most unfortunately, administrative problems at each practice (problems completely independent of the PRN project) have prevented us from proceeding with any installations.
9. Identified practices in North Charleston and Myrtle Beach as potential pilot sites, but again, logistical delays have prevented us from proceeding with installations.
10. Identified Hampton County General Hospital (HCGH) as a potential pilot site because of its involvement in the MUSC efforts to develop

telemedicine technology in South Carolina. Two general practitioners (one trained in family medicine and one internist) and a physician's assistant there expressed interest. On August 23 Dr. Afrin traveled to HCGH and installed access to PRN on two computers in the hospital and the home computer of the physician's assistant. Access logs from WebSite and the MicroAnnex communications server show that this group has been accessing the PRN database briefly once or twice a week but has been using the project-provided infrastructure to explore medical information resources on the Internet much more frequently, almost on a daily basis. Accesses have been made from the physician's assistant's home computer just as frequently as from the hospital computers. Brief interviews with the HCGH users show them to be very pleased and satisfied with the service.

11. Identified a potential pilot site in Aiken, with one medical oncologist and one radiation oncologist. Installation and training at this location currently are scheduled for early next quarter.
12. Continued to work closely with all the targeted pilot sites to expedite as much as possible the installation of and training for PRN access. We currently expect most of the targeted sites to come online next quarter.

Milestones and Products Projected for Second Quarter, Year 4

Notes

As of October 1, the Hollings Cancer Center's CTP will no longer maintain any of the approximately ten copies of protocol documents currently scattered about the campus. A single master reference hardcopy of each protocol will be maintained in the CTP office, but otherwise all protocol information will be distributed via PRN. Estimates compiled by the CTP staff indicate a total labor savings of 1.0 FTE. Also, the CTP currently makes approximately 20,000 photocopies a month, and we expect this figure to be cut in half initially.

1. Will anticipate a great demand for internal installation and training once the clinical staff involved in protocol treatment realizes that protocol information will only be available through PRN.
2. Will proceed with most of the planned (but currently on-hold) extramural installations.
3. Will establish relations with the MUSC Children's Hospital staff and Division of Pediatric Hematology/Oncology regarding the POG protocols they service.