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ARCTIC RESEARCH

OF THE UNITED STATES

INTERAGENCY ARCTIC RESEARCH POLICY COMMITTEE

About the Journal

The journal *Arctic Research of the United States* is for people and organizations interested in learning about U.S. Government-financed Arctic research activities. It is published semi-annually (spring and fall) by the National Science Foundation on behalf of the Interagency Arctic Research Policy Committee (IARPC) and the Arctic Research Commission (ARC). Both the Interagency Committee and the Commission were authorized under the Arctic Research and Policy Act (ARPA) of 1984 (PL 98-373) and established by Executive Order 12501 (January 28, 1985). Publication of the journal has been approved by the Office of Management and Budget.

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- Reports on current and planned U.S. Government-sponsored research in the Arctic;
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- Summaries of other current and planned Arctic research, including that of the State of Alaska, local governments, the private sector and other nations.

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Issues of the journal will report on Arctic topics and activities. Included will be reports of conferences and workshops, university-based research and activities of state and local governments and public, private and resident organizations. Unsolicited nontechnical reports on research and related activities are welcome.

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Cover

Alaska's rugged terrain complicates the delivery of health care and contributes to Alaska's high occupational fatality rate.

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Stigma, Ethics, and the Frontier

Challenges in Caring for People with Serious Illnesses in Alaska and New Mexico

This report was prepared by the two teams conducting this study. The New Mexico team consisted of Laura Weiss Roberts, Principal Investigator; Teddy D. Warner, Co-Investigator; Janet L. Brody, Co-Investigator; Pamela Monaghan, Project Coordinator; Julienne Smrcka, Special Project Assistant; Khanh Nguyen, Statistician; and Alexis Kaminsky, Research Scientist. The Alaskan team consisted of John Battaglia, Co-Investigator; Christiane Brems, Co-Investigator; Mark E. Johnson, Co-Investigator; and Tracy Speier, Alaskan Site Project Coordinator.

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Foreword

The following paper explores some of the difficult and unique public health problems affecting the estimated 62 million Americans who live in Arctic, rural, and frontier areas of the United States. A multidisciplinary research team of National Institute on Drug Abuse grantees from the University of New Mexico (UNM) and the University of Alaska Anchorage (UAA) have described in this paper their ongoing systematic study comparing and contrasting the ethically important aspects of rural health care provision for stigmatizing illnesses like substance abuse, mental illness, or sexually transmitted diseases in Alaska and New Mexico. Stigma is a particularly important barrier to obtaining health and social services in such places. Those who dwell in low-population-density locales tend to know each other, and obtaining such services as drug and alcohol, psychiatric, and sexually transmitted disease treatment can be hindered by fear of others knowing about their health problems.

This article is hopefully the beginning of more scientific investigations aimed at understanding the complex interaction between stigma, ethical health care decision making, and health care access in the Arctic and other remote locations. This work is also the first step in helping international scientists address issues of improving health care quality and access in parts of the world dominated by low-population rural or frontier areas. The authors do an admirable job of overcoming major obstacles to conducting this type of research. Not only do the research strategies being developed and described have applications to the current UNM-UAA project on stigma and ethics, but they will also have applications to other research efforts dealing with health in remote areas. This importance cannot be understated because of the rise of health problems, especially substance abuse and infectious diseases, in such locales. This article is timely in pointing out that rural and remote area populations have significant health issues unlike those found in most major urban areas. The UNM-UAA project will make significant contributions to health services research in the Arctic and other frontier/rural areas, as well as opening new doorways leading to a better understanding of rural health problems and finding their solutions.

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Introduction

The vastness, isolation, and cold of Alaska create extraordinary challenges for human survival. The people of this region experience significant health needs, including physical, mental, and substance abuse problems, but the development of sufficient infrastructure for health care delivery in Alaska, as well as other sparsely populated regions of the U.S., has been particularly difficult. Well-documented barriers to care for rural people include few and undiversified clinical resources, unstable economic support for health care, tremendous physical distances to reach clinics, and poor systems for transportation, communication, and health information. For these reasons it is increasingly recognized that the 62 million residents of our country's rural and frontier areas represent a highly underserved patient population.

In the shadow of these prominent barriers to care in rural areas are other obstacles that are ethically important and appear to be potent determinants of care for serious illnesses. The difficulty of preserving patient confidentiality in small communities, for example, may interfere with a patient's willingness to seek care from a clinician for an embarrassing health issue related to drug abuse,

sexual behavior, depression, or anxiety. Rural settings in which stoicism, sturdiness, and self-reliance are highly valued may interfere with the acceptance of a diagnosis of mental illness or alcohol dependence. Cultural dimensions of rural care for Native people are especially complex, affecting what is experienced as symptom and illness, as cause and cure, as health and healer, and as self and family. In very remote villages in the Arctic or in pueblos in the high deserts of the Southwest, the interdependence of community members also alters the role of the clinician, who may provide care for a patient one day, negotiate with him for necessary fuel or food on the next, sit next to him at a religious ceremony on the third day, and so on.

The nature of these rich, overlapping relationships may make confrontation of substance dependence, domestic violence, or other stigmatizing issues very difficult. It may also make the discovery and disclosure of a serious illness painful for both patient and caregiver, contributing to the heightened stresses and exhaustion of rural clinicians. On the other hand, when care is provided by "outsiders" or itinerant clinicians in frontier areas, the patient may speak a different language and have a life history so different from the caregiver that establishing a therapeutic relationship is elusive. Finally, because rural clinicians experience professional isolation and often have limited access to health care resources including specialist expertise, they struggle to acquire new skills and advanced knowledge as standards of care evolve in urban settings.

For the first time, ethically important aspects of rural health care for stigmatizing illnesses will receive systematic study in a five-year project funded by the National Institute on Drug Abuse. This work is being conducted in Alaska and New Mexico by our collaborative multidisciplinary team with direct clinical and research experience in these two rural and frontier states.

Key concepts in our program of work include rurality, ethics, clinical ethics, psychosocial issues, stigma, and barriers to optimal care. In keeping with the broader rural health literature, we generally define "rural" for this study as communities that have fewer than 2500 residents and frontier areas as those that have less than 7 residents per square mile, although it is apparent that many complex issues accompany the definition of rurality.

Our use of the term "ethics" refers to ways of understanding and examining moral life, thus creating a systematic, coherent, shared, and justifiable view of what is good and right in human experience. Perceptions of ethical issues and the processes surrounding ethical reflection are influenced by religious, cultural, historical, and gender-related values. Ethical inquiry serves to clarify the rules of conduct that govern society, and as such, ethics serves as a guide for the actions of individuals and groups, including the health professions. The field of health care uses the study of ethics (called biomedical ethics) to create principles and standards that guide clinical practice. "Clinical ethics" in particular is the branch of biomedical ethics that seeks to improve patient care by refining clinical decisions; pursuing empirical inquiry, scholarship, and education; and shaping social policy that is richly informed by clinical experience and science. Clinical ethics decision making employs formal case analysis (such as casuistry) as well as social scientific methods and is informed by professional principles such as beneficence, justice, autonomy, respect for persons, and veracity. "Psychosocial issues" are the psychological (attitudes, beliefs, cognitions, emotions) and social (societal, familial, and interpersonal roles, emotional supports, cultural traditions, social structures, economic conditions) attributes that influence views of health and health behaviors.

"Stigma" is defined as phenomena that carry negative value judgments by society and have consequences in thoughts, emotions, or behaviors of the stigmatized person and of others (for example, ascribing blame, feeling shame or embarrassment, or being shunned and avoided by others). Finally, "barriers to optimal care" for stigmatizing illnesses are factors that inhibit or prevent people from receiving care that meets professional clinical and ethical standards for a given illness (such as engagement in a therapeutic relationship, preventive efforts, prompt symptom recognition, accurate diagnosis, fully informed and autonomous consent, confidentiality protections, integrated treatment interventions, compliance with recommended therapies, and appropriate follow-up and relapse prevention).

In this article, we first outline the serious health needs experienced by rural residents in this country, giving special attention to stigmatizing illnesses and related issues in Alaska and New Mexico. Second, we illustrate key features of the experience of clinical care in Alaska. Third, we describe the aims of our research and offer comments on the future direction of this research and its implications for communities, large and small, in our nation.

Health Needs and Services in Rural Regions

The United States, comprised of 3.6 million square miles, is the fourth largest country in the world, with roughly 45% of the land frontier areas (less than 7 people per square mile). Most states have some rural areas (less than 2500 residents per town), and in eight states (Alaska, Idaho, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming), more than 10% of people reside in frontier counties.

Stigmatizing Illnesses

More than 15 million rural and frontier residents suffer from stigmatizing illnesses such as mental illness, substance abuse, and substance dependence. Lifetime prevalence data reveal significant use of substances, including alcohol, marijuana, cocaine, inhalants, and stimulants, by rural youth and adults. Heavy drug and alcohol use among rural residents has been strongly associated with other problem behaviors and violence. In 1990, more than half of non-metropolitan adult residents routinely drank alcohol, and one in seven had at least two social consequences of excessive use. Alcoholism's acute health effects (such as motor vehicle deaths due to alcohol) and chronic health effects (such as cirrhosis and fetal alcohol syndrome) are greater among rural than non-rural residents. Ten percent of rural twelfth graders report "high involvement" with drugs and alcohol. A 1991 study revealed that 14% of rural residents had used illegal drugs in the preceding year, and 41% of these illegal drug users experienced significant problems as a result. Although the figures for rural drug use currently resemble metropolitan data, rural substance abuse and dependence are increasing at rates far beyond those of urban areas. Illicit drug production is also growing.

About one fourth of rural residents are affected by mental illness. Symptoms related to mood, anxiety, trauma spectrum, and developmental, cognitive, and psychotic disorders appear to be as common among rural residents as urban dwellers. During certain seasons (such as whaling and fishing seasons and harvest time), symptoms may become more frequent among rural residents, as they may live in areas that have had natural disasters or severe economic hardships. Rural residents who are poor, minority, or women or have heightened psychosocial problems (such as unemployment) represent populations with "overlapping vulnerabilities" and manifest greater psychiatric symptoms. The rural elderly perceive themselves as more depressed than do their urban peers. Rural suicide rates have increased, surpassing urban suicide rates over the past 20 years. Suicide rates among the 1.5 million rural elderly are higher than among the metropolitan elderly and are three times the national adult average in some areas.

Numerous reports of HIV, other sexually transmitted diseases, hepatitis B, and hepatitis C infections in rural areas have been published. These infections are often linked to drug use in terms of direct transmission (for example, needle-sharing), as well as to drug-related risky sexual behavior or poor self-care. Such drug-related behaviors are also linked to transmission of tuberculosis. Although HIV prevalence in non-metropolitan areas is relatively low (27,504 deaths due to AIDS through 1995), it has increased annually by 30% (as opposed to 26% in major cities), largely because of "outmigration" of infected urban residents. Certain sexually transmitted diseases (such as syphillis, gonorrhea, and chlamydia) occur at much greater than national rates in many predominantly rural states.

Overall Health Needs

The age-adjusted death rate is greater in rural areas than in non-rural areas. Rural residents have higher rates of chronic illness, life-threatening medical conditions, physical activity limitations, and medical–psychiatric comorbid conditions. Rural regions have a greater prevalence of motor vehicle and environmental hazards (for example, contaminated water supplies). Morbidity from cancer, heart disease, arthritis, and diabetes is greater in rural communities, and in 1987, 47% of rural adults had a diagnosed chronic condition, as opposed to the 39% urban rate, although rural areas have many fewer clinicians available to diagnose and treat illnesses. Rural and frontier areas have greater proportions of elders and children, populations that often require greater medical attention than young and middle-age adults. Rural areas have more domestic and occupational injuries (for example, forestry or farming accidents). Groups such as the rural elderly, farmers, American Indians, southern blacks, and Appalachian whites are more greatly affected by problems such as diabetes and nutritional deprivation. Finally, fewer non-metropolitan than metropolitan dwellers in 1991 assessed their personal health as "excellent," and greater proportions of rural residents reported "fair or poor" health. The poorest rural residents are four times as likely to give this

negative assessment, a critical consideration because rural unemployment is severe, with 20% of rural residents living below the poverty line and often without health insurance.

Limited Rural Health Care Resources

Despite substantial needs, access to care in rural areas and especially in remote frontier areas is limited. Urban health care paradigms are characterized by specialists, high technology, individualism, good availability, high insurance rates, and high standards of care. In contrast, rural health care models have been characterized by generalists, paraprofessionals and self-help, low technology, extended interdependent families and communal systems, poor availability, inadequate insurance rates, and overall lower care standards than urban areas. Compared to urban settings, rural and particularly frontier areas experience many obstacles to health care access, including lack of a continuum of services, reduced actual use of services, less willingness to use services, less ability to use services, and relatively low effectiveness of services.

Primary and specialty medical care resources are limited in rural areas. For instance, 1 of 17 rural counties in the U.S. had no physicians in 1985. Of those with practicing physicians, more than two of three rural counties had no pediatricians or obstetricians and over one in four had only general and family practitioners. Over the past 15 years, physician availability has not significantly increased in rural areas. Indeed, challenges to rural health access are intensifying with new financial pressures driven by managed care systems in both private and public sectors. Rural facilities increasingly face threats of closure, challenges to financial viability and quality of care, and lower skill levels of practitioners. For people with substance abuse and dependence, mental illnesses, and sexually transmitted diseases, rural care often lacks any specialist support or expertise. Also, rural patients are twice as likely as urban dwellers to travel over 30 minutes to reach health services.

Finally, it is increasingly recognized that the use of services also may be affected by psychosocial factors such as attitudes toward illness and perceived vulnerability, the ethnicity and cultural background of the providers, perceived effectiveness of past treatment, the languages spoken in the clinic, and factors such as the acceptance of alternative healing approaches, tolerance of illness, stoicism, and mistrust of technology. In sum, heightened needs for health resources due to growing levels of drug abuse, HIV, hepatitis B, hepatitis C, and mental illness, combined with greater barriers to care, make rural residents a special, underserved population, particularly with respect to stigmatizing disorders. This is especially true for residents of smaller, more isolated communities that have more limited communication and transportation abilities, fewer clinics and clinicians, and fewer health care resources (for example, no emergency services), such as those in Arctic Alaska. These issues prevent optimal care to relieve great suffering of rural people with multiple physical and mental health needs related to stigmatizing illnesses and suggest broad public health consequences.

Health Issues in Alaska and New Mexico

While Alaska has 615,230 square miles—equal to nearly one-fifth of the continental United States—the population of the state is only 626,932. Alaska Natives comprise 16% of the state's overall population. Almost all (99.7%) of the land of Alaska is non-metropolitan, but about half of the state's population (52%) reside in the three largest cities, Anchorage, Fairbanks, and Juneau. Of these, only Anchorage has more than 100,000 inhabitants. Juneau and Fairbanks have only about 31,000 inhabitants, and most of the remaining communities have populations of under one hundred to a few thousand. Thus, most of the immense area comprising Alaska has from 0 to 0.20 people per square mile. The significance of this observation is hard to comprehend unless it is compared to the population density of New Jersey (1098 people/sq mi) or to the U.S. average (77 people/sq mi) or to Denmark (940 people/sq mi) or Japan (865 people/sq mi). Alaska has the most water area (44,856 sq mi) of any state in the U.S., the lowest annual mean temperature (41°F), and the fewest days of sunshine annually. Almost 9% of Alaskans live in poverty. Thirteen percent of Alaskans lack health insurance, slightly better than the national average of 15%, but unfortunately the number of uninsured Alaskans increased 33% between 1994 and 1998.

New Mexico is the fifth largest state in the U.S. with 121,598 sq mi. Its population, 1.8 million, is ranked 37th in the U.S., with a density of 14 people/sq mi. It, too, has only one city over 100,000 people, Albuquerque, and most of the remaining population lives in rural and frontier regions of the state. New Mexico is a tri-cultural state, with 40% of the population Hispanic, 9%

Vignettes Illustrating Ethically Important Barriers to Care in Remote Rural Areas

- Several women who were raised in the same rural community were being treated in an urban center for a stigmatizing illness. All of these women independently reported sexual abuse by the same adult male perpetrator. The perpetrator was of high status in the rural community, which led to the community rallying around the offender and ostracizing the victims. The women felt uncomfortable returning to the rural community after treatment.

- A resident of a rural village was in need of psychiatric treatment only available in a large urban center. After treatment the individual was discharged without arrangements for transportation back to the village. As the individual was indigent, he was unable to return to his village and ended up homeless in the urban center. This ultimately led to psychiatric relapse and re-institutionalization.

- A Pueblo religious leader collapsed during a secret ceremony. He was wearing sacred clothing not to be seen or touched by people outside of his clan. He was brought by ambulance to a hospital but, at his family's and the community leaders' insistence, he was not treated until other religious leaders could be brought in to remove his clothing. The risk to the family and the Pueblo was believed to be dire if any religious taboos were violated. He refused care, and he died without receiving treatment. The rural caregivers were distressed because, although they understood the Indian cultural issues, the experience did not meet accepted standards for informed consent or informed refusal of care.

- A 34-year-old woman sought treatment at a university hospital in a rural state, complaining of multiple infections, fatigue, and severe weight loss over several months. During her evaluation she was discovered to be HIV positive. When asked about her local care, she replied that she had received none. She said that she was aware that she "probably had AIDS" due to known exposure. She hadn't sought treatment because she "knew" that she would "die anyways" and didn't want her family to be ostracized by the local community. She stated, "There are no secrets here."

- A Native teenager in a rural area was brought to a clinic by a social worker. She was found to be pregnant and to have chlamydia and genital herpes infections. She had not received health care earlier in her pregnancy. Fearful and embarrassed, she would not speak to the clinicians through the clinic translator, who was a member of her family.

- The only mental health professional in a very isolated area was named as the court-ordered therapist for a patient who had killed the therapist's own father the year before.

- A social work aide and psychiatric nurse performed an annual home visit to a poor family living in a frontier area. They found that their patient, who was diagnosed with a chronic mental illness, had been badly beaten by her husband. The extended family sided with the husband in the marital disputes. No domestic shelters and no trained therapists were available in neighboring counties. The woman did not accept or consent to recommended follow-up care because she believed that the problems were her "own fault."

Native American, and the remaining 51% primarily white. More than 22% of all New Mexicans and 17% of New Mexican families live in poverty, the highest rates in the U.S. (the national rates are 13% and 10%, respectively). Twenty-two percent of New Mexicans are uninsured, significantly higher than the national average (15%), ranking New Mexico last in the U.S.

Alaska and New Mexico are thus predominantly rural and frontier states, and both experience significant health burdens associated with stigmatizing illnesses. New Mexico and Alaska have the two highest death rates due to alcohol-induced deaths (both at 16/100,000), over twice the national rate (7/100,000). New Mexico has about 321,000 residents with alcohol, drug abuse, and mental health problems, including 62,000 severely mentally ill people. One-quarter to one-third of the population in New Mexico, with large groups of Hispanic, white, and Native American people, have substance abuse problems (10%), mental health problems (22%), or both (3%). New Mexico ranks last in the U.S. for the age-adjusted death rate by chronic liver disease and cirrhosis (13/100,000), the reported arrest rate for driving under the influence (972/100,000), and the rate of drug-induced deaths (12/100,000). About 10% of rural residents of New Mexico and Alaska have mood disorders such as major depression, bipolar disorder, and dysthymia, and 13% have anxiety disorders such as phobias and panic disorder. The age-adjusted suicide rate in Alaska is second in the nation (21/100,000 residents), and New Mexico is fifth nationally (17/100,000), in comparison with the national average of 11/100,000. Alaska experiences the highest rate of any state in terms of years lost by premature death from suicide, with 817/100,000 years lost, compared with 378/100,000 years lost nationally.

The prevalence of sexually transmitted and infectious diseases in Alaska and New Mexico has generally been lower than in other areas, but these states are experiencing dramatic increases far beyond many other areas in the country. Among the fifty states, Alaska is ranked second for tuberculosis and tenth for chlamydia, whereas New Mexico is ranked 31st for tuberculosis and 25th for chlamydia. Unstable rates of hepatitis A, B, and C in Alaska have warranted sufficient concern that these infections have been an important focus of preventive efforts by the Center for Disease Control and Prevention's National Center for Infectious Diseases. Through 1998, 784 New Mexican and 153 Alaskan AIDS cases were reported, far

higher numbers than four years earlier; by June 1999 the numbers had more than doubled to 1858 AIDS cases in New Mexico and 448 in Alaska.

New Mexican Indian and Alaska Native communities in particular struggle with serious problems accompanying stigmatizing illnesses, including homicide, violent crimes, child abuse, and fetal alcohol syndrome, that have not been fully studied. Nationally there are 558 Federally recognized tribes, 229 of which are in Alaska. American Indian and Alaska Native life expectancies in 1995 were 66 years for males and 74 years for females, compared with 73 and 80 years, respectively, for Caucasians in this country. These figures in part stem from increased death rates due to social problems that are associated with stigmatizing illnesses. Deaths due to alcohol-related motor vehicle crashes for American Indians, for example, are roughly twice the national average, far greater than for other ethnic groups. In 1995, alcohol-related deaths (cirrhosis/chronic liver disease and alcohol-induced deaths) were 67/100,000 for American Indian and Alaska Native women, compared with 7/100,000 for Anglo women. Of people living in reservation Indian communities, 10–30% need mental health services. But non-reservation health care is also poorly understood, coördinated, and accessed by American Indians. Needs may be especially acute among Alaskan Native and New Mexican American Indian adolescent boys and young men, as they commit suicide at a rate two to six times the national average. Moreover, official statistics related to these social problems with health consequences are under-representative, as shown by a Department of Justice finding that child abuse cases on Indian reservations are grossly under-reported. Such stigmatizing health issues occur in a context of intractable social problems such as poverty, poor education, and trauma.

Despite great human need, health care services in Alaska and New Mexico are relatively limited. Overall, there are only 1.4 physicians/1000 residents in Alaska and 1.9/1000 residents in New Mexico. Alaska is ranked 50th and New Mexico is 47th in community hospitals per square mile (0.03/1000 and 0.30/1000 sq mi, respectively), a small fraction of the national rate of 1.40/1000. The lack of psychiatric resources in New Mexico is well documented. Only 4 of 44 counties have sufficient numbers of psychiatrists, and in the remaining counties the population to psychiatrist ratio is over 30,000:1 (over 20,000:1 where there are unusually high needs for psychiatric services). Most counties (23 of 33) have no psychiatric or alcohol treatment beds. Few community mental health clinics exist in rural Alaska, and there are only 11 general health clinics in its rural and frontier areas. Only one publicly funded psychiatric hospital serves the entire state of Alaska, and 12 psychiatric hospitals exist in New Mexico, well under national averages. Alaska and New Mexico thus represent rural and frontier states with tremendous need, reduced access, and limited resources for health care, especially for those illnesses that may be stigmatizing. Moreover, an array of psychosocial issues complicate our ability to understand and remedy these problems of inadequate care.

Lessons Drawn from Clinical Experiences in Arctic Alaska

A great number of elements shape clinical experience in Alaska. Perhaps one of the most serious is the scarcity of health care resources in the face of overwhelming clinical need. Another serious element relates to the distinct cultural challenges of Western-trained health care providers caring for Native people, often without appropriate preparation for interacting respectfully with Native culture. Other elements include the vastness of the state, extreme weather conditions, difficulties in travel to roadless areas, the absence in many places of modern amenities such as running water and sewer systems, and limited technological infrastructure.

Approximately one third of Alaska is considered "Arctic," formally defined as the area lying above 66°33' north latitude. Only three small towns exist in this region, with populations of 3800 (Kotzebue), 3500 (Deadhorse), and 3000 (Barrow). These towns have grown largely as a result of trade and commerce (for example, the "Gold Rush" and oil drilling/reserves), and their populations are predominantly Alaska Natives and Caucasians. Medical services in these communities are limited, with one community having a medical center, one relying on emergency medical technicians at the nearby oil-drilling facility, and one having a small hospital. These medical services are primarily provided by Western-trained physicians, nurses, and other health care professionals. For the most part, primary care clinicians work in these settings, although itinerant clinicians sometimes provide specialist expertise. The remaining populations in Arctic Alaska reside in predominantly Native villages—approximately 20 in all—each having from less than a dozen to several hundred members.

These communities rarely have resident health care professionals but instead rely on paraprofessional "health aides," who usually are Alaska Natives raised in the village. These special individuals carry extraordinary responsibilities, although their training often consists only of a high school degree followed by a brief period of Western medical training in Anchorage. These health aides may have only telephone access to physicians and nurses in neighboring towns, areas that often are not physically accessible except by a small plane and then only when weather conditions permit. Once or twice a year, a physician, nurse, physician assistant, or other professional health care provider may visit the more remote villages. In some areas, no outside clinician is ever present.

Given the features of the Alaskan Arctic, the challenges and obstacles for delivering health care are appreciable. The geography, terrain, and climate certainly make these areas poorly accessible for supplies as well as personnel. There are times when travel to these regions is simply impossible, and the inhabitants must wait and hope for desperately needed medical care. To get a sense of the distances involved, consider a patient living in Point Hope on the Chukchi Sea who needs hospital or specialist care that is only available in Anchorage; the distance involved in such a trip is equivalent to traveling from Washington, D.C. to Missouri. Moreover, the Alaskan travel would be much more difficult, owing to small plane travel and frequently severe weather conditions. For a person who is in physical pain or who is frightened, psychotic, or suicidal or withdrawing from drugs or alcohol, such a trip would be extremely strenuous. Even when travel is possible, the cost of travel is prohibitive for many residents of remote areas, so their care is restricted to what is available nearby. For these reasons, local health care professionals often find themselves in the situation of treating illnesses that would be beyond the scope of their practice in any urban area.

At times the human costs of limited access to care can be devastating both to patients and to caregivers. In one example, a health aide was treating an infant with an influenza-like upper respiratory illness. Although the child had a high fever, he was generally stable and the decision was made to treat him in the village. Several hours later, his condition worsened with the development of stiff neck, vomiting, and continued high fever unresponsive to medications. Weather would not permit a plane to come to the village. The child died within a few days from bacterial meningitis. The health aide suffered severe mental trauma and anguish from this event, and despite the fact that the provider was recognized for excellent work, that person felt compromised and unable to treat people with severe symptoms in the future. This provider prematurely retired from the position.

Another issue relates to the care of serious illness in the context of dramatic cultural change now being experienced in Arctic Alaska. Despite having adapted to one of the harshest environments on earth for nearly 10,000 years, large numbers of Arctic residents have succumbed tragically to illnesses introduced, triggered, or amplified in the region over the past century. The Alaskan experience with tuberculosis provides one illustration. During the 1920s the annual tuberculosis death rate among Alaska Natives was the highest documented in the U.S., and by 1944 tuberculosis was the leading cause of mortality in Alaska. Rates of tuberculosis infection in Alaska (10/100,000) remain twice the national average (5/100,000), placing it as the second highest state in the U.S. Native populations have also suffered tremendous morbidity and mortality from stigmatizing illnesses such as drug abuse, sexually transmitted and blood-borne infectious diseases, alcohol dependence, and mental disorders. Related psychosocial problems of domestic violence, sexual abuse, abuse and neglect of children, and homicide have grown to epidemic proportions. Although measures of suicide in Alaska are twice those nationally, the figures are much more daunting for Alaska Natives (45/100,000 annually), Alaskan youths (38/100,000), and Alaskan young men (65/100,000). Moreover, although Alaska Natives comprise 17% of the Alaska population, they comprise 26% of the individuals served by the mental health system. Western health care is, for the most part, not available, and many traditional ways of Native healing have been lost, displaced, or denigrated. While the Alaskan Arctic population experiences the "worst" illnesses from both cultures, clinical approaches that integrate the best features of Western and Native healing do not yet exist.

> "I have just landed on a small airstrip shared by several Native villages in an Arctic territory of Alaska. I am a psychiatrist and have come to this region to provide assistance with a healing conference among these villages, as there has been an epidemic of suicidal deaths among teenagers in the area. I am met by Andrew, a sturdy, cheerful, Inupiaq man who hands me several layers of winter gear. Straight and to the point, he tells me to get ready for a cold ride. I dutifully don these items, then climb aboard a wooden dog sled that

is pulled by Andrew in his snow machine. It is 40 degrees below zero, and I keep my face pointed to the ground to stop the biting, icy cold from abusing my skin. As we skim along the snowy surface, I occasionally peek up at the expansive, barren white tundra surrounding us. How can anyone live here, I wonder?

When we arrive at the conference I am struck by how little I understand of the proceedings, despite the best efforts of an interpreter. Armed with contemporary medical knowledge and expertise, I try my best to transcribe my ways of healing into theirs, but my interventions seem flat and ineffectual. Literally everyone in the room has been a personal witness or victim of severe trauma. Suicide, sexual abuse, physical abuse, domestic violence, and alcoholism are "givens" in this setting, and there is plenty of illness at work here. Although I am the recognized "expert" at these proceedings (there are no nurses, doctors, or professional clinicians of any type living in these villages), the Elders are held in awe and their word clearly carries the most weight. Sometimes we are at odds with how to proceed. With how much force do I present my learned views, especially when they are different from the Elders? I have the science and knowledge of contemporary psychiatry at my disposal, they, thousands of years of wisdom and experience. And yet the problems they face are modern ones, I think.

How much do I really understand of what is happening here? Despite being an accomplished clinician and academician, I seriously wonder how much I can be of help to these people. I am a stranger in a strange, estranged land."

In this illustration, a Western-trained psychiatrist, equipped with all the tools of modern medicine, traveled to a remote Arctic region to provide mental health care to a group of people who have inhabited the region for nearly 10,000 years. They dressed in Native garb, spoke their Native tongue, and continued to practice some of the traditional Native hunting, fishing, and trapping methods handed down through centuries. A closer look at the picture, however, reveals some important recent cultural changes. For instance, while many families did not have clean, running water, many had satellite TV, CD players, and Internet access. The adolescents spoke mostly in English and had adopted clothing like those of teenagers in urban settings. The "modern" problem, and the presence of the Western psychiatrist, challenged traditional beliefs and activities. In this story, based on the direct experience of one of the authors (JB), the outside clinician was invited to help the communities as they suffered after the suicides of their young people, their children and grandchildren, nieces and nephews. There were no precedents—only questions—regarding how to honor Native ways of healing and pair them with Western clinical practices.

Thus, Western-trained clinicians who travel to remote Arctic regions encounter cultural issues that greatly influence their ability to provide care effectively. Language itself is the first obstacle, and this is accompanied by differences in customs, social repertoire, and conceptual models of illness. For example, a man with a chronic, severe mental illness was banned from his village after he burned down his home. A mental health professional attempted to work with the village to educate community members about the contribution of delusional beliefs to this man's behavior (that is, to convey that the person was "sick," not "bad"). The village Elders, however, believed that the man was evil and that he placed the village at risk. They would not allow him to come back to the village, and this was supported by the other nearby villagers, nearly all of whom were related by blood or by clan. This situation was ironically complicated by Alaskan state legal doctrines guaranteeing the right of a patient to return to their home after psychiatric commitment, indicating how even local and state governance in rural areas may be incompatible.

When a stigmatizing disorder is involved, these issues become especially prominent. Village inhabitants may not entrust the caregiver with sensitive information until a closer relationship has been established, often requiring several years. A Native person, may, in fact, be ostracized by their local Native community because of their symptoms and underlying disease, while at the same time they may feel unable to seek help from the designated health care professional because of wide cultural disparities or because disclosure through a translator may feel shaming or unsafe.

In summary, clinical care in rural Alaska is greatly affected by scarcity of resources, cultural issues, and the vastness of the state, and few simple solutions exist for the dilemmas encountered by resident health aides, local caregivers, or outside clinicians. Clinical experience suggests that the barriers to optimal care are heightened in the case of people with stigmatizing illnesses. These issues have yet to receive systematic study in Alaska or in other frontier regions of the U.S. If we are to be effective in our efforts to provide clinically and ethically sound care to the underserved peoples in the rural areas of this country, efforts to clarify the character and prevalence of these barriers are essential.

Quotations from Health Care Providers in Rural Alaska and New Mexico

"I never felt like I was a trusted provider in the community. I felt like I was another white girl coming in.... Some of that was my fault in that I didn't make enough effort to do community activities...."

"If you're not from the culture, you are almost always suspect on some level... but the very fact I have been [working with the community] for a long time, I have developed trust with the people I work with."

"It's really important to deal with... community issues collectively as a community [rather than just working with individuals. If you don't], it's like rescuing drowning people when you don't know why they are falling in the water."

"There is a huge network you develop wherever you are, whether in town or in rural [areas], that just becomes part of your extended care network."

"I've seen Western model professionals snap because they didn't think they were getting anything done."

"When [patients] walk in, they see a very dominant white culture. They see the minorities occupy the positions of clerical and the docs are not. When you walk into an institution . . .it says certain things very loud and clear, where the values are in the institution. Minority patients read those very clearly."

"When you are in a rural area... [and]... not getting along with someone, there are limited places to turn. You have to figure out a way to work through it because there aren't other options available. If you burn your bridges with one organization, you're in trouble...."

"I work primarily with emergency medical services.... None of the villages have organized EMS groups. There is a lack of trained people to do the job... there are just not enough of them."

"I am as creative as I can be with what I have to work with."

"You just don't have all the resource and highest quality resources. There is a higher chance up here that you are working on a skeleton crew of people, less trained and overworked."

"Our village-based counselors have certificates of training that are less than Associates Degrees. They are dealing with psychotic and suicidal people when some with a master's degree or even a Ph.D. would have problems."

"I've really tried to empower [people] who are from the community to be the ones who are actively involved with the patients.... There are fewer barriers to have to bridge."

"[Patients] really want to identify and bond with a provider.... They don't want to be abandoned. If you're going to leave, then do it over time. Don't just suddenly leave."

"All the dual relationships... are unavoidable here. What I try to do about it is just to be very aware of it and document it the best I can. I'm trying to protect the patient as much as possible."

"As long as I can offer something to the community and I feel that I am making a difference, I will keep this job."

Research Aims

Rural life has been depicted as having unique community structures and processes, psychological and cultural features, and service delivery properties that present significant barriers to care for stigmatizing illnesses such as substance disorders, HIV and sexually transmitted diseases, and mental illnesses. Based on our clinical experiences in New Mexico and Alaska, we see six ethically important aspects of isolated settings that intensify the barriers and dilemmas encountered in rural health care:

- Relationship, role, and therapeutic boundary problems;
- Difficulties in protecting confidentiality;
- Cultural issues;
- Over-reliance on generalist care and insufficient expertise;
- Limited consultation for ethics issues; and
- Heightened stresses on caregivers.

"Being in a small place... you can make more of a difference and you can see it...."

"It is easy for me to interact with people now, but before there were barriers, especially cross-cultural. I broke in through the kids.... The way I got to know people is through their kids."

"The poverty combined [with] the distances that people have to travel make it difficult [to work here]. There is no public transportation. There are no services for people that are living in poverty. There are not as many services here that will help them get on their feet, to help them get clothing and things like that....When you put all those together, it can make a very difficult problematic picture."

"Really this is the 21st century. I think physicians need to think beyond their patients and their practices and practice within a public health paradigm [that] includes case management and multi-discipline team care of patients."

"For young people the big problem is substance abuse, which I attribute to lack of hope for the future. Now they have satellite and they can see how everybody out there lives and they want those things too, but they can't get them here. I see a lot of dissatisfaction and lack of opportunities."

"[Some problems that my patients have relate to] chronic post-traumatic stress disorder that is intergenerational. Grief, loss, and change... that have never been completely...addressed in families...are...pushed into the next generation."

"Part of the stigmatizing piece is that a lot of our work is with suicide, substance abuse, and violence, and those are not the kinds of things that people are going to talk openly about. Everybody in town knows about what is going on, but stigma and fear are very strong."

"I am there to help them, they are not there to meet my expectations."

"Don't ever lie.... Don't promise things you can't deliver. Be honest."

"You need to take into consideration their pace of life, their priorities, what is important to them, and work within that construct because you are playing in their sandbox."

"Confidentiality is one of the most important things to maintain in a small rural area. Without it people don't trust you, and if they don't trust you, they won't come to you."

"People go to other communities to get their health care [for certain illnesses] just because they don't want people [from their own community] to know about their illnesses."

"I may deal with my documentation a little bit differently, especially if someone has relatives within our facility or things like that. I'm more cautious and careful about the documentation and may not include things that would be embarrassing or compromise the patient were someone to break confidentiality."

"[I'll be here] four more months. The essence of the work is great, but I can't deal with the environment... it's buggy in the summer and it's frozen most of the year."

The goal of our five-year project, initially funded in December 1999, is to identify ethically important and potent barriers to optimal care for rural residents suffering from serious and potentially stigmatizing disorders. We have chosen to focus specifically on Alaska and New Mexico because these states have immense frontier and rural regions and have extraordinary health care needs in relation to stigmatizing illnesses. In addition, these states provide the opportunity to understand neglected but important Native populations. The two states have sufficient differences in geography, population composition and distribution, and cultures that they merit separate examination as well as comparison. To understand what is distinctly rural, it is essential to assess the continuum of experiences from various rural through urban communities. Our research centers on specific domains of clinical practice that represent the cornerstone of ethically sound care:

- Establishing a therapeutic alliance;
- Safeguarding confidentiality;
- Supporting informed consent processes; and
- Seeking to assure treatment compliance.

These issues are particularly important when caregivers treat people with stigmatizing illnesses.

This project seeks to fulfill three specific aims. First, during the first two-year phase of the project, we are gathering extensive qualitative data through

telephone interviews, in-person key informant interviews, and regional focus groups conducted both in Alaska and in New Mexico. Based on our understanding of the extensive information we are gathering in the first project phase and in combination with the existing literature regarding rural health care, we will develop a new health care survey instrument to comprehensively assess ethical and psychosocial issues reported by multidisciplinary clinicians in diverse settings. The instrument will examine the barriers that clinicians believe affect their efforts to care for people with substance abuse and dependence, sexually transmitted and infectious diseases, and mental illness in comparison with treating those with less stigmatizing illnesses.

Second, we will then use the instrument developed to gather quantitative, confidential survey data from a stratified random sample of up to 3200 licensed, multidisciplinary clinicians in Alaska and New Mexico. Three primary hypotheses will be tested. The first is that clinicians will identify ethical and psychosocial issues that arise as barriers to optimal care for highly stigmatizing illnesses. These issues will be seen by clinicians as adversely affecting their abilities to establish a therapeutic alliance, safeguard confidentiality, support informed consent processes, and assure treatment compliance. Furthermore, these issues will be reported as greater in number and impact in the care of more highly stigmatizing illnesses than less stigmatizing ones, and this effect will be greater for clinicians practicing in rural than non-rural areas. Our second hypothesis is that clinicians will report distinct problem-solving strategies and behaviors that differ in nature and frequency in the care of more highly stigmatizing illnesses than less stigmatizing ones, and this effect will be greater for clinicians practicing in rural than non-rural areas. Finally, we hypothesize that the ethical problem-solving strategies and behaviors employed by clinicians will be influenced by clinicians' reports of:

- Community characteristics (for example, size, degree of isolation, and access to resources such as hospitals, specialists, or emergency services);
- Practice characteristics (for example, caseload and frequency, and severity and range of illnesses of patients);
- Their own professional and personal attributes (for example, health care discipline and gender); and
- Their level of integration into the community in which they provide services.

Quantitative data derived from this second phase of the study will allow us to test and refine the fit of a tentative causal model of the factors that are related to stigma and barriers to care in rural areas compared to non-rural areas.

Our third aim is to perform a thorough needs assessment for clinical and ethics resources for rural caregivers in Alaska and New Mexico. Throughout both the qualitative and the quantitative phases of our research project, we will ask clinicians to identify educational and informational resources that are needed to help in their efforts to address ethical and psychosocial issues that arise in the care of people with stigmatizing illnesses. We will focus on obstacles to optimal care affecting clinicians' abilities to establish a therapeutic alliance, safeguard confidentiality, support informed consent, and enhance treatment compliance for people with stigmatizing illnesses.

This project will thus yield a novel survey instrument, extensive qualitative and quantitative data, and an empirically tested causal model for the influence of stigma, ethics, and rurality on barriers to care, as well as a careful needs assessment for clinical and ethics educational resources that will help in the care of people with stigmatizing illnesses. It is our hope that this work will lay valuable theoretical and empirical groundwork as an initial step of a larger program of inquiry to characterize barriers to optimal clinical care for pervasive disorders that represent immense burdens in our country, in terms of both human suffering and resources. This work should support a longer-term goal of examining ethical and psychosocial dimensions of care from the perspective of patients and community members in relation to specific clinical and service outcomes in diverse rural and urban regions of the U.S.

Conclusion

Failure to study and dismantle barriers to rural care will result in ongoing, systematic neglect of highly vulnerable, poorly protected patient populations. In greatest peril are children, women, the poor, and culturally distinct ethnic minority individuals who are at ever-increasing risk for devastating illnesses such as drug abuse, HIV, and serious mental disorders. In addition, poor attunement to rural situations, particularly in exceptional frontier regions such as Arctic Alaska, may lead to the ineffective use of scarce health care resources, a tragic consequence given the severity of need in these areas. Only by understanding the nature of barriers to care will we be able to improve treatment strategies for patients suffering from serious stigmatizing disorders. For the broader significance of this work, it is important to note that while an

individual rural community may be unique with respect to its geography, history, ethnic composition, and other factors, we will study the rural–urban continuum and are certain to have results from this project that have genuine relevance and value for the urban as well as rural ill. For these reasons, we believe that the survey instrument, the qualitative and quantitative data, the needs assessment findings, and a new causal model derived from this project potentially represent significant contributions to health care research, and we are grateful for the privilege of being able to conduct this endeavor. We hope that this effort in turn may help to inform clinical practice, public policy, codes of ethics, and education. In so doing, our greater aim is to improve health care for people suffering from stigmatizing illnesses in all areas of the country.

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Occupational Injury Research and Prevention in Alaska

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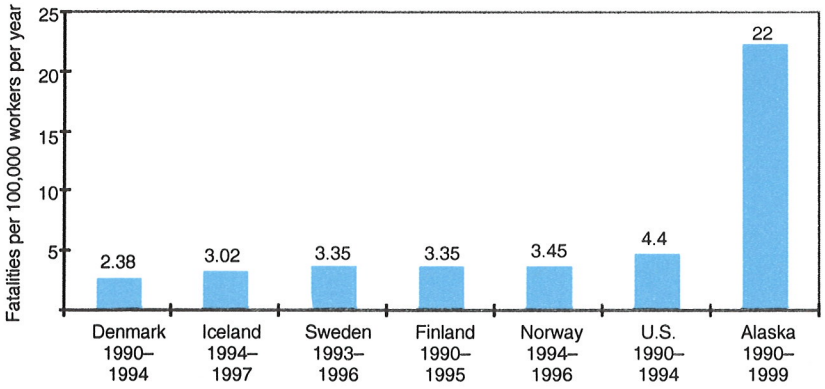
Introduction

During the twentieth century a major health transition has occurred worldwide because of rapid development and urbanization, with the diseases of poor nutrition and endemic infections being largely replaced by diseases caused by man-made exposures, such as tobacco smoke (lung cancer and coronary artery disease), a surfeit of food and too little exercise (obesity, diabetes Type II, and coronary artery disease), and injuries. Indeed, by late in the twentieth century, injuries had become the leading cause of death and disability in children and young adults, even in developed nations such as the U.S. Annually 140,000 Americans die from injuries, and one in three people sustain an injury requiring medical attention. Injuries kill more Americans aged 1–34 than all diseases combined, and they are the leading cause of death up to the age of 44. Injuries also cause the loss of more working years of life than do cancers and heart disease combined. Globally, half of deaths in ages 10–24 are caused by injuries. In American workplaces, injury also exacts a huge toll. On average, 16 U.S. workers are killed and 17,000 workers injured each day, at a cost of over $120 billion per year.

During the 1980s it became apparent that Alaska had the highest occupational injury fatality rate of any state (34.8 per 100,000 per year for the 10-year period 1980–1989, five times higher than the U.S. average of 7.0 per 100,000 per year). Furthermore, it was noted that the high mortality rate for Alaskan workers was not necessarily attributable to the northern locale, weather conditions, or the prominence of resource harvest industries (fishing, petroleum, logging) and non-roadway transportation. The Nordic nations share many similar conditions but have substantially lower occupational injury fatality rates than the U.S. overall, let alone Alaska. For example, Norway, which has a similar industrial makeup to Alaska, with commercial fishing, petroleum, tourism, logging, and small-airframe aviation all prominent as industries, experienced an occupational injury mortality rate of 3.8 per 100,000 per year for 1980–1989, below that observed for the U.S. and much lower than that for Alaska.



Occupational fatality rate comparison: Nordic nations vs. the United States and Alaska, 1980–1989. The Nordic data are from Arbejdstilsynet, the Danish Working Environment Service, 1980–1989, Copenhagen, 1993. The U.S. data are from Fatal Injuries to Workers in the United States, 1980–1989: A Decade of Surveillance, *NIOSH, CDC, 1993.*

In 1991 the National Institute for Occupational Safety and Health (NIOSH) established its Alaska Field Station (AFS). This office's role was to establish a comprehensive occupational injury surveillance system in Alaska and to develop and facilitate interagency working groups (of state and Federal agencies) to definitively address major factors leading to occupational death and injury in the state.

The major research questions addressed by the AFS are:

- How many severe fatal and nonfatal occupational injuries occur in Alaska?
- In which Alaskan industries and occupations do they occur?
- What risk factors are identifiable for these events?
- Which of these risk factors can be eliminated or mitigated?
- How can this most effectively be accomplished?

The objectives of the program are to:

- Characterize and reduce occupational risks in workplaces and industries by using epidemiologic surveillance and analytic methods and engineering hazard and task analysis techniques;
- Establish and refine statewide occupational injury and fatality reporting systems;
- Conduct prevention-oriented research addressing high-risk operations and populations (for

example, commercial fishing, air transport, and logging);
- Use the on-site location as a "living laboratory" for conducting state-of-the-art injury surveillance, intervention trials, and demonstration projects; and
- Promote worker injury prevention technology transfer to and from Alaska.

The purpose of this article is to provide an account of AFS's efforts to prevent occupational injuries in Alaska. Preliminary evidence shows that this program is being effective.

Methods and Approach to the Problem

Public health surveillance has been defined as the ongoing systematic collection, analysis, interpretation, and dissemination of health data. More succinctly it has been defined as "information for action." The following illustrates the effective application of this approach to a pressing public health problem in America's northernmost state. To detect and work toward preventing acute traumatic occupational injuries, AFS's program development followed a set of principles derived from this approach, the "Alaska Model for Occupational Injury Surveillance and Prevention." This model includes:

- Painting an accurate picture of the problem by establishing effective and timely surveillance systems, obtaining information via data-sharing with jurisdictional agencies and from direct investigation of incidents, and tailoring available methodology to local needs;
- Negotiating and constructing working relationships among local, state, regional, and Federal government agencies, workers, industry and labor organizations, and non-governmental organizations (NGOs);
- Prioritizing, via the use of a hierarchical approach for the full spectrum of injury events, multiple and single fatalities, severely disabling injury, hospitalizing injury, less severe injury (including lost time events), and hazards; and
- Planning, with a concentration on the technical, geographical, environmental, political, and cultural features of local and regional injury problems, with programs designed specifically to fit those problems, rather than using a "one size fits all" approach.

Systematic formulation of effective prevention strategies for injuries has depended on a clear understanding of risk factors for these events. Thus, when faced with particularly challenging categories of traumatic fatalities in Alaska's helicopter logging and fishing industries, a refinement of Haddon's matrix (an analytic tool frequently used in injury research) has been developed for use as an analytic and planning tool.

Phases	*Host/ Human*	*Agent/ Vehicle*	*Environment*
Pre-event/ injury			
Event/ injury			
Post-event/ injury			

A Haddon's matrix.

Using Haddon's matrices, surveillance data are first organized into risk factors discernible from investigation of these events; then a consensus safety recommendation matrix is developed using each cell in the original matrix. Working closely with industry, state and Federal agencies, and NGOs, immediate improvements may be made, for example, in worker training, work/rest cycles, and oversight. Surveillance results are then used to evaluate the effectiveness of interventions. Finally, a prevention matrix is developed for further refinements of safety in the industry.

The Alaska Field Station has designed and implemented a comprehensive surveillance system for occupational injuries—the Alaska Occupational Injury Surveillance System (AOISS). AOISS compiles risk factor information and permits quantitative epidemiologic analyses to be used for sound public health and prevention planning. AFS staff become aware of new injury events from a variety of sources: press releases from the Alaska State Troopers, reports from electronic or print news media and wire services, or telephone calls from jurisdictional agencies or the Fatality Assessment and Control Evaluation (FACE) Program. FACE, a NIOSH-funded occupational injury surveillance and analysis project being conducted by the Epidemiology Section of the Alaska Department of Health and Social Services (AKDHSS), is shedding light on fatal injuries occurring in Alaska's building trades, logging, machine-related, and occupational motor vehicle deaths. The respective jurisdictional agency (for example, the National Transportation Safety Board [NTSB], the U.S. Coast Guard [USCG], the Occupational Safety and Health Administration [OSHA], or the Alaska

Department of Labor [AKDOL]) is contacted, and NIOSH or AKDHSS FACE personnel accompany the investigator on an on-site investigation when possible. The data from other sources, which are entered into the AOISS database, are obtained from these jurisdictional agency's reports and databases. Reports are also requested from the Alaska State Troopers and local police agencies (incident reports), the Alaska Bureau of Vital Statistics (death certificates), the Alaska Department of Transportation (motor vehicle accident reports), and the State of Alaska Medical Examiner's Office (autopsy reports). Data are shared or reconciled with occupational traumatic injury fatality statistics from the AKDHSS's FACE program and with Alaska's Census of Fatal Occupational Injuries at AKDOL. The system is validated with these two offices and through a follow-up meeting with contacts from all of the jurisdictional agencies.

AOISS also obtains information from Federal Aviation Administration (FAA) Alaska Region (operator summaries), the U.S. Department of Transportation (quarterly carrier statistics), the Alaska Department of Fish and Game (fishing permit information), and the Alaska Department of Labor (information on workforce population and business licenses). Weather information is obtained from the National Weather Service.

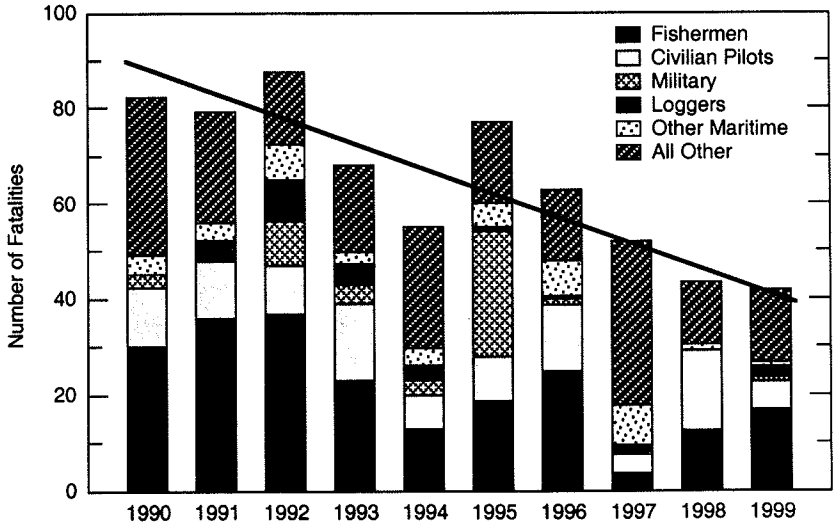
Implementing the ambitious goals of the AFS program with limited personnel and resources was challenging. Strong working relationships were established during the early 1990s among the many other Federal, state, municipal, and nongovernmental agencies that are engaged in detecting, investigating, or preventing occupational injuries and fatalities. These relationships, formalized within the Alaska Interagency Working Group for the Prevention of Occupational Injuries, include the AKDOL, AKDHSS, NTSB, USCG, FAA, OSHA, and U.S. Forest Service, as well as representatives of industry, NGOs, organized labor, and professional associations. This network has since served to foster injury surveillance, a broader understanding of occupational injuries in the state, and opportunities to effectively influence the immediate response to emerging occupational injury problems. Included in this group are the jurisdictional agencies overseeing the highest-risk industries in Alaska. The Working Group has three committees focusing on preventing deaths and injuries in aviation, commercial fishing (particularly crabbing), and the construction industries.

These collaborations in Alaska emphasize nonregulatory, collaborative responses in intervention strategies. Industry and workers are invited to be full partners in planning and executing interventions and providing ongoing surveillance data as a mirror for successes and failures. Recommendations for new rulemaking are only used as a last resort. The working groups have also explored other ways to motivate corporate management by discussing possible voluntary work standards with insurers and by assisting in discussions of possible insurance rate discounts for companies subscribing to more rigorous voluntary standards.

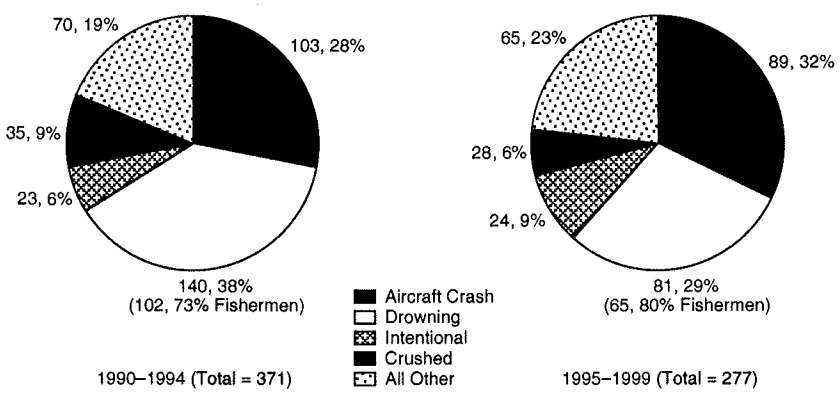
Overview of Alaskan Work-Related Fatalities

During 1990–1999, there were 648 acute traumatic occupational injury fatalities in Alaska. While the age distribution of occupational injury fatalities in Alaska closely mirrored that of Alaska's workforce, the overwhelming majority (96%) occurred among male workers. This disparity is partially explained by the most hazardous Alaskan occupations employing primarily males: there were 193 commercial fishermen, 107 commercial pilots, 47 military personnel, and 26 loggers killed on the job during this 10-year period. The major circumstances of death for workers during this 10-year period were drowning (219), aircraft crashes (192), being crushed (53), homicide or suicide (47), motor vehicle crashes (29), and falls (26). Many of these occupational fatalities were to young workers, resulting in 17,493 years of potential life lost (YPLL < 65).

Using available workforce denominator data, occupation-specific mortality rates were calculated for Alaskan pilots (410/100,000/year average for 1990–1999), loggers (150/100,000/year average



Occupational fatalities in Alaska, 1990–1999. The total number was 648. The data are from AOISS.



Proportion of occupational fatalities in Alaska, 1990–1999.

for 1990–1999), and fishermen (110/100,000/year average for 1990–1999), compared to an all-Alaska rate for 1990–1999 of 22/100,000/year and a U.S. all-workers rate for 1991–1995 of 4.4/100,000/year.

Since 1990, Alaska has experienced a 45% overall decline in work-related deaths (from an average of 83 deaths in 1990–1992 to an average of 46 deaths in 1997–1999), with the bulk of the improvement occurring among fishermen and loggers.

However, there was no significant decrease among pilots, who now account for an increased proportion of occupational mortality in the state. While drowning was the most common cause of death during 1990–1994, in the years 1995–1999 aircraft crashes had become the most common cause of death for Alaskan workers.

Helicopter Logging

The first major test of the "Alaska Model" approach came during the establishment of the AOISS in 1992. Because of increasing and changing environmental restrictions on road building in Alaska's national forests in the late 1980s, helicopters emerged as a major transportation mode for moving cut logs in the state by the early 1990s. Amid the rapid growth of this new industry in Alaska, between 1 January 1992 and 30 June 1993, there were six helicopter crashes, with nine fatal (including four pilots) and ten severe nonfatal injuries, out of only 25 helicopters flying in helicopter logging operations. These events led to an extraordinarily high annual crash rate of 16% and a catastrophic pilot fatality rate of 5,000/100,000/year. Investigation revealed that all crashes involved improper operational and/or maintenance practices.

After two serious helicopter logging crashes during one week in May 1993, we began a series of urgent consultations, culminating in an emergency session of the Alaska Interagency Working Group for the Prevention of Occupational Traumatic Injuries in early July 1993. Prior to this meeting the first helicopter logging matrix was developed to identify risk factors contributing to these events.

The prevention-matrix approach resulted in recommendations, including more vigorous oversight; development of rigorous voluntary industry standards for equipment, maintenance, and training; exclusive use of multi-engine rotorcraft; and more vigorous controls on alcohol and drug use in this industry.

By late July 1993, all helicopter logging sites and ramps in the state had been visited by the jurisdictional agencies, with a number of these operations being curtailed or entirely shut down

Features of Alaska Helicopter Logging Injury Events.

Phases	*Host/ Human*	*Agent/ Vehicle*	*Environment*
Pre-event/ injury	Pilot training, experience, fatigue, stress, medications, illegal drugs, and alcohol Ground crew training and experience	Helicopter design lift and durability, maintenance and repairs, engines and controls, and ergonomics Unstable work platform Surplus or improvised equipment	Terrain Weather Landing zones Oversight FAA (CFR pt 133) Industry
Event/ injury	Pilot reaction to emergency situation (i.e. autorotation); task overload Ground crew reaction and avoidance	Helicopter autorotation, performance, deformation on impact, and fires and explosion	Terrain Weather
Post-event/ injury	Types and severity of injuries		Little assistance available EMS not available

Alaska Helicopter Logging Injury Recommended Countermeasures. (From Alaska Interagency Working Group for the Prevention of Occupational Injuries, July 1993.)

Phases	*Host/ Human*	*Agent/ Vehicle*	*Environment*
Pre-event/ injury	Increased training for pilots and ground crew Improved work/rest cycles	Maintenance per manufacturer's recommendations Impact (g)-resistant seats NTSB to prohibit surplus equipment	Improved interagency communication Increased FAA oversight
Event/ injury	Practical training in autorotation		Emergency (backup) landing zones
Post-event/ injury			

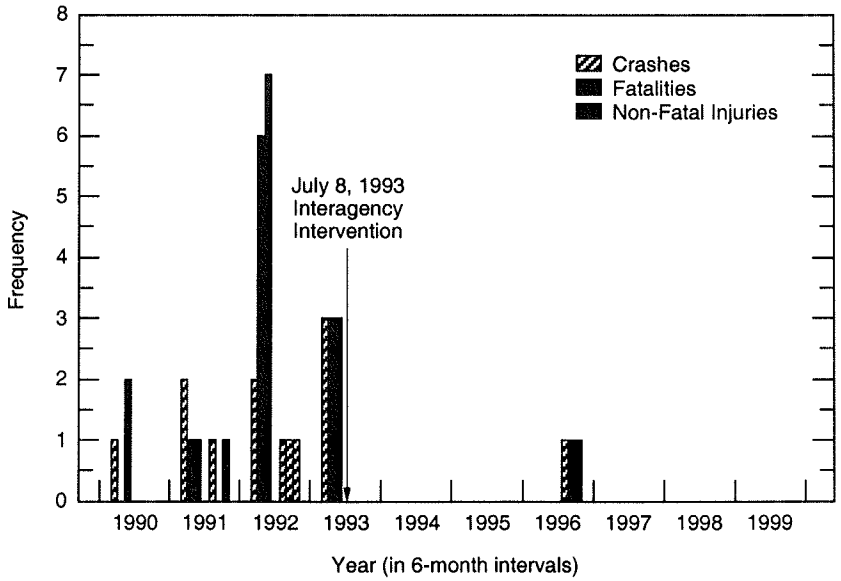
for irregularities. Since that intervention and the implementation of the Working Group's recommendations during July 1993, there were no additional helicopter logging crashes or fatalities in Alaska until July 1996, when a single crash did occur, with one fatality. There have been no more since (through 2000), despite continued growth of helicopter logging in Alaska.

This effective application of surveillance data in an interagency intervention for helicopter logging crashes has continued. In March 1995 the Alaska Interagency Working Group for the Prevention of Occupational Injuries and NIOSH co-sponsored a Helicopter Logging Safety Workshop. A third prevention matrix was developed to further refine safety countermeasures in the industry.

Additional workshops were held in 1996 and 1997. The proceedings of these workshops have been combined and published in one volume. Building on Alaska's leadership in this area, a Helicopter Logging Safety Committee was formed under the auspices of the Helicopter Association International (HAI) "...to help promote the safe use of helicopters in all aspects of the helicopter logging industry." The committee has established its own Helicopter Logging Guidelines, which address four issues: general helicopter safety for forestry operations, integration of ground and flight activities, helicopter-specific planning, and a pre-accident plan. The insurance industry has also played a major role in progress made in helicopter logging by substantially discounting insurance costs for operators adhering to standards developed by the helicopter logging guidelines.

The partnership developed among government agencies, HAI, and insurance underwriters has demonstrated the value of joint efforts to address specific occupational safety problems to workers in Alaska.

Crashes, fatalities, and non-fatal injuries in Alaska helicopter logging operations, 1990–1999.



Commercial Aviation

A disproportionate number of U.S. aircraft crashes occur in Alaska. Between 1990 and 1998 (the most recent period for which aggregate U.S. data are available), there were 823 commuter and air taxi crashes in the U.S., of which 229 (28%) were fatal, resulting in 653 deaths. Alaska accounted for 304 (37%) of the total U.S. crashes, 49 of which were fatal (21% of the U.S. fatal crashes), resulting in 131 deaths (20% of all U.S. deaths). Alaska's aircraft crash rate (crashes per 100,000 flight hours) for air taxi and general aviation during 1992–1994 was 2.5 times higher than the U.S. average.

To understand the importance of air transportation in Alaska, some background information on the Alaskan environment is needed. With over 586,000 square miles, Alaska has more than twice the land area of Texas and, with over 47,000 miles of shoreline, more shoreline than the remaining 49 states combined. It also has 17 of the 20 highest

Alaska Helicopter Logging Injury Countermeasures, Proposed at March 1995 Workshop, Ketchikan, Alaska.

Phases	*Host/ Human*	*Agent/ Vehicle*	*Environment*
Pre-event/ injury	Qualified second pilot Flight/duty time limits Drug/alcohol testing Availability of alcohol/drug rehabilitation	Multi-engine only Dual drive train Improved controls Improved crashworthiness Limit to certified parts with valid FAA history	Standard industry procedures for maintenance, safety culture, and management Helilogging association Educate FAA and FSDO Improve communications
Event/ injury	Qualified second pilot	Crash-resistant fuel tanks Controlled deformation	
Post-event/ injury		Electronic position-indicating radio beacons	Improved EMS availability CPR/first aid training for crews

peaks in the U.S., including the highest peak in North America, Mt. McKinley, yet only 60% of Alaska has radar coverage above 10,000 feet. Radar coverage allows aircraft to be seen and followed on a radar screen by air traffic control, and it allows for flight in low-visibility conditions.

Even though Alaska is large, it has only 12,200 miles of public roads, approximately the same mileage as Vermont, a state with less than 2% of the land area of Alaska. Furthermore, 90% of Alaska's communities are not connected to a highway system. That is, even if a road is in place, it may not go any farther than the edge of town or may be seasonal, such as ice roads (frozen rivers or streams) only usable during winter. Because of this, commuter and air taxi flights must serve in lieu of a traditional road system. This makes aircraft essential for personal and commercial transportation of passengers, cargo, and mail to outlying communities.

Aerial view of Alaska.

Between 1990 and 1999, aviation crashes in Alaska caused 106 civilian occupational pilot deaths. This is equivalent to 410/100,000 pilots/year, approximately 100 times the mortality rate for all U.S. workers. This rate is higher than for any other occupation in Alaska; the next two highest occupational fatality rates are logging (150/100,000/year) and commercial fishing (112/100,000/year). During the 1990s there were 1,684 general and commercial aircraft crashes in Alaska, equivalent to a crash every two days. Of these crashes, 188 were fatal and resulted in 402 deaths. On average there were 19 fatal crashes per year, with 2 fatalities per crash and 40 fatalities per year, equivalent to a fatality every nine days.

The pilot fatality rate of 410/100,000/year is nearly five times the rate for all U.S. pilots (88/100,000/year). This equates to a 12% cumulative risk for a commercial pilot in Alaska being killed in an aircraft crash over a 30-year career.

Although Alaska has experienced an overall downward trend in occupational fatalities since 1990 (from 82 fatalities in 1990 to 42 in 1999, a decrease of 49%), occupational aviation fatalities continue to be a major problem. The work-related deaths resulting from aircraft crashes include pilots and copilots, as well as passengers who fly to do their jobs, including biologists, health care workers, and government employees. During the

1990s there was a proportional change in occupational fatalities. In the five-year period from 1990 to 1994, 38% of occupational fatalities were attributable to drowning, primarily involving commercial fishermen, and 28% were from aviation crashes. However, the proportion shifted during the five-year period from 1995 to 1999, when 29% of occupational fatalities were from drowning and 32% were from aviation crashes. Thus, aircraft crashes have become the leading cause of death to Alaska's workers.

A total of 114 work-related crashes occurred in Alaska from 1990 to 1999, resulting in 192 fatalities. One hundred and six civilian pilots and six military pilots died in aircraft crashes in this period. Workers from other occupations who were flying in the course of their work duties accounted for an additional 80 occupational deaths due to these crashes. Of those, 31 deaths were to military non-pilots and 49 to civilian non-pilots. Twenty-four of the military deaths resulted from one catastrophic crash in 1995.

A recent research effort has elucidated one of the most lethal types of aviation crash: controlled flight into terrain (CFIT). CFIT is a leading cause of commuter and air taxi airplane fatalities in Alaska. CFIT crashes are aircraft collisions with land or water in which the pilot was in control of the aircraft (that is, there was no detectable mechanical failure or emergency) but had lost situational awareness (the pilot was unaware of altitude, terrain elevation, and/or latitude and longitude). Although CFIT represented only 17% of all crashes for 1991–1998 in Alaska, it was responsible for 59% of all commuter and air taxi fatalities. Neither the annual number of commuter and air taxi crashes nor the annual number of CFITs has improved significantly over the past decade.

Evaluation by NIOSH of work-related crashes occurring in Alaska from 1990 to 1999 found that 108 nonmilitary work-related crashes resulted in 155 work-related deaths; 106 these deaths were nonmilitary pilots; and 47 (44%) of these pilot deaths were attributed to CFIT.

One of the factors contributing to CFIT crashes in Alaska is pilots who continue flying itineraries under visual flight rules (VFR) despite poor-visibility weather conditions that call for instrument navigation. Visual flight rules pertain when weather conditions allow a pilot to navigate without instrumentation. The majority of flights in Alaska take place under these conditions. However, operating under instrument flight rules (IFR) may be needed if a pilot flies into reduced-visibility weather in instrument meteorological conditions. Legal instrument flying requires advanced training, an instrument rating, and sophisticated avionics equipment. It further requires that a pilot file a flight plan and that, while in transit, he or she stay in communication with air traffic control. Of the 49 fatal CFIT crashes that occurred from 1990 to 1999, 29 (59%) were attributed to pilots on VFR-only flights entering instrument meteorological conditions. These 29 crashes resulted in 47 (63%) of the work-related deaths.

The high occupational pilot fatality rate in Alaska and the high fatality rate associated with CFIT accidents reinforce the importance of addressing this type of accident and examining the associated risk factors. Understanding the factors that result in a pilot flying a well-functioning aircraft into the ground due to inappropriate or poor decision making and/or inadequate situational information could help in the design of appropriate training programs and other interventions. This could ultimately result in a major reduction of commercial aviation fatalities.

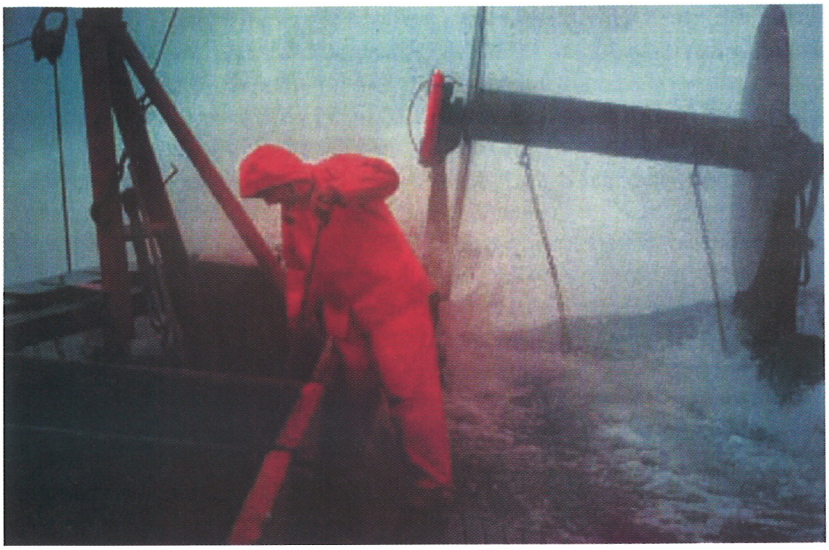
Technological improvements that could result in fewer aviation deaths for Alaskan workers include expansion of navigational aids and weather reporting systems in Alaska to reduce the likelihood of encountering unexpected weather. Improvements can also be made in aviation technology to aid navigation in reduced-visibility weather through global positioning systems, ground proximity warning systems, and ground collision avoidance systems.

Commercial Fishing

Working conditions in the Alaska commercial fishing industry are very hazardous, compounded by isolated fishing grounds, seasonal darkness, cold waters, high winds, icing, and brief fishing seasons. In the early 1990s this setting resulted in an unacceptably high occupational fatality rate of 200/100,000/year for 1991–1992 for Alaska's commercial fishermen. Over 90% of these deaths were from drowning, presumed drowning, or drowning plus hypothermia, in association with vessels capsizing or sinking or with falls overboard.

Several countries have reported similarly high fishing-related mortality rates, also primarily from cold-water drowning. For example, Iceland experienced a fishing-related fatality rate of 89.4/100,000/year from 1966–1986.

Safety programs implemented by different



Commercial fishermen working in Alaskan waters are often exposed to harsh conditions.

countries vary, focusing on vessel quality, operator licensing, staffing standards, and safety training. In the United Kingdom, comprehensive regulations implemented in 1975 include inspections of fishing vessels, personnel training, and staffing and watch-keeping requirements. Research from the U.K. has shown that human error is a common cause among fishing incidents. The Canadian commercial fishing industry operates in cold waters and has fisheries similar to the northern U.S. fishing industry. Canada experienced high mortality rates, 46/100,000/year for 1975–1983. In the mid-1980s Canada examined the fatalities in their fishing industry and developed many safety standards that have been implemented, including requiring safety training to obtain a commercial fishing license, increasing public awareness programs targeting high-risk fisheries, inspecting fishing vessels under 15 gross tons, and requiring the annual submission of self-inspection checklists as a prerequisite for vessel fishing licensing. Although nonfatal injuries associated with vessel emergencies and workplace hazards continue to occur at about the same rate as before, fatalities have generally been reduced.

Throughout the 1970s and 1980s Alaska experienced a boom in its commercial fishing industry. By the mid-1980s it had become clear that commercial-fishing-related deaths were the principal contributor to Alaska's high occupational fatality rate. During 1982–1987 a mean national annual total of 108 deaths occurred in the commercial fishing industry. Another study identified 31 Alaska fisherman deaths per year during 1980–1988. The hazards of commercial fishing captured the attention of the U.S. Congress and led to the enactment of the Commercial Fishing Industry Vessel Safety Act (CFIVSA) of 1988. During 1990–1995 the CFIVSA was implemented incrementally, requiring fishing vessels to begin carrying specific safety, survival, and fire-fighting equipment and requiring crew members to obtain first-aid and emergency-drill training. In the past NIOSH has not included fish processors in the overall risk factor analysis for commercial fishing. However, for this document, including the calculations of full-time equivalents (FTEs), AFS has included floating fish processor-related fatalities for the purposes of analysis.

From 1990 to 1999 Alaska experienced a 49% decline in work-related deaths, including a 67% decline in commercial fishing deaths (1990–1992 average compared to 1997–1999 average). By 1999 there had been a significant decrease in the number of deaths in the Alaskan commercial fishing industry. While man-overboard (MOB) drownings and vessel-related events in crabbing (often conducted far offshore and in winter) have continued to occur and still require urgent attention, marked progress has been made in saving lives of those involved in vessel-related events. The reduction of fishing-associated fatalities since 1990 has been associated primarily with vessels operating in fisheries other than crabbing. In 1994 an anomaly occurred because of a reduction of crab stocks and a closure of the largest (and historically most dangerous) red king crab fishery in Alaska. The processed net weight of crab was down 51% from 1992. No similar resource anomaly occurred in 1997, when the number of fishing-related fatalities was substantially lower than in other years.

From 1990 through 1999, 648 occupational fatalities occurred in Alaska. Commercial fishermen represented 217 (33%) of these fatalities. Given the mean full-time equivalent (FTE) Alaska commercial fishing workforce of 17,500, this is equivalent to a fatality rate of 112/100,000 workers/year. This rate has decreased from the rate reported in 1991–1992 (200/100,000/year). However, it is still 28 times the overall U.S. occupational fatality rate of 4.4/100,000/year.

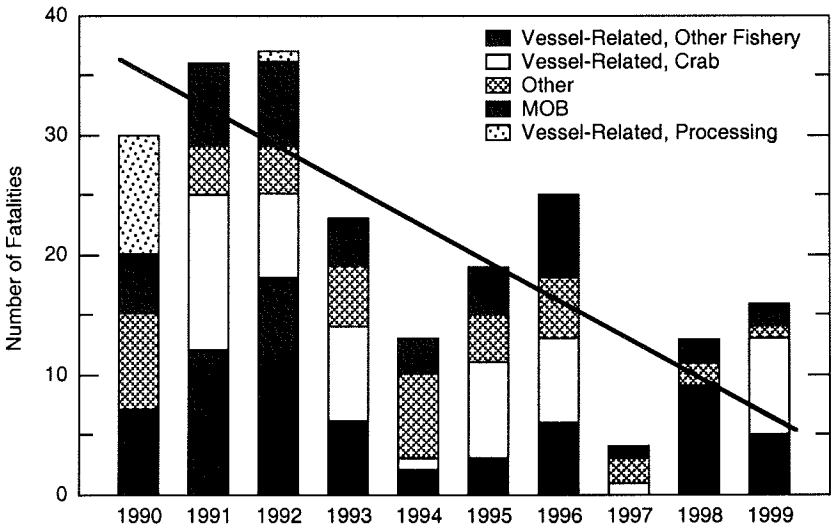
This mean FTE does not adequately measure the amount of time a fisherman or fish processor spends on the water and that worker's commensurate risk exposure for drowning. AFS's work in determining FTEs included consideration of compatibility of commercial fishing FTE rates with other countries and industries. The rates assume that workers are credited with 24-hour work days during the opening of fishing seasons lasting less

than 16 days. The rates also credit fishermen with 12-hour working days for seasons that last up to 50 days in an opening. However, if a person worked on a vessel for more than 50 days (that is, they resided on the vessel), they were only given single work day credit (eight hours). It is important to note that the FTE calculations may not reflect the actual amount of time fishermen spent in Alaskan waters.

The fatality rate among fishermen varied considerably by type of fishery: shellfish (primarily crab) had the highest (407/100,000/year), followed by herring (204/100,000/year) and halibut (119/100,000/year). Fisheries differ in geographic location of fishing grounds, type of harvesting equipment and techniques, time of year, and duration of seasons. Crabbing, a shellfish fishery, is particularly hazardous, because crab species in Alaska are generally harvested during the winter, when the weather is often rough. In addition, the equipment used in crabbing includes large steel cages ("pots"), each of which weighs up to 800 pounds when empty.

Most (186; 86%) deceased fishermen drowned and/or died from hypothermia, the result of vessel-related events (133; 72%), falls overboard (43; 23%), diving incidents (5; 3%), or other drowning events (5; 3%). Other fatalities were due to deck injuries (16; 7%) or some other event (15; 7%). Of 133 fatalities in vessel-related events, the largest number (61; 46%) of fishermen were participating in the shellfish fishery. Of those falling overboard and drowning, 22 (51%) were also participating in the shellfish fishery. Fatalities from falling overboard were categorized by cause of immersion: entanglement in net or line (12; 27%), observed fall (12; 27%), unobserved fall (victim missing from vessel) (10; 23%), or being washed or blown into the water (10; 23%). None of these workers were wearing a personal flotation device (PFD).

Commercial fishing fatalities in Alaska, 1990–1999.



Of the 71 fishermen who drowned in vessel-related events and for whom PFD usage information was available, 54 (76%) were not wearing any type of PFD, whereas 17 (24%) were wearing such devices. (For 62 fishermen in vessel-related events, it is unknown whether they were wearing any type of PFD.) On the other hand, among survivors of such casualties, 34 of 47 were wearing PFDs. Thus, an odds ratio calculation shows that survivors of these vessel-related events in which at least one person drowned were 8.3 times more likely to have been wearing a PFD than those who did not survive.

Personal Flotation Device (PFD) Usage among Vessel-Related Victims and Survivors in Alaska, 1990–1999.

	Victims	*Survivors*	*Total*
Wearing PFD	17	34	52
Not wearing PFD	54	13	67
Total	71	47	118

AFS's analysis of USCG vessel casualty statistics for 1991 through 1999 revealed that the number of vessels lost has remained relatively constant (averaging 34), as did the number of workers on board (that is, the number of persons at risk) (averaging 106), whereas remarkable progress has been made in the case-survivor rate (the number of survivors compared to the number on board) in these types of vessel-related casualties. This figure has increased from an average of 78% in 1991–1993 to 92% in 1994–1996 and then to 94% in 1997–1999. These data only represent fatalities due to the loss of a vessel. Therefore, MOBs, crushings, and fires are not represented.

While mortality in commercial fishing has indeed been reduced, the continuing pattern of losing 25 to 45 vessels every year and approximately 100 persons who must be rescued each year from cold Alaskan waters remains problematic. Successful rescue still depends on the expertly trained personnel of the USCG search and rescue (SAR) operations, and such efforts can hindered by the harshness of seas and weather. Furthermore, the people involved in USCG SAR operations are themselves at considerable risk during these rescue attempts.

Our surveillance findings for causes of fishing-related fatalities parallel those for the Alaska commercial fishing industry reported in previous reports of surveillance data, incident investiga-

Recent Decrease in Case Fatality Rate in the Alaska Commercial Fishing Industry, 1991–1999.

Year	Vessels lost*	Persons on board*	Fatalities†	Fatality rate (%)**
1991	39	93	25	27
1992	44	113	26	23
1993	24	83	14	17
1994	36	131	4	3
1995	26	106	11	10
1996	39	114	13	11
1997	31	84	1	1
1998	37	124	9	7
1999	28	104	11	11

* Source: U.S. Coast Guard, 17th District, Fishing Vessel Safety Coordinator.
† Fatalities from capsized or lost commercial fishing vessels only.
** Fatality rate = (Number killed / Number at risk) × 100%.

tions, and survey information collected for 1980–1992 by NIOSH, USCG, NRC, NTSB, and the University of Alaska. Workers at greatest risk for fishing-related fatal injuries are those who fish for crab aboard unstable vessels. However, our more recent findings reveal a consistent reduction of fatalities linked to vessel-related emergencies.

The causes of Alaska commercial fishing-associated fatal and nonfatal injuries are complex. Gear type, fatigue, and environmental conditions also contribute to the severity, if not the frequency, of occupational incidents.

The impressive progress made during the 1990s in reducing mortality in fishing-related incidents in Alaska has occurred largely after the event, primarily by keeping fishermen who have evacuated capsized or sinking vessels afloat and warm (using immersion suits and life rafts) and by being able to locate them readily via electronic position-indicating radio beacons (EPIRBs). All of these regulations required by the CFIVSA were implemented during 1990 through 1995. The CFIVSA emphasizes the use and availability of safety equipment during and after emergency incidents at sea. The findings presented here show considerable reductions in fatalities in some sectors of this industry but show persistent problems in other areas and no change in the most severe nonfatal injuries.

Alaskan efforts have started to benefit fishermen in other parts of the U.S. as well. In 1999 the USCG established a Fishing Vessel Casualty Task Force to perform a fast-track examination of commercial fishing industry operational and safety issues that may have contributed to a recent increase in marine casualties on the east coast of the U.S. A report of their findings was published in April 1999, written with a list of recommendations for the fishing fleet. The task force relied heavily on three earlier government studies, including a 1987 report from the NTSB, a 1991 proposal for a national fishing safety program, and a NIOSH/AFS 1997 study of Alaskan fishing deaths. Eight of the major recommendations for changes in national management and policies for commercial fishing safety came from the 1997 Alaska report. The USCG

Features of Commercial Fishing Injury Events in Alaska.

Phases	Host/ Human	Agent/ Vehicle	Environment
Pre-event/ Injury	Captain and crew fatigue, stress, medications, inadequate training/ exposure	Unstable vessel Unstable work platform Complex machinery and operations	High winds Large waves Icing Short daylight Limited fishing seasons Vessels far apart
Event/ Injury	Captain and crew reaction to emergency PFD not available or not working	Leaning or capsized vessel Delayed abandonment Emergency circumstance not understood Man overboard (MOB)	High winds Large waves Darkness Poor radio communications Cold water
Post-event/ injury	Poor use of available emergency equipment Hypothermia Drowning Lost at sea	Vessel sinking Poor crew response to MOB	High winds Large waves

Alaska Commercial Fishing Injury Countermeasures According to the Commercial Fishing Industry Vessel Safety Act of 1988 (Implemented 1990–1995).

Phases	*Human Agent/*	*Host/ Vehicle*	*Environment*
Pre-event/ injury	Drills		Navigation publications Compasses Anchors
Event/ injury	Immersion suits PFDs	Fire extinguishers/systems Fireman's outfits/SCBAs High water alarms Bilge pumps/alarms	
Post-event/ injury	Immersion suits PFDs	Distress signals Life rafts EPIRBs	First aid kits CPR and first aid

has also recently developed a number of innovative programs, including damage control training, vessel risk indexing, and safety checks prior to historically high-risk fishery season openings.

Nonfatal Injuries to Alaskan Workers

Surveillance of nonfatal work-related injuries can come from various data sources. Originally designed for internal quality control of patient care for hospital and state trauma systems, trauma registries contain many fields of information that are useful for injury surveillance. Trauma registries are a unique source of injury data: demographics, geographic information, disability, medical cost, payment source, cause of injury, discharge diagnosis, and severity scoring are only a few of the examples of data that are collected. Some trauma registries are limited to a single hospital or group of hospitals, while others, as in Alaska, are state-wide.The NIOSH Alaska Field Station has created a strong partnership with the AKDHSS, Section of Community Health and Emergency Medical Services, Alaska Trauma Registry (ATR), which includes Federal program support and funding.

EPIRB and life raft aboard vessel working in Alaskan waters.

The ATR has proven to be a useful information source in monitoring nonfatal work-related injuries in Alaska, and it is a model for other trauma registries nationwide. The ATR is a population-based data system, gathering information on traumatic injury hospitalizations from all of Alaska's 24 acute-care hospitals. In 1988 a pilot project began in seven hospitals in Alaska for development of a trauma registry. Success as a quality assurance tool and in injury prevention led to the implementation of a statewide registry in January 1991.

AFS collaborated with AKDHSS on the development and implementation of work-related injury information collection. Information on work-related injuries, including industry and occupation, is being used for injury surveillance in this area. To be included in the ATR, patients must have suffered a traumatic injury or poisoning. Patients either have to be admitted to a hospital in Alaska, transferred to another acute care facility for a higher level of care, or declared dead in an emergency department. Up to 158 data elements are abstracted from medical record charts. The information is sent to AKDHSS to be compiled into the ATR database. A data subset is then created for occupational injury prevention research. The injury surveillance data for work-related injuries are then transferred to NIOSH/AFS and undergo further coding and analysis. Analysis of the trend data and identification of hazardous processes are used in developing injury prevention strategies specifically targeted to high-risk industries and work environments.

From 1991 through 1997 commercial fishing had the highest number of injuries. However, by 1998, construction had overtaken commercial fishing as the industry with the highest number of hospitalized injuries. When measuring injury by industry using available denominator data to calculate rates, analysis demonstrated a change in the ranking order of industries with these hospitalized injured workers. The logging industry led with the highest injury rate (18/1,000 workers/year), followed by construction (6/1,000 workers/year).

Alaska Commercial Fishing Injury Countermeasures Proposed by CDC/NIOSH, Alaska.			
Phases	*Host/ Human*	*Agent/ Vehicle*	*Environment*
Pre-event/ Injury	Licensing of skipper Increased training on vessel stability Increased drills	Reassessment of stability after refitting Retrofitting of sponsons	Evaluate impact of management regimes for fisheries No-sail guidelines due to weather Development/refinement of icing nomograms
Event/ Injury	Wearing PFDs, MOB alarms, EPIRBs		
Post-event/ Injury			

An analysis of work-related injury allows research into types of injuries, using codes from the ATR. The ATR includes information on the body regions injured and the cause of injury. The AFS focuses its injury prevention efforts on the leading three causes of injury, types of injury, and body regions affected for each of the priority industries.

Logging Industry

In the Alaskan logging industry the majority of the injuries were caused by being struck by an object (often a falling tree or log), followed by cutting or piercing objects, then falls. From the ATR's narrative field, research showed that the objects most commonly striking workers were trees, logs, or limbs. The most common type of injury was a fractured bone, and the body region most commonly injured was the lower extremity, which includes workers' legs and feet.

Work is being done with the Alaska Department of Labor and AKDHSS to better understand the high rate of hospitalized injuries in the logging industry. Information on nonfatal injuries was presented to logging safety personnel at the OSHA Region X Logging Safety Summit at Ketchikan, Alaska, in March 2000, and the ATR has been useful in work with the University of Washington to produce the *Occupational Research Agenda for Northwest Forestlands* to set priorities in health and safety research in the northwest logging industry.

Commercial Fishing

Injury from machinery was the leading cause of nonfatal injuries in the commercial fishing industry. Falls ranked a close second. The ATR's narrative field showed that falls most often occurred into holds, through open hatchways, and on ladders and gangways. Injuries from machinery often involved equipment unique to this industry. "Crab pots" (baited cages weighing up to 800 lb) and a "crab pot launcher" were listed in the records as factors in a number of injuries. A crab pot launcher is a hydraulic lift that raises and tilts the pot over the top of the gunwale, where it slides into the water. Fishing nets, lines, and winches were also repeatedly mentioned. Extremities were the body regions most often injured.

Contributing factors in commercial fishing deaths vary from nonfatal injuries to workers in this industry. Most commercial fishing deaths result from the loss of a vessel or from a fisherman falling overboard. Most nonfatal injuries occur while working on the vessel (either on deck or below), from machinery on deck, falls, and/or being struck by objects. The deck of a fishing boat is an unusually hazardous working environment. Not only are workers exposed to the elements, but the deck is an unstable work platform, as it is constantly moving and is often congested with machinery. In addition it may be covered with oil, ice, water, and fish slime. In its 1991 study on fishing vessel safety, the National Research Council (NRC) noted, "The apparent high incidence of workplace accidents suggests inadequately designed safety features in machinery, deck layouts, and fishing gear." Research on characterizing the relationships among the vessel, fishing equipment, and workers is underway by NIOSH, as well as efforts to develop and organize safer on-deck equipment.

Conclusions

Using surveillance data as information for action, collaborative efforts in Alaska have been very successful in applying these insights toward

preventing occupational mortality and serious injury. Specifically, epidemiological analysis has been effectively applied toward reducing mortality in Alaska's rapidly expanding helicopter logging industry, and it played an important supportive role in tracking the continuing progress made in reducing the mortality rate in Alaska's commercial fishing industry, as well as numerous local injury prevention efforts.

Some of the methodological refinements presented here may be useful elsewhere. Layering Haddon matrices provides a useful insight for planning for injury prevention. This method should be widely applicable.

The results suggest that the extension of Alaska's approach to occupational injury surveillance and prevention to other locales, and the application of these strategies to the full spectrum of occupational injury hazards, could have a broad impact on the reduction of occupational injuries.

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Prevention and Control of Infectious Diseases in the Arctic

This report was prepared by Alan J. Parkinson and Jay C. Butler, both of the Arctic Investigations program, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Anchorage, AK.

Arctic populations have long been plagued by debilitating effects of endemic and epidemic infectious diseases. The advent of antibiotics and vaccines; improvements in housing, sanitation, and water quality; and cooperative public health programs of Native health organizations, the Indian Health Service, the State of Alaska, and the Centers for Disease Control and Prevention have dramatically reduced morbidity and mortality from infectious diseases in the U.S. Arctic. However, in today's world of rapid regional, national, and international transportation and global commerce, Arctic communities are no longer isolated, and new threats for importation or exportation of infectious agents have emerged.

In 1948 the U.S. government established the Arctic Health Research Center (AHRC) to address public health problems in the U.S. Arctic (Alaska). Over the next 25 years the AHRC, together with staff from the Alaska Native Medical Center in Anchorage, conducted studies on a variety of diseases of concern to the Alaska Native population. In 1973 the AHRC closed, and the medical epidemiology unit and laboratory became the Ecological Investigations Program of the Centers for Disease Control and Prevention (CDC). Because persons in the Arctic, and Alaska Natives in particular, are disproportionately affected by infectious diseases, the unit became the Arctic Investigations Program (AIP), a division of CDC's National Center for Infectious Diseases in 1989.

The mission of AIP is prevention and control of infectious diseases among peoples of the Arctic and sub-Arctic, with a special focus on diseases of high incidence and concern among indigenous peoples of the circumpolar region. Priority activities include prevention of diseases caused by *Streptococcus pneumoniae, Haemophilus influenzae* type b (Hib), *Helicobacter pylori*, and respiratory syncytial virus (RSV); control of viral hepatitis; and prevention of drug-resistant pathogenic organisms, such as methicillin-resistant *Staphylococcus aureus*. Prevention and control strategies employed by AIP include:

- Development of surveillance systems to monitor rates of diseases;
- Conduct of epidemiologic research to understand the transmission and risk factors for infection;
- Development of diagnostics tests;
- Evaluation of prevention interventions, including vaccines and education;
- Implementation of successful interventions; and
- Collaboration with state public health organizations, Native health entities, laboratories within universities and industry, and other Federal agencies.

Invasive Disease caused by Haemophilus influenzae *Type b*

Infection with *Haemophilus influenzae* type b (Hib) can result in serious invasive diseases, including meningitis, sepsis, pneumonia, and epiglottitis. It is primarily an infection of the very young, although disease occasionally occurs in adults, particularly those with certain underlying medical conditions. Hib can be carried in the oropharynx of healthy persons, providing a source of transmission to susceptible persons. Active surveillance for invasive Hib has been conducted by AIP in the U.S. Arctic since 1980. Between 1980 and 1982, Alaska Native children under five years of age had an incidence rate of invasive disease of 601 cases per 100,000. The attack rate was highest among those aged six to seven months. This was in contrast to non-Native children of the same age in Alaska, who had a rate of 128.6 per 100,000, with a peak incidence at eight to nine months of age.

Between 1984 and 1987 the National Institutes of Health (NIH) funded an efficacy trial using the first of a new generation of vaccines—the conjugate vaccines—which consist of Hib polysaccharide linked to a protein. The conjugation of polysaccharide to a protein produces a vaccine that induces good immune responses in very young infants, the group at highest risk for serious Hib disease. One of these new vaccines, PRP-D, was studied for efficacy against invasive infection in high-risk Alaska Native infants less that 24 months of age. This study was a collaborative venture between the University of California–Los

Angeles, CDC, and the Indian Health Service (IHS). While this vaccine was found to be safe and its efficacy was confirmed in other populations, the trial failed to show significant protective efficacy against invasive Hib in Alaska Native infants. An active immunization program using another Hib vaccine, PRP-OMP, was begun in Alaska in 1991, resulting in a more than ten-fold decline in invasive Hib cases in Native children.

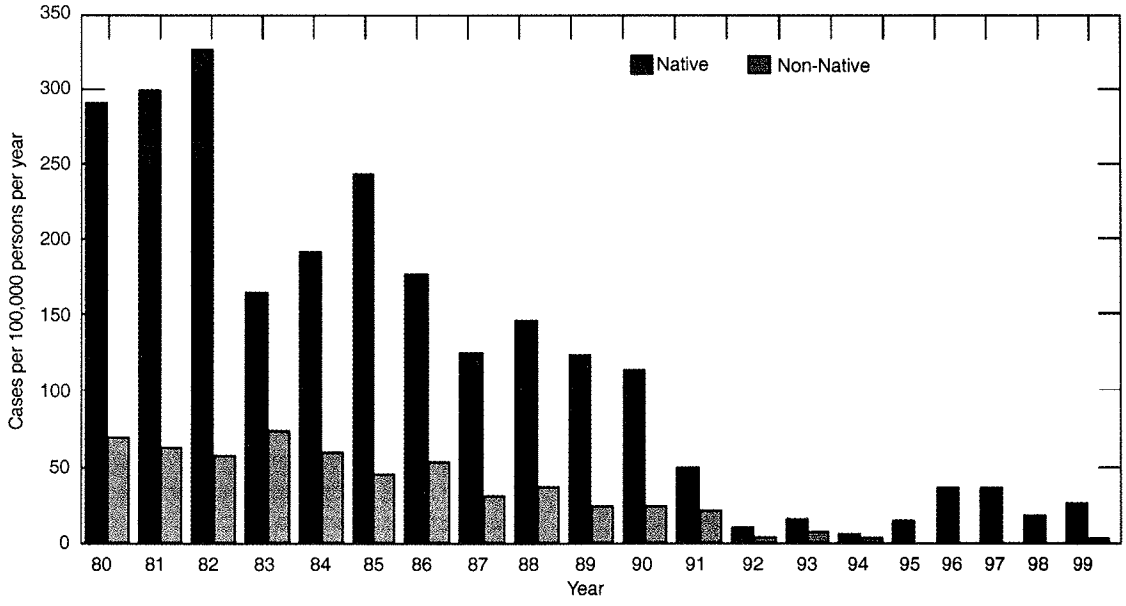
Hib disease in Alaska has been reduced but not eliminated. In May 1996, surveillance detected four cases of invasive Hib in children less than two years of age, and over the next 12 months a total of 10 cases occurred, all in Alaska Native children less than five years of age. The majority of cases were in infants who received one or two doses of Hib vaccine after a statewide switch to a less immunogenic Hib vaccine in early 1996. In the investigation that studied these cases, it was found that older children and adults were asymptomatically colonized with Hib and could transmit the infection to under-immunized children. This experience, like the inefficacy of PRP-D documented in the trial among Alaska Native infants, demonstrates the shortcomings of generalizing data from other regions when developing public health policy in the Arctic. Therefore, AIP, with support from the CDC's Office of Minority Health, NIH, and local Native Health entities, has begun a series of studies intended to provide a more complete understanding of the epidemiology of Hib carriage in rural Alaska communities and to assess the feasibility of eliminating both Hib disease and carriage.

Invasive Diseases caused by Streptococcus pneumoniae

Worldwide, *Streptococcus pneumoniae* is a leading cause of death and is among the most common causes of bacterial meningitis, community-acquired pneumonia, sepsis, acute otitis media, and sinusitis. Serious pneumococcal infections are particularly common in the very young and the elderly. Over the last decade, pneumococcal strains resistant to penicillin and other antibiotics have emerged, complicating the management of patients with these common infections. A vaccine containing the polysaccharide antigens of 23 pneumococcal serotypes has been available since 1983 for use in children aged two years and older and in adults. Surveillance for invasive disease caused by *S. pneumoniae* was established in Alaska in 1986 and has shown that these 23 serotypes cause 85–90% of pneumococcal disease. Alaska Natives have the highest reported average overall rate of invasive pneumococcal disease in the world (62 cases per 100,000), four times higher than that for non-Natives living in Alaska (16 cases per 100,000). Among children less than two years of age, the rates are 450 cases per 100,000 among Alaska Natives and 129 cases per 100,000 among non-Natives.

Surveillance for invasive pneumococcal disease first detected isolates with decreased susceptibility to penicillin in the Yukon–Kuskokwim Delta region in the 1980s. Although these isolates were only moderately resistant to penicillin, resistance

Invasive bacterial diseases caused by Haemophilus influenzae *type b in Alaskan children less than 10 years of age: 1980–1999.*



to multiple antibiotics including erythromycin and trimethoprim-sulfamethoxizole was also found by 1989. These multi-drug-resistant isolates were recovered mainly from children less than two years of age living in rural parts of the state, and the majority were serotype 6B. Recent molecular typing of the 6B isolates has provided evidence of the emergence of a distinct 6B clone in rural Alaska during the 1980s, with subsequent spread of the strain throughout the state. In 1993 the first multi-drug-resistant pneumococcal isolates with full resistance to penicillin were identified in Alaska. These isolates (usually serotypes 9V, 19F, and 23F) were first recovered from patients living in urban points of entry to Alaska and are indistinguishable from multi-drug-resistant strains circumnavigating the globe. Statewide, the proportion of pneumococcal isolates fully resistant to penicillin has increased from 0% in 1991 to 6.1% in 1998, and the proportion of isolates that are multi-drug resistant increased from 4.7% in 1991 to 17.7% in 1998.

Epidemiological studies have shown that antibiotic use increases the risk of infection with drug-resistant strains of *S. pneumoniae*. A CDC study has documented the impact of educational programs targeting patients and clinicians on reducing inappropriate antibiotic use in rural Alaska villages. Ongoing work is assessing the effect of these programs in reducing the transmission of drug-resistant strains. Equally important for controlling the spread of drug-resistant *S. pneumoniae* is the use of vaccines. In Alaska the 23-valent pneumococcal polysaccharide vaccine is recommended for all persons aged 55 years and older. However, this vaccine remains underutilized. A new 7-valent conjugate pneumococcal vaccine has recently been licensed in the U.S. for use in infants. Among Alaska Native children less than two years of age, the seven serotypes in the conjugate vaccine cause 77% of bacteremia and meningitis cases caused by pneumococci with reduced susceptibility to penicillin. AIP will evaluate the effect of this vaccine in Alaska through ongoing surveillance for invasive disease and through studies of pneumococcal carriage among children.

Respiratory Syncytial Virus

Respiratory syncytial virus (RSV) is the single most important respiratory pathogen in infancy and early childhood in the U.S. Arctic. Over 30 years ago a study of children in Bethel, AK, documented the high prevalence of RSV infection and high mortality caused by viral respiratory tract infection. Today, RSV is still the major respiratory pathogen among children in Alaska. Of children born in the Yukon–Kuskokwim Delta region during the 1990s, as many as 25% required hospitalization for RSV infection in the first year of life. RSV hospitalization rates are three times higher for Native infants in rural Alaska than for those living in Anchorage. The economic impact of the high rate of infection in remote areas is profound. During one year, over $1000 was spent for every child less than three years of age to provide medical care for those infected with RSV.

Other than breast-feeding, no economical prevention tools exist to reduce RSV disease in rural Alaska. A recently licensed humanized monoclonal antibody directed against the F-protein on the viral surface is used for preventing severe RSV disease in rural Alaska, but high cost restricts its use only to premature infants and those with other lung conditions that increase the risk of fatal RSV infection. An effective prevention strategy for all infants in rural Alaska, such as an RSV vaccine, is desperately needed. Future research in Alaska should include evaluation of RSV vaccines.

Infections caused by Staphylococcus aureus

Furunculosis ("boils") caused by *Staphylococcus aureus* has been a particular problem for Alaska Natives for centuries, as reflected by accounts of early European explorers. Today, these common skin infections continue to challenge health care providers, as methicillin-resistant *Staphylococcus aureus* (MRSA) has become an increasingly common cause. While MRSA infections have been common in hospitals for more than two decades, MRSA infections have recently appeared as causes of community-acquired infections, causing disease in persons without known exposures to health care settings. Recent reports of community-acquired MRSA outbreaks suggest that these infections may be more common in children, American Indians, and Australian Aboriginal people. Although community-acquired infections appear to be more likely to involve skin and soft tissue and less likely to be associated with more severe disease compared to hospital-acquired infections, morbidity from community-acquired MRSA skin infections can be significant, and invasive infections (endocarditis and osteomyelitis) and deaths have been reported.

Outbreaks of boils have been reported by Alaska Native villages. An investigation of an out-

break in a rural village in 1996 showed that 25% of residents reported having at least one boil during a one-year period. The risk of developing a boil was greater in those who used steam baths. Among those who used steam baths, the risk of infection was lower for those who sat on a towel while steaming and for those who shared the steam with fewer than eight people. During the summer of 1999 a marked increase in boils was reported from 10 villages in the Yukon–Kuskokwim Delta of Alaska. The outbreak affected people of all age groups, and 85% of the cases were caused by MRSA. In this outbreak the risk of MRSA skin infection was greater for persons who steamed with a greater number of people. The risk of infection was also increased for persons who used antibiotics during the year prior to illness. MRSA was isolated from wooden surfaces within steam baths, and the risk of infection was greatest for persons using steams colonized with MRSA. AIP, together with the State of Alaska Division of Public Health and the Yukon–Kuskokwim Delta Native Health Corporation, is developing treatment guidelines for managing boils caused by MRSA and preventing future outbreaks. Areas of further research include ways to decrease antibiotic use and determining the most efficient and economical method of cleaning a steam bath.

Viral Hepatitis

Alaska Natives have high rates of chronic hepatitis B virus infection and associated hepatocellular carcinoma. However, during the 1980s hepatitis B vaccines were evaluated in rural Alaska Native villages, and a program to provide vaccine to all infants and all uninfected children and adults has virtually eliminated new cases of acute and chronic hepatitis B infection in Alaska. A program to screen carriers of hepatitis B virus to provide early detection of hepatocellular carcinoma has been ongoing since 1982. Earlier detection allows curative surgical removal of small tumors. This program has likely contributed to significantly prolonged five- and ten-year survival in persons with chronic hepatitis B and hepatocellular carcinoma since 1982, compared to carriers who developed cancer before this program.

Since the 1960s recurrent epidemics of hepatitis A have been documented in rural Alaska. Most communities within the state are involved in these epidemics, which occur roughly every seven to ten years and generally last three to five years. Hepatitis A vaccine has been highly effective in preventing cases of acute hepatitis during these epidemics, and preliminary data suggest that widespread use of hepatitis A vaccine may prevent epidemics.

In the U.S. Arctic, new cases of hepatitis C virus (HCV) infection occur primarily among urban residents. A survey of injecting-drug users in Anchorage found 81% to be infected with HCV, a prevalence similar to that found in the inner cities of major metropolitan areas in other parts of the U.S. The full public health impact of transfusion-associated HCV acquired before routine screening of blood products was initiated in 1992 is poorly defined because of the long interval between exposure and the onset of illness. The hidden nature of the HCV epidemic is reflected by the near doubling in the number of positive HCV tests reported in Alaska, from 570 in 1997 to 1004 in 1998, likely due to increased testing of persons at high risk of infection. Cirrhosis associated with HCV infection is now the most common reason for liver transplants among Alaska Natives. Over 1000 Alaska Natives with hepatitis C have been identified, and longitudinal studies in this population are underway. In addition, a program to identify transfusion recipients prior to 1992 and offer counseling and testing for hepatitis C is ongoing.

Vaccination against hepatitis A and B and screening and counseling of persons at risk for HCV infection are the cornerstones for prevention of viral hepatitis. Ongoing research by investigators at the Alaska Native Tribal Health Consortium and AIP is directed toward defining the duration of protection following vaccination against hepatitis A and B, determining the immunogenicity and optimal vaccination schedule for infant immunization against hepatitis A, designing efficient programs for identifying persons at risk for HCV infection, and determining the most cost-effective strategy for treating persons with symptomatic HCV infection.

Infections caused by Helicobacter pylori

Helicobacter pylori is a bacterium that infects the stomach of humans and can cause gastritis, gastric or duodenal ulcers, and certain types of gastric cancer. In developing countries the prevalence of infection is high: 85–95% of adults have serological evidence of infection. Although many persons are infected and infection persists for life if untreated, only a minority become ill because of *H. pylori*. Treatment of *H. pylori* infection, which is only recommended for those persons who have

symptoms, commonly consists of one to two weeks of at least two antimicrobial drugs (amoxicillin, clarthromycin, metronidazole, or tetracycline plus bismuth) and a proton pump inhibitor (omeprazole). Published cure rates from developed countries document between 85 and 95% eradication of the infection, with a re-infection rate of less than 1% following successful treatment.

The epidemiology of *H. pylori* in Alaska is similar to that reported from developing nations. *H. pylori* infection rates are high among Alaska Natives in rural villages. Among children aged zero to four years, 32% have serological evidence of a current or past infection. By age 20, 86% of persons tested from rural areas are seropositive. Moreover, preliminary data suggest that rates of recrudescence or re-infection are high in Alaska Natives who have been successfully treated. Of nine persons successfully treated in 1994, five (55%) had evidence of infection two years later. In 1995 AIP established the laboratory capability to culture *H. pylori* from biopsy material and determine the susceptibility of *H. pylori* to antibiotics. Of 466 isolates of *H. pylori* recovered from patients seeking care at the Alaska Native Medical Center between 1995 and 1998, 370 (79.3%) were resistant to metronidazole and 126 (23.3%) were resistant to clarithromycin. By comparison, in a large multi-center study performed in Europe during 1997-98, resistance ranged between 20 and 60% for metronidazole and between 0 and 22% for clarithromycin. The risk of infection with drug-resistant *H. pylori* in Alaska is greater for persons treated with macrolide antibiotics or metronidazole during the eight years before culture. Decreased susceptibility to clarithromycin and metronidazole may account for the high rates of initial treatment failure and apparent recurrence of infection among Alaska Natives.

To better understand factors contributing to treatment failure and infection recurrence, AIP and the Alaska Native Medical Center initiated a study to document treatment success in persons with confirmed, symptomatic *H. pylori* infection and to identify factors associated with the recurrence of *H. pylori* infection among patients who had been successfully treated. This multifaceted study will allow documentation of antibiotic resistance patterns and virulence factors of clinical isolates, evaluation of host and environmental risk factors associated with recurrence of infection, and evaluation of the sensitivity and specificity of available diagnostic tests.

International Circumpolar Surveillance of Infectious Diseases

Many of the infectious disease challenges for communities and public health authorities in the U.S. Arctic are also concerns for communities and public health authorities in other Arctic nations. International infectious disease surveillance networks are needed to monitor trends in disease and drug resistance across international boundaries in this day of international travel, to efficiently assess prevention and control measures, and to facilitate sharing of public health information among professionals working in other parts of the circumpolar region. To this end the CDC's Arctic Investigations Program proposed to the Arctic Council's Sustainable Development Working Group in 1998 that an International Circumpolar Surveillance network of clinical public health laboratories and authorities be established for monitoring infectious disease problems in Arctic nations. The network will allow the collection and sharing of uniform laboratory and epidemiologic information, which will define the prevalence of infectious diseases of concern and assist in formulating prevention and control strategies.

In 1999 a cooperative pilot system of international, population-based laboratory surveillance for invasive pneumococcal disease was established by the AIP and Health Canada's Bureau of Infectious Diseases. This surveillance system links clinical and reference public health laboratories throughout Alaska and northern Canada. In 2000 this surveillance was extended to include laboratories in Greenland, Iceland, Norway, and Finland and broadened to include the surveillance of invasive diseases caused by *Haemophilus influenzae*, *Neissera meningitidis*, and Groups A and B streptococcus.

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Alaska Native Traditional Food Monitoring Program

This report was prepared by James E. Berner and Katherine T. Taylor of the Alaska Native Tribal Health Consortium, Office of Community Health Services, Anchorage, Alaska.

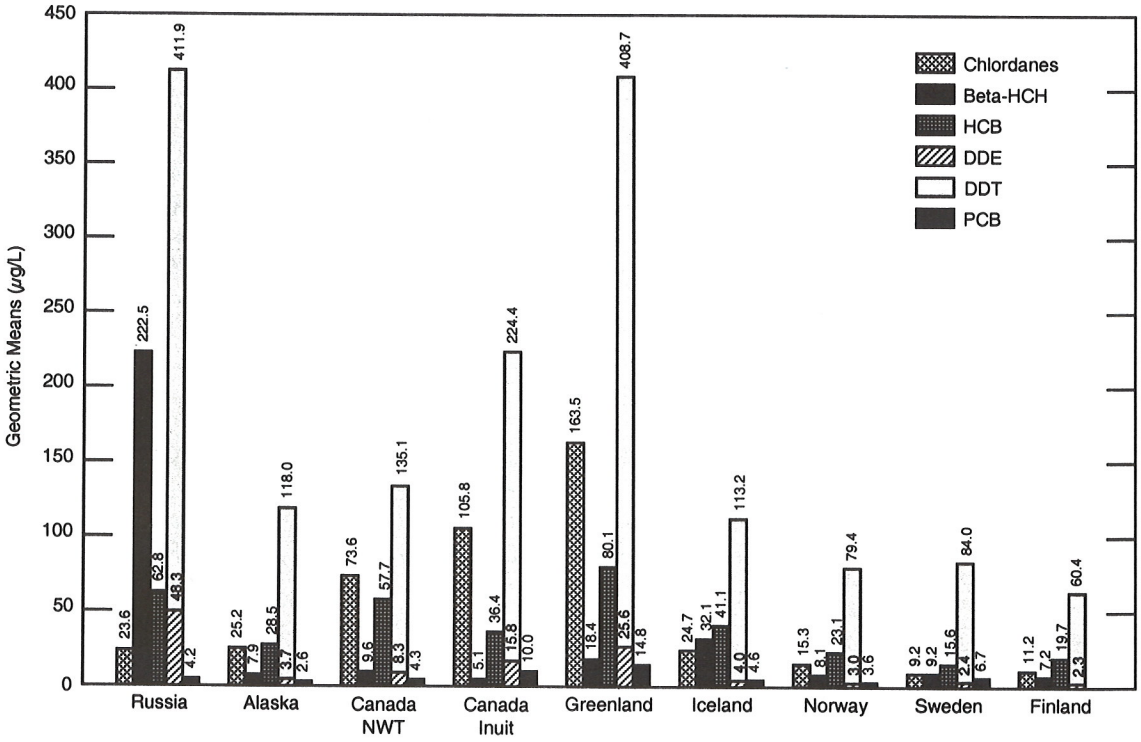
With the unexpected discovery of persistent organic compounds (POCs) of anthropogenic origin in human breast milk in Inuit women in Arctic Quebec in 1989, considerable effort has been made to investigate tissue levels, transport mechanisms, trends, and health effects in Arctic residents. The eight Arctic nations signed an agreement creating the Arctic Council (originally called the Arctic Environmental Protection Strategy) in 1991. Since that time the participating nations have cooperatively created five permanent programs within the Arctic Council, one of which, the Arctic Monitoring and Assessment Program (AMAP), has a permanent workgroup devoted to examining human health issues, the Human Health Expert Group (HHEG).

The initial five years of AMAP activities (Phase 1) documented and reported mechanisms by which POCs and heavy metals (HMs) are transported to the Arctic. There they are taken up by the biota, biomagnified through the food web into wildlife species utilized by Arctic residents as subsistence foods, and accumulated in humans.

U.S. participation in AMAP Phase 1 human tissue assessment began in 1998 with the collection of 25 maternal and umbilical cord blood specimens from Alaska Native residents of the North Slope region of Alaska. This was undertaken at the request of the Inupiat residents of the region, who were concerned with the safety of their traditional foods.

The Phase 1 AMAP Report's final recommendations on subsistence foods in the Arctic are as follows:

> "There is a need for improved information on spatial and temporal trends to clarify the adverse effects of POCs, methylmercury, and cadmium on human populations, especially on child development.
>
> "Weighing the well-known benefits of breast milk and traditional food against the suspected but not yet fully understood effects of contaminants, it is recommended that:
>
> - Consumption of traditional food continues, with recognition that there is a need for dietary advice to Arctic peoples so they can make informed choices concerning the foods they eat.
> - Breast feeding should continue to be promoted."



Levels of representative POCs in maternal blood samples of the Arctic countries for 1994–1997. For Alaska, Canada, and Greenland the specimens represent aboriginal residents of small remote communities who are highly dependent on subsistence foods. For Russia, Norway, and Finland the specimens are from non-aboriginal northern residents. For the remaining countries, they are samples of convenience, not selected for area of residence

The joint decision of the nations of the Arctic Council, after reviewing the report of the Phase 1 AMAP activities, was to charge the HHEG with the responsibility to establish a program for the second five years (Phase 2) that would begin to examine the health impact of the POCs and HMs, as well as the benefits of subsistence diets of Arctic residents.

The Phase 2 AMAP HHEG activities are summarized below:

"The objectives of the programme are:
- Analysis and quantification of the impact of environmental factors of human health.
- mental hazards including mixed exposures, cumulative and low dose effects."

"The outcome of the programme will be:
- Improved scientific and public knowledge on the links between exposure, health outcome and risk taking advantage of the cross-border environmental diversity of the Arctic.
- Identification of dose-response relationships between specific environmental exposures and health outcomes.
- Support to decision-making in environmental and health policies.
- Providing knowledge on links between diet and chronic diseases and disorders."

The Phase 2 AMAP activities began in 1998 and have a planned five-year activity cycle. With respect to human health, the activities will extend monitoring to areas of the Arctic not previously monitored and will begin to study the effects of POCs and HMs in humans. Alaska Native tribal health organizations have requested that a permanent monitoring program be established.

Monitoring Health and Diet among Alaska Natives

There are approximately 115,000 Alaska Natives (AN), of which some 65,000 live in small, isolated rural communities without road access and often only small-aircraft access much of the year. This makes the population dependent on traditional subsistence species to a degree not seen in any other U.S. population. Medical care for AN in rural Alaska is carried out by member organizations of the Alaska Native Tribal Health Consortium (ANTHC) under a compact agreement with the U.S. Indian Health Service (IHS) utilizing a uniform system of village-based primary care providers (the community health aide), a network of small tribally operated hospitals and clinics, and a referral center (the Alaska Native Medical Center in Anchorage). The system uses a shared medical record system. The isolated setting of Alaska's villages results in complete dependence on the facilities of the Alaska Native tribal health care system for any illness, as well as routine well-child care. This allows unusually complete ascertainment of health conditions, as well as of growth and development of children.

The difficulty of access to rural communities in Alaska results in high costs for any resident who has to replace the subsistence diet with imported market foods. In addition, all AN cultures include traditional food harvest, preparation, and communal consumption as critical cultural components. The loss of any traditional food, or the suggestion that it represents a health risk, creates a sense of loss of a magnitude that is difficult for an outsider to understand. The population health benefits of a northern subsistence diet, rich in micronutrients, has been amply documented, while the risks, except in very few circumstances, are primarily theoretical. However, continued release of POCs and HMs in various parts of the world warrants careful monitoring of the environment, plants, animals, and people.

The ANTHC developed a partnership with the Environmental Protection Agency's Office of International Activities, the Centers for Disease Control and Prevention's National Center for Environmental Health, the State of Alaska, the University of Alaska, and the Alaska Native Health Board to constitute the Alaska Native Traditional Foods Monitoring Program (ANTFMP) in 1999. The goal of the program is to ensure the continued safety of traditional foods. Its objectives are to:
- Monitor trends in the dietary intake of subsistence foods and trends in blood levels of micronutrients;
- Monitor trends in exposure to organic pollutants and heavy metals;
- Monitor trends in the health of pregnant women and their infants;

Analytes Measured in the Maternal and Infant Specimens.

	Women	*Newborns*
Whole blood	Lead, mercury, selenium, cadmium	Lead, mercury, selenium
Serum	IgE, PCBs, PCDD/Fs Chlordanes, DDT, Dieldrin Aldrin, Endrin, Mirex HCB Toxaphene, Heptachlor Omega-3 and omega-6 fatty acids	IgE, PCBs, PCDD/Fs Chlordanes, DDT, Dieldrin Aldrin, Endrin, Mirex HCB Toxaphene, Heptachlor Omega-3 and omega-6 fatty acids
Hair	Total/organic mercury exposure by month of pregnancy	
Urine	Urine radionuclides, phthalates	

- Examine data for associations between micronutrients and beneficial health outcomes and between contaminants and negative health outcomes; and
- Develop useful data for Alaska Native communities to develop strategies to ensure traditional food safety.

The ANTFMP analyzes blood, urine, and hair from AN pregnant women who ask to enroll in the program. Blood and urine are obtained at the first prenatal visit, hair is obtained at the six-week postpartum visit, and infant blood is obtained from the umbilical cord at delivery. Maternal health records are reviewed after the clinic visit six weeks after delivery, and infant health records are reviewed after the first year of life.

The results are shared with participants and their medical provider. A variety of outcomes are monitored, and results are examined for associations with levels of the analytes and micronutrients. Since there is no control group, the comparison will be between quartiles of POC exposure within the cohort. The data generated by the ANTFMP are regionally aggregated and presented to regional tribal health boards and other agencies.

Analyzing the Data

The unique status of Alaska Natives is apparent in several ways. First, they form over 90% of the residents of America's Arctic. Second, they depend on subsistence—culturally, economically, and nutritionally—to an extent not seen in any other American population. Third, for this population, exposure to known toxins occurs in a diet that has demonstrated health benefits for the populations consuming it.

Available data from Alaska fish and subsistence wildlife species show generally low levels of POCs and HMs. Tissue levels of POCs in AN mothers are also low, compared to maternal samples from other Arctic nations, as seen in the accompanying graph.

At exposure at parts-per-billion levels, it is generally felt that fetal development and tissue changes during pregnancy are the most likely to show possible effects. Commonly used infant outcome indicators in low-level fetal exposure studies are:

- Maternal complications during pregnancy, labor, delivery, and the postpartum period;
- Birth weight, gestational age, length, head circumference, and blood pressure;
- Infant growth and development;
- Infectious events in the first year of life; and
- Maternal and infant levels of micronutrients.

All of these indicators are problematic because they are influenced by a wide variety of confounding factors, such as maternal nutrition, prenatal use of alcohol and tobacco, prenatal infection, and socioeconomic factors.

In addition, exposure is to a mixture of compounds, so it is difficult to say that any outcome depends on a single compound and would occur in the absence of one or more of the other components.

Further complicating the analysis is the association of micronutrients in the subsistence diet with positive infant and maternal health outcomes. Population health benefits have been demonstrated from the traditional subsistence diet used by AN, as well as population benefits of breastfeeding for the infants of subsistence-dependent AN women. Exposure to POCs and HMs occurs via the subsistence diet, and while some studies of such exposure have shown subtle negative health effects, none have been shown for the levels so far seen in pregnant AN women.

As yet, no trend data exist for human tissue levels of POCs and HMs in the Arctic. However, POCs and HMs continue to be transported to the Arctic, so continued monitoring is essential.

Summary

The rural AN population of Alaska is the most subsistence-dependent population in the U.S. All AN cultures are linked to subsistence wildlife harvest, preparation, sharing, and consumption. So far, most wildlife and all human tissue studies on AN women and infants show low levels of POCs and HMs, not associated with known health effects. The Arctic subsistence diet is associated with positive population health effects, as is breastfeeding among AN women.

Continued monitoring of air, water, biota, and people in a coordinated way is essential because of the continued release and transport to the Arctic of POCs and HMs. A "community-owned" human tissue monitoring program, with appropriate state, Federal, and academic partners, is a mechanism to provide critical data to the AN residents and empower them to create strategies to reduce risk while maintaining the benefits, both cultural and health, of a traditional diet.

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Cancer in Alaska Natives

This report was prepared by Anne Lanier and Janet Kelly, Alaska Native Tribal Health Consortium, Office of Alaska Native Health Research.

Cancer was virtually unknown to Alaska Natives as recently as a generation or two ago, and there is no term for cancer among their various languages. Cancer is now the leading cause of death among Alaska Natives, and incidence and mortality rates exceed those of U.S. whites. Alaska Native people perceive that they are experiencing an epidemic of cancer. Data from the Alaska Native Tumor Registry allow us to analyze cancer patterns as they have changed over the past 30 years.

Cancer incidence rates for all Alaska Natives (AN)* were first reported in 1976. The most important findings were that, although the age-adjusted average annual incidence rates for cancer among Alaska Natives were somewhat lower than among U.S. whites, the difference was not significant. Furthermore, although the rates for all cancers combined were similar, there were marked differences for many cancer sites. Specifically, compared to rates for U.S. whites, AN rates were higher for cancers of the nasopharynx, stomach, liver, gall bladder, cervix, and kidney, but lower for leukemia, lymphoma, and cancers of the prostate, breast, uterus, bladder, and brain.

Since then, numerous reports have documented the unusual cancer patterns in this population. The complete report on the first twenty years of data from the Alaska Native Tumor Registry (ANTR) was published in the journal *Alaska Medicine* in 1994, and changes over time were published in the journal *Cancer* in 1998. Since then, the ANTR has provided annual updates on incident cancer cases for all Alaska Natives and by major service areas. The most recent update is *Cancer in Alaska Natives 1986-98*. Survival rates for cancer in this population are described in the *Alaska Native Cancer Survival Report*.

This report provides information on the current cancer rates and rank order based on data for 1994–1998 and trends over the thirty years from 1969 to 1998 for all cancers combined and by major site.

* The term Alaska Native is used to refer to the people who occupied what is now the state of Alaska prior to contact with Europeans. They include Eskimo, Aleut, and Indian. Within these three major groups there are many linguistic, cultural, and ethnic subgroups. The Eskimo or Inupiat (terms used in the U.S.) share a language similar to the Inuit of Canada and Greenland.

Data Sources

Incidence data are from the ANTR. This registry began in 1974 by identifying all Alaska Natives who were eligible for Indian Health Service medical care and who had been diagnosed with cancer while residents of Alaska during the years 1969–1973. Since then, data have been collected on all incident cases and are felt to be complete for the 30 years from 1969 to 1998. For the first 15 years, data were collected only on patient demographics, cancer site, and histology. Since 1984, additional data on cancer staging, treatment, and follow-up have been included in the registry. Items of data collected, coding, and classification of cancers have followed the methods of the National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) Program. In the year 2000, the Alaska Native Tumor Registry became an official SEER site, one of 16 population-based registries nationwide that follow specific standards and procedures for cancer registration, analysis, and reporting. Support for ANTR has been primarily from the National Cancer Institute.

Population statistics were obtained from census data. The AN population increased from 50,819 in 1970 to 85,698 in 1990. Linear interpolation was made for years between censuses. AN and U.S. rates were age-adjusted to the 1970 U.S. standard population (all races). Comparisons between AN and U.S. whites were made by calculating odds ratios (OR) and 95% confidence intervals (CI).

Results

Rank Order

Among Alaska Natives the leading cancers in both sexes combined in 1994–1998 were lung, colon/rectum, breast, prostate, and stomach. For males the leading cancers were also lung and colon/rectum, followed by prostate, stomach, and oral/pharynx. Among women, breast is the leading cancer, followed by colon/rectum, lung, kidney, and ovary.

Alaska is divided into eight major geographic regions for purposes of delivery of care to Alaska Natives. Because of the traditional geographic dis-

Rank Order of Top Ten Cancers among Alaska Natives, 1994–1998

	Males and Females Combined	
1	Lung	243
2	Colon/rectum	237
3	Breast	212
4	Prostate	66
5	Stomach	58
6	Oral/pharynx	53
7	Kidney	47
8	Pancreas	36
9	Lymphoma	30
10	Leukemia	26
	Males	
1	Lung	157
2	Colon/rectum	122
3	Prostate	66
4	Stomach	39
5	Oral/pharynx	35
6	Kidney	21
7	Pancreas	16
8	Leukemia	15
9	Esophagus	14
10	Lymphoma	13
	Females	
1	Breast	212
2	Colon/rectum	115
3	Lung	86
4	Kidney	26
5	Ovary	25
6	Pancreas	20
7	Stomach	19
8	Oral/pharynx	18
9	Lymphoma	17
10	Corpus uteri/uterus, NOS	15

tribution of ethnic groups of AN people, most of these service areas provide health care to predominantly one ethnic group. The data for the years 1984–1998 show that the leading causes of cancer in each service area are similar to those for all Alaska Natives statewide. Lung, colon/rectum, and breast cancer are the three most frequently diagnosed cancers in all service regions but one. (The exception is Mt. Edgecumbe/Annette Island, where the number of prostate cancers slightly exceeded lung cancers.) Although the three leading cancers are the same in each service area, the rank order may differ. Among the cancers that ranked fourth and fifth, there was considerable variation by service area. The fourth and fifth most common cancers included prostate, oral/pharynx, stomach, kidney, and lymphoma.

The leading invasive cancers were ranked by sex for each ten-year age group (these data are not shown here). The most frequently diagnosed cancer sites varied markedly by both sex and age group. Lung cancer ranked first among men 40 years old and older, while breast cancer was first in women from ages 30 through 69. Colon/rectum cancer ranked among the top three in men and women 30 years old and older. Among Alaska Natives age 20–29, cervix is the leading cancer in women, and testicular cancer in men. Leukemia and liver cancer rank highest among men and women under age 20.

Alaska Native Rates Compared to U.S. Whites

The age-adjusted cancer incidence rates for the years 1994–1998 for AN for all sites exceeded those of U.S. whites (OR = 1.1). This is because of the high rate in females (OR = 1.2); the rate for AN men was somewhat lower than for U.S. whites (OR = 0.9; data by gender not shown).

Although the rates for all cancers combined were 10% higher than for U.S. whites, the rates for maome were higher, others lower. The rates for the most frequently diagnosed cancers in Alaska Natives were similar to those in U.S. whites, specifically lung, colon/rectum, breast, and prostate cancers, which account for over half of all newly diagnosed invasive cancers. However, the rates were significantly higher for AN males and females combined for cancers of the oral cavity (particularly salivary glands and nasopharynx) and all organ sites in the digestive tract, lung, and kidney. On the other hand, rates for AN for males and females combined were relatively low for cancers of the larynx, corpus uterus, prostate, urinary bladder, and brain and nervous system; melanoma and other skin; lymphomas (both Hodgkin's and non-Hodgkin's); and leukemia. Of note, cancer of the breast occurred as frequently among AN as among U.S. whites, a change from the first five years of the registry, when breast cancer occurred roughly half as often as in U.S. whites. On the other hand, cancer of the cervix, for which the rates in the early years of the registry were consistently several times higher for AN than for U.S. whites, occurred at a rate similar to U.S. whites in 1994–1998. The rate for cancer of the ovary among AN women did not differ from that of U.S. whites, a finding that has been consistent over the thirty years of the registry.

Changes over Time

Changes in rates over time were analyzed by comparing rates for each of six five-year time

Average Annual Age-Adjusted* Cancer Incidence Rates for Alaska Native and U.S. White Populations, 1994–1998 (Males and Females Combined).

Site	Number of AN cases	Rate per 100,000 AN	Rate per 100,000 U.S. white	Odds ratio	Confidence interval Lower	Confidence interval Upper
All sites	1252	425.0	395.4	1.1	1.0	1.1
Oral cavity and pharynx	53	17.3	9.5	1.9**	1.4	2.4
Salivary glands	6	1.5	1.0	1.8	0.8	4.0
Nasopharynx	21	7.4	0.4	16.4**	10.6	25.4
Gum and other mouth	6	1.9	1.6	1.2	0.6	2.8
Digestive	400	141.6	69.6	2.1**	1.9	2.3
Esophagus	23	8.9	3.5	2.4**	1.6	3.7
Stomach	58	17.9	6.1	3.4**	2.6	4.4
Colon and rectum	237	86.4	42.3	2.1**	1.8	2.3
Colon	165	61.6	30.2	2.0**	1.7	2.4
Rectosigmoid junction	17	6.0	4.1	1.5	0.9	2.4
Rectum	55	18.8	8.0	2.5**	1.9	3.2
Liver	22	6.7	2.9	2.6**	1.7	4.0
Gall bladder	7	2.7	0.9	2.8**	1.3	5.8
Other biliary	8	2.8	1.1	2.6**	1.3	5.3
Pancreas	36	13.2	8.5	1.6**	1.1	2.2
Respiratory	257	94.7	59.1	1.6**	1.4	1.8
Larynx	5	1.9	3.6	0.5	0.2	1.2
Lung and bronchus	243	90.0	53.9	1.7**	1.5	1.9
Bones and joints	3	0.8	0.9	0.7	0.2	2.2
Soft tissue	5	1.3	2.5	0.5	0.2	1.2
Skin	11	3.3	18.3	0.2**	0.1	0.3
Skin melanoma	6	1.4	15.3	0.1**	0.0	0.2
Other skin (non-epithelial)	5	1.9	3.0	0.4**	0.2	0.9
Breast	212	66.6	62.8	1.1	1.0	1.3
Female genital	55	16.5	25.9	0.7**	0.5	0.9
Cervix	11	2.5	4.0	0.6	0.4	1.2
Corpus uteri/uterus, NOS	15	4.8	12.2	0.4**	0.3	0.7
Ovary	25	7.9	8.1	0.9	0.6	1.4
Male genital	77	28.9	62.1	0.5**	0.4	0.6
Prostate	66	26.5	59.1	0.4**	0.3	0.6
Testis	9	1.7	2.7	0.6	0.3	1.1
Urinary	58	20.5	27.6	0.8	0.6	1.0
Urinary bladder	10	3.4	17.6	0.2**	0.1	0.4
Kidney and renal pelvis	47	16.7	9.3	1.7**	1.3	2.3
Eye and orbit	1	0.1	0.8	0.3	0.0	2.4
Brain and nervous system	10	2.0	6.3	0.4**	0.2	0.8
Endocrine	19	5.0	6.2	0.7	0.4	1.1
Thyroid	17	4.5	5.6	0.7	0.4	1.1
Lymphomas	30	8.7	19.3	0.5**	0.3	0.6
Hodgkin's disease	3	0.8	2.8	0.2**	0.1	0.7
Non-Hodgkin's lymphoma	27	8.0	16.5	0.5**	0.4	0.7
Multiple myeloma	6	2.1	4.1	0.5	0.2	1.2
Leukemia	26	5.8	10.8	0.7	0.5	1.0
Ill defined and unspecified	29	9.7	9.5	1.1	0.8	1.6

* All rates age-adjusted to 1970 U.S. standard population.
† U.S. data from SEER Cancer Incidence Public-Use Database, 1990-1998, Aug. 2000 submission, National Cancer Institute.
** 95% confidence intervals for odds ratios do not include 1.

periods from 1969 to 1998 for all cancers combined and for each major cancer site.

For invasive cancers of all sites and both sexes combined, age-adjusted incidence rates increased about 50% (305 to 420 per 100,000) over the thirty years, a significant increase. Significant increases also occurred in cancer of the lung: rates increased at least two-fold and four-fold in males and females, respectively. Breast cancer increased significantly in women (more than three-fold), while prostate cancer increased in men (nearly two-fold). Colorectal cancer increased, with the largest increases in cancer of the colon in men.

The only significant decline over time was for

Average Annual Age-Adjusted Cancer Incidence Rates per 100,000 for Alaska Natives, 1969–1998, by Five-Year Periods (Males and Females Combined).

Site	*1969–1973*	*1974–1978*	*1979–1983*	*1984–1988*	*1989–1993*	*1994–1998*
All sites	305.1	313.3	341.2	376.5	390.6	419.7*
Oral cavity and pharynx	16.4	18.5	12.7	16.2	18.0	17.1
Salivary gland	3.8	1.5	1.0	1.5	1.5	1.5
Nasopharynx	7.7	13.4	6.9	7.7	9.0	7.2
Gum and other oral cavity	1.5	1.0	3.1	1.7	1.4	1.9
Digestive	128.3	110.5	119.8	128.6	124.5	139.5
Esophagus	7.4	5.9	7.1	6.3	5.9	8.8
Stomach	15.6	13.7	17.5	16.9	18.7	17.7
Colon and rectum	66.2	63.0	63.5	75.4	76.2	85.0
Colon	43.8	45.6	49.5	58.6	61.6	60.5*
Rectosigmoid junction	5.7	5.6	4.8	5.0	4.0	5.9
Rectum	16.7	11.8	9.2	11.9	10.6	18.6
Liver	6.0	6.7	6.6	6.4	4.6	6.8
Gall bladder	12.2	9.5	7.6	4.9	3.3	2.6*
Other biliary	4.0	0.6	0.0	3.9	3.5	2.8
Pancreas	10.6	9.4	10.2	11.9	10.1	13.0
Respiratory	34.3	50.3	58.5	88.0	77.6	93.3*
Larynx	0.0	0.5	2.9	1.9	2.5	1.9
Lung and bronchus	32.9	48.7	54.8	84.6	74.2	88.6*
Bones and joints	3.1	1.4	0.5	2.6	1.4	0.8
Soft tissue	3.5	2.5	1.1	1.9	0.8	1.3
Skin	0.5	1.2	0.9	1.9	3.4	3.2
Skin melanoma	0.5	1.2	0.9	1.0	1.2	1.4
Other skin (non-epithelial)	0.0	0.0	0.0	0.9	2.2	1.8
Breast	16.5	22.5	25.7	37.7	46.5	65.8*
Female genital	13.6	22.5	25.1	17.9	24.3	16.5
Cervix	5.6	15.4	16.4	8.5	7.8	2.5
Corpus uteri/uterus, NOS	1.7	1.3	1.9	2.9	5.3	4.8
Ovary	5.1	4.8	5.7	5.5	8.7	7.9
Male genital	18.9	16.6	25.0	18.6	36.9	28.7*
Prostate	15.2	13.0	22.9	16.0	33.5	26.3*
Testis	1.6	2.9	1.9	1.9	2.1	1.7
Urinary	19.4	18.0	18.0	26.4	20.5	20.2
Urinary bladder	6.7	5.5	7.3	5.2	2.6	3.4
Kidney and renal pelvis	12.7	11.6	10.2	21.2	17.0	16.4
Eye and orbit	0.2	0.0	1.2	0.2	0.3	0.1
Brain and nervous system	2.4	2.8	1.8	2.3	1.5	2.1
Endocrine	4.0	5.7	5.4	5.5	3.7	5.0
Thyroid	4.0	5.1	4.4	4.8	3.7	4.5
Lymphomas	5.7	4.2	12.6	7.6	7.9	8.6
Hodgkin's disease	0.0	0.3	1.6	0.9	1.0	0.7
Non-Hodgkin's lymphoma	5.7	4.0	10.9	6.7	7.0	7.9
Multiple myeloma	3.9	3.0	3.6	2.9	3.4	2.0
Leukemia	7.0	3.1	2.9	4.3	5.2	5.7
Ill defined and unspecified	27.5	30.6	26.2	14.0	14.7	9.6*

* Test for trend is significant.

gall bladder cancer, primarily among women. Cancer of the cervix showed an interesting pattern over the three decades. It increased several-fold from 1969 to 1983 and then declined. Based on the most recent five-year data, rates for cancer of the cervix are lower than rates for 1974-1983. Importantly, the current rate for invasive cervical cancer is similar to that for U.S. whites; this is the first time that the rate for Alaska Natives has not exceeded that for U.S. whites.

Discussion

Mortality data over many years have documented numerous health disparities among the Alaska Native population. Incidence data are often

lacking on special racial and ethnic groups. The Alaska Native Tumor Registry is a unique source of accurate incidence data on a special population with unique patterns of cancer and needs for culturally appropriate education, primary and secondary prevention, treatment, and research.

Lung Cancer

Lung cancer occurs most frequently and has increased most rapidly because of the high rate of tobacco use in the past few decades. Tobacco was introduced by European contact; Alaska Native cultures neither grew nor used tobacco in traditional ceremonies. The current use of cigarettes and spit tobacco among Alaska Natives far exceeds rates of use among any other U.S. racial/ethnic group, and the prevalence of adult Alaska Native smokers is now nearly twice the national average. The increase in lung cancer in this population paralleled increased availability of cigarettes. High prevalence rates and subsequent increases in lung cancer are shared by other circumpolar populations. Lung cancer is almost entirely preventable.

Breast Cancer

Alaska Native concerns about major environmental changes in and around their communities, identification of numerous contaminated sites near their homes or hunting grounds, and knowledge that their subsistence foods (fish, sea mammals, etc.) may contain persistent organic pollutants (POPs) are responsible for studies in progress examining the relationship of exposure to POPs to the development of breast cancer and other health disparities.

Gall Bladder and Cervical Cancer

Over the thirty-year period of the ANTR, there is evidence that cancer rates have decreased for only two sites: gall bladder and cervix. The reason for the decline in gall bladder cancer is not known. However, the decline in cervical cancer is presumably a result of extensive focus on Pap smear testing. For years the Indian Health Service has recommended annual Pap tests for women and provided a special training program for nurse practitioners in colposcopy to provide timely follow-up for women with abnormal Pap tests. Opportunities for Indian Health Service and tribal groups to receive money from the CDC Breast and Cervical Cancer Early Detection Program has greatly increased routine screening for these two cancers. Similar programs are needed to enhance screening for colorectal cancer.

Oral Cancer

The largest difference in cancer rates between Alaska Native and U.S. whites is for nasopharyngeal cancer. Research has been conducted in Alaska on nasopharyngeal, salivary gland, and liver cancers. The nasopharyngeal cancer that occurs among Alaska Natives is an undifferentiated carcinoma, also known to occur at particularly high rates in southern China and parts of Asia. The prevalence of salivary gland cancer is due to a unique type (malignant lymphoepithelial lesion) that appears to be more common primarily among Eskimo and Inuit of Alaska, Greenland, and Canada. Both of these cancers are strongly associated with Epstein Barr virus (EBV) in Alaska and worldwide. However, infection with EBV is common worldwide, and other factors yet to be identified contribute to the high risk of nasopharyngeal cancer among Alaska Natives.

Liver Cancer

Primary hepatocellular carcinoma (HCC) is more common among Alaska Natives than among U.S. whites. It occurs predominantly in males and especially in young people. There is familial aggregation among patients with this disease. It is now known that the high rate of HCC among Alaska Natives has been due mainly to infection of children at an early age, resulting in a large number of hepatitis B surface antigen carriers. HbsAg carriers are nearly 100 times more likely to develop HCC than non-carriers. A screening program testing Alaska Native HbsAg carriers for the tumor marker alpha-fetoprotein (AFP) has resulted in early detection of liver cancers at a resectable and curable stage.

In 1982 a hepatitis B vaccination demonstration project in Alaska was found to effectively prevent infection with HBV. This was the first use of this vaccine in the U.S. following licensure. In 1985 a statewide HBV program was begun to vaccinate Alaska Natives of all ages who had not already been infected with HBV, to routinely immunize babies at birth and one and six months of age, and to administer hepatitis B hyperimmune gamma globulin (HBIG) to carrier mothers at the time of delivery. This program has almost entirely eliminated the new infections of HBV and consequently the development of new HbsAg carriers. The population of AN born since the mid-1980s is no longer at increased risk for liver cancer due to HBV. Unfortunately, hepatitis C is now responsible for more recently diagnosed patients with liver cancer.

Conclusion

Cancer is now the leading cause of death among Alaska Natives, and incidence and mortality rates exceed those of U.S. whites. Of the four leading cancers, lung cancer is nearly entirely preventable by eradication of tobacco use. Cancers of the breast, colon/rectum, and prostate may still occur, but it should be possible to detect them at an early, curable stage. Therefore, a comprehensive cancer control program that includes primary and secondary prevention should be able to markedly reduce the prevalence of this disease. Studies of cancer etiology, prevention, and control should be a priority for the Arctic Research program.

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Report of the Interagency Working Group on Arctic Health Research

This report was prepared by the Interagency Arctic Research Policy Committee's Working Group on Arctic Health Research. It has been submitted to the full Interagency Arctic Research Policy Committee.

Arctic health research encompasses two major subdivisions: environmental health and public health. The former includes the topics of environmental contaminants, the effects of climate change (Arctic Climate Impact Assessment), and radioactive nuclides. The latter includes infectious diseases, occupational injuries, chronic diseases, behavior, delivery of health care, capacity building, and the elimination of health disparities between the Alaska Native and non-Native populations.

Environmental Health

The occurrence of artificial radionuclides and pesticides in the environment and biota has been documented for over 30 years and has since remained a matter of scientific and public concern. This concern was heightened considerably in 1990s, first by an increased awareness of the unexpectedly high levels of contamination in the Arctic that led to the adoption of the Arctic Environmental Protection Strategy in 1991 by the eight Arctic countries, including the U.S. Soon thereafter, in 1992, there was a major disclosure of widespread dumping of nuclear reactors and wastes into the Arctic and northwest Pacific Ocean by the former Soviet Union. Later in the same year, it was reported that 15,000 pounds of soil contaminated with radioactive material, including fallout material collected from an atom bomb test in Nevada, was buried 30 years ago near Cape Thompson, Alaska.

Sievert (Sv) is a measure of absorbed radiation dose per unit mass, often expressed as millisievert (mSv). A 1-mSv yearly dose is often equated to an increased risk of cancer in one person out of 20,000, and a dose of 0.01 mSv is generally considered negligible in terms of potential risk to individuals

In recent years it has become increasingly clear that many contaminants found in the Arctic, particularly certain pesticides and industrial chemicals, originate in areas far removed from the Arctic but that those chemicals tend to persist and accumulate in the Arctic environment and food chains, including human residents. Because of their reliance on local fauna for subsistence and preserving their cultural heritage, Alaska Natives have become increasingly apprehensive about the quality of their traditional food resources and the health of Arctic ecosystems. The paucity of scientific data on the nature and severity of environmental contamination on human health and renewable biological resources has prompted the Interagency Arctic Research Policy Committee (IARPC) to begin planning for a focused, interagency research program emphasizing health concerns in the U.S. Arctic, including its environmental aspects.

Radionuclides in the Environment and Subsistence Foods

Global fallout from atmospheric testing of thermonuclear devices is the principal environmental source of artificial radionuclides in the U.S. Arctic. Even though the ground deposition of fallout radionuclides is quite pervasive, its distribution is greatly influenced by patterns of mean annual precipitation. Thus, portions of southeastern Alaska (which is not part of the U.S. Arctic) are estimated to have orders-of-magnitude higher activity of the radionuclide cesium-137 than, for example, the North Slope of Alaska. However, proportionately high consumption of caribou, freshwater fish, berries, bowhead whales, and other subsistence foods in the U.S. Arctic is often considered an important means of radionuclide exposure to humans.

The National Oceanic and Atmospheric Administration (NOAA) in collaboration with the Los Alamos National Laboratory (LANL) have measured activities of anthropogenic and naturally occurring radionuclides in coastal sediments and a number of faunal species that are used for subsistence in the U.S. Arctic. The study, supported in part by the Office of Naval Research (ONR), showed that typical yearly consumption of caribou meat by an adult resident of Barrow added a very small amount (0.0045 mSv) to the average effective dose equivalent of ionizing radiation. This value should be viewed in relation to the average radiation dose to humans from natural sources (3.0 mSv), such as exposure to radon and cosmic radiation, and other anthropogenic sources (0.6 mSv), such as consumer goods, medical x-rays, and air travel. Subsistence foods derived from marine food chains accounted for a much smaller, and perhaps negligible, dose.

It is generally concluded that human health and ecological risks from projected releases from nuclear waste dump sites in the Arctic are likely to be inconsequential. However, a summary of ONR-funded studies has noted the need to consider other known sources and potential transport pathways for radionuclides in the Arctic. For example, major Siberian rivers may potentially contribute significant amounts of radionuclides from nuclear power plants and weapons factories in Russia, amounts that could pose as much or greater risks than the materials dumped directly into the Arctic Ocean.

Contaminants in Species of Subsistence, Commercial, and Aesthetic Value

The presence of persistent organic contaminants in Arctic wildlife has been documented for more than 30 years. For example, specimens of gyrfalcons collected from the Seward Peninsula in 1970 had highly variable levels of DDE (a metabolite of DDT that is most often related to adverse biological effects in the field) and PCBs in their tissues, but in some cases the levels exceeded 200 ppm. The peregrine falcon in the Amchitka region was considered a highly vulnerable species as early as 1970, when DDE residue in members of that population were associated with thinning of eggshells. Since then, relatively high levels of these and other contaminants, such as hexachlorocyclohexane (HCH), have been reported in liver and fatty tissues of many species of fish and wildlife, including marine mammals. Some marine mammals, such as the Pacific walrus, have relatively high concentrations of potentially toxic metals in their tissues.

Both NOAA and the U.S. Fish and Wildlife Service (FWS) have ongoing programs to determine the contaminant levels and their biological effects in protected and threatened species under the Marine Mammals Protection Act and the Endangered Species Act. Nearly all marine mammal tissue collected for contaminant analyses in these programs were from animals harvested by Alaska Natives, often in consultation with statewide Native organizations and cooperatives, such as the Alaska Eskimo Walrus Commission. This results in a broad geographic distribution of samples and cooperative efforts with subsistence hunters. Examples of contaminant-related studies on selected Arctic faunal species are noted below.

The polar bear biomonitoring program of the FWS was initiated in 1995 to determine if contaminant levels in polar bears from the two Alaskan population stocks were of concern. The Chukchi/Bering Seas and southern Beaufort Sea population stocks in Alaska are shared with Russia and Canada, respectively. Levels of PCBs in adult male polar bears from Alaska analyzed to date are relatively low compared to the high levels found in polar bears in eastern Hudson Bay, Canada, and Norway. Average levels of HCH in Alaskan bears are among the highest reported in the Arctic. Little is known, however, about the potential impacts that these relatively high HCH levels may have on the health of polar bears, human consumers, and the Arctic ecosystem. To date, samples have been obtained from approximately 28 bears. Sampling for this project will continue through FY 02, when a final report will be prepared. Polar bears have been identified as a sentinel species under the Arctic Monitoring and Assessment Program (AMAP) for monitoring environmental contamination in the Arctic ecosystem because of their wide distribution, position at the top of the Arctic marine food chain, and value to Native subsistence users.

Tissue samples have also been collected for long-term storage by the Alaskan Marine Mammal Tissue Archival Project (AMMTAP) for use in future analyses as analytical techniques improve and for assisting in the development of spatial and temporal trends of contaminant levels in the Arctic. AMMTAP is a cooperative interagency program supported by the U.S. Geological Survey (USGS), NOAA, and the National Institute of Standards and Technology (NIST). Standardization of quality assurance and quality control procedures will help reduce past limitations that have hindered making meaningful comparisons among various data sets. The contaminant data collected from the polar bear biomonitoring program have been used for inter-laboratory comparisons, as well as for physiological studies on contaminant accumulation and effects on polar bears.

The FWS studies of organochlorine pesticides and industrial chemicals, hydrocarbons, and heavy metals in walrus tissues over the past two decades have shown only extremely low levels of organic contaminants in walrus blubber collected from coastal and offshore sites in the Bering Sea. However, these studies have documented high levels of cadmium in the kidney and liver tissues of walrus in the Bering and Chukchi Seas. In several instances, cadmium concentrations in kidney tissues were higher than the level thought to interfere with organ function in some mammals. A positive correlation between cadmium and age was found in both liver and kidney. Similar relationships

were found between age and concentrations of zinc (kidney) and arsenic (liver and kidney). Histopathological examination of samples from 170 animals collected from Gambell and Diomede indicated that the metals present in the kidneys and livers did not appear to cause injury to the tissues. Data on heavy metal contamination in the walrus tissues are being synthesized for publication. Although data are few and from disparate sources, high levels of cadmium in bowhead whale kidney tissues have also been reported.

Concentrations of persistent organic pollutants (POPs) in blubber, and heavy metals in liver and kidney, have been determined for two stocks of Alaskan Arctic beluga whales (Beaufort Sea and Eastern Chukchi Sea stocks) from the Bering Sea population and for beluga whales from the sub-Arctic Cook Inlet population. Generally the Cook Inlet animals appear to be substantially different from the two Alaskan Arctic stocks, having lower concentrations of POPs and metals (except for copper). The two Alaskan Arctic stocks have concentrations of POPs that are similar to levels reported for beluga populations across the North American Arctic; however, certain metal concentrations are substantially different. Hepatic total mercury concentrations are higher and cadmium concentrations are lower in these Alaskan belugas than have been reported for belugas farther east in the Canadian Arctic.

In recent years, FWS has made organochlorine and heavy metals measurements in livers and kidneys from 66 sea otters that were collected in coastal waters throughout Alaska. Preliminary results have identified several otters with low levels of PCBs, beta-BHC, pp-DDE, and dieldrin. Given a rather sparse sampling coverage, the source of these contaminants is unclear, and the physiological effects of contaminants on sea otters can only be speculated.

Mercury is a naturally occurring element that is present in rocks and ores. It is also released into the atmosphere by degassing of the earth's crust and oceans in large amounts; an approximately equal amount is released by way of human activities, such as burning of household and industrial wastes and waste discharge from certain industries. Its presence in food chains, particularly large predators such as sharks, swordfish, and large species of tuna, has been well documented. In recent years, the presence of mercury in coastal and freshwater fish has become a matter of great concern, prompting many states to issue fish consumption advisories. Although extensive data are available on mercury concentration in fish tissues in the Arctic, data from the U.S. Arctic are scant. Few data have recently been obtained on total mercury and methylmercury in the muscle and liver tissues and eggs of Pacific salmon species from the Yukon, Kuskokwim, Nugashak, and Kvichak Rivers. The higher concentration of mercury in chinook salmon could be because of its longer life span in ocean waters and its higher trophic level. Analysis of these data continues. It is not clear whether mercury in natal streams and lakes is further recycled by freshwater fauna or whether there is further bioaccumulation through freshwater and terrestrial food chains.

Comparisons of hepatic total mercury concentrations in beluga whales across the North American Arctic indicate that the highest concentrations may be found in the Beaufort Sea and Chukchi Sea stocks of the Alaska Bering Sea population (averaging around 50 mg/kg ww); these levels are within the range reported for the St. Lawrence Estuary population. Although levels of total mercury in the Cook Inlet animals have been found to be much lower (averaging 5 mg/kg ww) than concentrations in the other Alaskan belugas, the hepatic concentrations of methyl mercury are similar among all three Alaskan groups (0.3–2 mg/kg ww).

FWS has determined concentrations of organochlorine pesticides, including toxaphene, in burbot collected from three National Wildlife Refuges in interior Alaska and the Tanana River near Fairbanks, Alaska. In general, there were greater contaminant concentrations from sites below Fairbanks and within the Yukon Flats Refuge than at Tetlin and Kanuti refuges. There were greater concentrations of DDT and its metabolites at Fairbanks, probably reflecting the historical use of that pesticide within the city of Fairbanks and at nearby military bases. Concentrations of DDT and metabolites from Fairbanks were up to two orders of magnitude greater than in burbot from five studies in Canada. The range of PCB concentrations were similar to those from four of six Canadian studies and were generally less than laboratory-derived effects values. Toxaphene concentrations were generally low. Because this was an initial assessment and sample sizes were low, further studies would illuminate whether the concentrations found at Fairbanks and Yukon Flats are of concern to fish and wildlife resources. This report will be finalized in FY 01.

Personnel from the Alaska Maritime NWR collected bald eagle carcasses from Adak Island

between 1994 and 1998. Tissues were collected for contaminants analysis, and data from the 1994–1996 samples were reported in a technical report entitled "Contaminant residues in bald eagles (*Heliaeetus leucocephalus*) from Adak Island, Alaska" (WAES-TR-97-02). Additional funding in FY 99 allowed for analysis of the remaining samples collected after 1996. Data from all birds have been combined, compared, and drafted into a manuscript, which will be submitted to a peer-reviewed scientific journal in FY 01.

The number of red-throated loons breeding in Alaska declined 53% from 1977 to 1993. Aerial population surveys in Alaska have produced rigorous trend data for red-throated loons, but despite this, only fragmentary knowledge exists about the natural history of this species. In 1998, FWS identified red-throated loons as a "species at risk" in Alaska and identified four specific data needs: demographic parameters, distribution among wintering areas and links to breeding areas, subsistence bycatch in fishing nets, and exposure to contaminants. This work will continue during FY 01.

The Agency for Toxic Substances and Disease Registry (ATSDR) has initiated the Alaska Native Subsistence and Dietary Contaminants Program to study contaminants in the environment, subsistence resources, and people in Alaska Native populations. Working with other Federal, tribal, state, and local governments, ATSDR will focus on research and public health activities necessary to empower Alaska subsistence diet users to make informed dietary decisions while incorporating traditional and western scientific information. The primary goals and activities for this program are to:

- Identify Alaska Native traditional subsistence diets and characterize human exposure to dietary contaminants;
- Characterize and analyze human health risks and nutritional benefits of the Alaska Native subsistence lifestyle;
- Evaluate human health effects in the Alaska Native population that may be associated with contaminants found to be part of the subsistence lifestyle;
- In partnership with the affected Alaska Native communities, provide communication and education to assist in culturally appropriate decisions on risks and benefits of the diet; and
- Develop and implement interventions that are culturally appropriate and based on the defined needs of the Alaska Native population.

Ecosystems at Risk

The U.S. Arctic ecosystems are quite varied in their complexity and biological productivity. In the marine environment, they include some the world's most productive, for example, the southeastern Bering Sea and Chirikov Basin ecosystems, which support important commercial fisheries and an extraordinary feeding habitat for wildlife. In contrast, oceanic waters of the Canadian Basin have low biological productivity, although they may contain faunal assemblages that are unique, consisting of species of both the Atlantic and Pacific Oceans, or species that have survived through the ages (certain sponges and bryozoans). On land the U.S. Arctic is dominated by wet and alpine tundra, both of which are critical to thousands of migratory birds, caribou, and other species. The spruce–poplar forests are extensive and highly productive, but they occupy a relatively small portion of the U.S. Arctic lands.

Irrespective of their location, all Arctic ecosystems are highly cyclic (because of large seasonal changes in light levels, nutrient input, and temperature) and have low species diversity. On an annual or decadal cycle, they are also affected by weather and climatic changes, such as those caused by the presence, intensity, and movement of the Aleutian Low Pressure System in the northern North Pacific Ocean. In the marine environment, the location of the ice edge, as well as continental shelf-slope exchange of materials, is also critically important to both the onset and sustenance of primary productivity and ultimately to food chains culminating in fish and wildlife species, many of which have considerable commercial, subsistence, and aesthetic value.

The structure and dynamics of the U.S. Arctic ecosystems have been studied for nearly 30 years with primary funding support from a number of Federal agencies, such as DOD/ONR, NSF, DOC/NOAA, DOI/MMS and others. Programs such as the Outer Continental Shelf Environmental Assessment Program, 1975–1992, provided a strong foundation for multidisciplinary scientific studies of coastal and continental shelf waters around Alaska. Many concurrent and follow-up studies, such as PROBES, ISHTAR, and SHEBA funded by the National Science Foundation and the Fisheries-Oceanography Cooperative Investigations (FOCI) funded by NOAA, have greatly advanced the scientific database and understanding of Arctic ecosystems. New studies and programs, as well as budget initiatives, will continue to shed new light on ecosystem dynamics, particu-

larly in relation to climatic changes, shelf-slope exchange of energy and materials, and factors controlling the deposition and environmental fate of contaminants.

Both NOAA and the Minerals Management Service (MMS), U.S. Department of the Interior, are continuing congressionally mandated studies of the Arctic environment and resources, notably those relating to fisheries and wildlife. In the case of MMS, the primary purpose is assessment of impacts from oil and gas activities along the North Slope of Alaska. The USGS will be conducting studies over the next five years (2001–2005) to examine the impacts of climatic change and atmospheric transport of contaminants in the Yukon River basin. The studies will be designed to characterize water quality parameters, identify contaminant sources, and assess the effects of contaminants on regional biota and ecosystems.

There are sixteen National Wildlife Refuges in Alaska, encompassing approximately 92,000,000 acres. Lands within the National Wildlife Refuge system in Alaska have had a varied and interesting history. While large tracts remain in near-pristine condition, past uses of refuge lands have also included oil exploration and drilling, mining, establishment of runways and support facilities for aircraft, and use by the military for various operations including military installations, staging areas, supply depots, training grounds, and historic battlefields. After these operations ceased, sites were often abandoned. At other sites, hazardous materials were spilled with no subsequent cleanup. The total number of formerly used defense sites (FUDS) in Alaska is 648. Most of them have undergone preliminary assessment for the nature of contamination and clean-up needs. A number of sites are currently scheduled for remediation by the U.S. Army Corps of Engineers, the Department of the Navy, or the Department of the Air Force. The FWS has also conducted numerous studies on contamination in refuges within the Arctic, establishing baseline conditions or investigating impacts on trust species. These investigations are needed to determine significant changes through time; the need will continue as new issues are identified.

EPA has been evaluating the Polar Sunrise Effect on atmospheric mercury in Barrow, Alaska, since 1999. Research has confirmed that mercury is depleted in the atmosphere during the month following Arctic sunrise. Preliminary results support the hypothesis that mercury is transformed from elemental mercury in the atmosphere to reactive gaseous mercury. Mercury may then become bioavailable in the terrestrial and aquatic environments following Arctic sunrise coincident with onset of the breeding season of Arctic wildlife.

Public Health

Infectious Diseases

The CDC's National Center for Infectious Diseases, Arctic Investigations Program (NCID/AIP), together with Health Canada's Laboratory Centres for Disease Control, Bureau of Infectious Diseases, has initiated an International Circumpolar Surveillance (ICS) system linking existing public health laboratories and facilities in the Arctic to address emerging infectious disease problems. This initiative follows U.S. government interagency recommendations established by the Committee on International Science Engineering and Technology (CISET) and the CDC's Global Health Strategy. In 2002–2006 ICS participant countries will include the U.S., Canada, Greenland/Denmark, Iceland, Norway, and Sweden with planned linkage with public health laboratories in the Barents Sea regions of the Russian Federation. The current focus of ICS is on population-based surveillance of invasive bacterial diseases caused by *Streptococcus pneumoniae, Haemophilus influenzae, Neissera meningitidis*, and Group A and B *Streptococcus* in aboriginal and non-aboriginal peoples residing in Arctic regions. Outcomes will include descriptions of diseases rates, epidemiologic factors, bacterial agent characteristics including antimicrobial susceptibility profiles, and collaborative approaches for prevention and control. Extending the ICS to include other infectious disease problems of Arctic countries is planned. Tuberculosis, particularly multi-drug-resistant tuberculosis, is once again becoming a threat to human health in many Arctic communities. Tuberculosis is expected to be included in the ICS in 2002–2006. NCID/AIP will continue research focusing on the prevention and control of infectious disease problems in the U.S. Arctic. These include viral infections caused by respiratory syncytial virus; hepatitis A, B, and C; and diseases caused by bacteria now commonly resistant to antibiotics (*Streptococcus pneumoniae*, *Staphylococcus aureus,* and *Helicobacter pylori*). Together with the Alaska Native Tribal Health Consortium, NCID/AIP will conduct projects to evaluate the immunogenicity of a new 7-valent pneumococcal conjugate vaccine in Alaska Native children and study the effectiveness of the current 23-valent pneumococcal vaccine in

Alaska Native elders. *Helicobacter pylori* infection is commonly associated with gastric ulcers. Recent studies conducted by CDC's National Center for Chronic Disease Prevention and Health Promotion's Division of Nutrition and Physical Activity, the Yukon Kuskokwim Delta Health Corporation, the State of Alaska Division of Public Health, and NCID/AIP have shown an association between *Helicobacter pylori* infection and iron deficiency anemia in Alaska Natives. Additional studies are needed to assess the validity of this association, as well as the development and evaluation of effective prevention and control strategies.

Occupational Injuries

The CDC's National Institute for Occupational Safety and Health, Division of Safety Research, Alaska Field Station (NIOSH/DSR/AFS), in collaboration with the Indian Health Service, the State of Alaska, the Alaska Native Tribal Health Consortium, and the Alaska Native Health Board, will continue studies on the epidemiology, risk factors, and prevention strategies for occupational injuries in Alaskan communities. The NIOSH/DSR/AFS will continue to coordinate the development of an integrated surveillance system for disease and injury in the Arctic, linking the existing NCID/AIP-initiated International Circumpolar Surveillance (ICS) system for infectious diseases with nascent systems for injuries and birth defects, eventually monitoring chronic diseases and malignancies, behavioral risk factors, and a broader spectrum of injury events. It will provide a more seamless picture of the current health status and trends by partnering with the Alaska Division of Public Health, the Alaska Native Medical Center, and the Alaska Native Health Board's Epidemiology Center.

The NIOSH/DSR Alaska Field Station is mounting two other initiatives in Arctic research. Surveillance for work-related injuries has identified the commercial fishing industry as contributing high numbers of fatal and severe non-fatal injuries. A new project will address the problems of vessel stability in the fishing fleet, the hazards posed by machinery and fishing equipment, and the physical design and layout of fishing vessels and will develop feasible interventions to prevent injuries among fishermen. Vessel stability and the deck environment surrounding the deployment and retrieval systems of fishing equipment (including the use of cranes, winches, lines, nets, crab pots, and crab pot launchers) will be examined from a mechanical and safety engineering perspective. Through effective industry focus groups and application and promotion of new technological innovations and interventions, the number of fatal and non-fatal injuries in this industry should decrease.

Alaska experienced an overall downward trend in occupational fatalities since 1990 (from 78 in 1990 to 42 in 1999, a decrease of 46%), but occupational aviation fatalities continue to be a problem. In response the U.S. Congress supported a Federal initiative to reduce aviation-related injuries and fatalities and to promote aviation safety in cooperation with the air transportation industry in Alaska. The initiative is a three-year partnership of four Federal agencies: the Federal Aviation Administration (FAA), the National Transportation Safety Board (NTSB), the National Weather Service (NWS), and the National Institute for Occupational Safety and Health (NIOSH). The goal is to reduce the number of aircraft crashes and injuries in Alaska by at least 50% by the end of 2009.

Chronic Diseases

The CDC's National Center for Environmental Health, Division of Environmental Hazards and Health Effects (NCEH/EHH), will continue studies on the relationship between exposure to environmental organochlorines and development of breast cancer in Alaska Native women. This will be assessed by collecting biological samples from women undergoing breast biopsy or surgery at the Alaska Native Medical Center and analyzing these samples for endocrine-disrupting chemicals (for example, DDE, PCB, and PBB). Interviews are being conducted to identify potentially confounding risk factors for breast cancer (such as parity and family history) and to collect dietary information.

The Alaska Native Tumor Registry (ANTR) was initiated in 1974 in collaboration with the National Cancer Institute (NCI), NIH, and the Centers for Disease Control and Prevention (CDC). From the outset of registry efforts, the procedures and policies followed were those of the NCI Surveillance, Epidemiology and End Results (SEER) Program. The registry takes an active role in management and follow-up care of cancer patients. All patients are tracked and notified of recommended follow-up appointments. Accurate information on the unique cancer patterns occurring in this population is useful for provider education and training, program planning, studies of cancer etiology, evaluation of screening programs, interventions to improve patient care, and programs for cancer prevention and risk reduction.

ANTR completed the "Alaska Native Cancer Survival Report," and several scientific articles have been published based on ANTR data. The registry will provide an update of cancer incidence for Alaska Natives statewide and by service unit. Discussions are underway with the Army Corp of Engineers and the Air Force to study contaminants at military sites and cancer patterns. Research studies in progress include:

- Serum PCB levels in breast cancer patients and controls;
- Prospective study of breast cancer and organochlorines in serum and fat tissue in the breast;
- *Helicobacter pylori* and cancer and other diseases of the stomach;
- Prevalence of colorectal cancer genes in (formalin fixed) tissue among colorectal cancer patients;
- Familial aggregation of nasopharyngeal cancer; and
- Biomarkers expressed in tumor tissue of Alaska Native breast cancer patients.

The Genetics of Coronary Artery Disease in Alaska Natives (GOCADAN) Study is a five-year project that is focusing on a family study of 1200 individuals comprising 40 families of adults and children over the age of 18, primarily from two villages near Nome, Alaska. This project is a partnership with Norton Sound Health Corporation, a subcontractor to the Indian Health Service, to study the etiology of heart disease in Alaska Natives using the protocol and many investigators from the Strong Heart Study, an NHLBI-funded 12-year study of cardiovascular disease in American Indians. The study will also include a cardiology center at Cornell Medical School, a genetics center at Southwest Foundation for Biomedical Research, a coagulation laboratory at the University of Vermont, a central laboratory at Medlantic Research Institute, and investigators located at the University of Alaska. Examinations began in October 2000. A ten-centiMorgan genetic scan will be used to identify significant linkages between markers and risk factors and disease.

Three projects are being reviewed or have been approved for funding during the coming year. The Age, Gene/Environment Susceptibility (AGES) study is funded from 2001 to 2008 by the National Institute on Aging. NIA is seeking additional funding to expand this study to an existing cohort of approximately 12,000 members to identify genetic and other new risk factors for selected diseases and conditions including atherosclerosis and stroke and to characterize phenotypes for these diseases and conditions, in relation to genetic susceptibility, gene function, and genetic/environmental contributions to disease. Improvement in the measurement of quantitative traits as phenotypes will result from the use of prior longitudinal data and more recent non-invasive imaging techniques. These include calcium scoring of the coronary arteries by computerized tomography (CT) and hippocampal volume by magnetic resonance imaging (MRI).

The second proposed project is an intervention study entitled Stroke Prevention in Alaska. The intervention will focus on dietary counseling of Alaska Natives to modify and reduce fat intake, improve weight control, and increase physical activity. The study will include 600 adults over the age of 24 from four Alaska villages, including two Siberian Yup'ik villages, one central Yup'ik village, and one Inupiaq village. Protocols for data collection will follow those for the Strong Heart Study. Data collection will include dietary assessments, cardiovascular disease risk factors, and ultrasound carotid artery measures, as well as extensive laboratory measures and lifestyle surveys.

The third proposed project is focused on Alaska villages below the Arctic Circle. It will expand, facilitate, and stimulate biomedical research, including multiple components focused on disease surveillance; survey systems for genetic, environmental, and behavioral risk factors; high-throughput genotyping; and cultural/behavioral research.

National Eye Institute (NEI) staff are engaged in discussions with investigators in the Department of Ophthalmology of the Alaska Native Medical Center regarding a proposed epidemiological study of refractive error in Alaskan children, adopting a protocol used successfully in China, Nepal, and Chile under WHO/NEI sponsorship. The Bethel area of Alaska is under consideration. With the increasing significance of refractive error as a public health problem in children, a study in a Native American population would be of high potential interest.

Alcoholism is a long-term, progressive disease that can lead to compromised workplace performance; disrupted families; long-term health complications including cirrhosis, heart disease, and cognitive impairment; and injuries and death from accidents or violence. Research into the causes, prevention, and treatment of alcoholism, including approaches that can serve the far northern environment in particular, is central to reducing the consequences of excessive alcohol use. Research sup-

ported by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) in Alaska is aimed at the nature of alcoholism in this population, approaches to treatment, and the impact of public policy on drinking. The research addresses features particular to the Alaskan environment, including the sparse population in a remote landscape with a significant Native American population.

One study is the first comprehensive clinical description of Native Alaskans in treatment for alcohol dependence using a standardized assessment protocol, identical to that used in NIAAA's multi-center Collaborative Study of the Genetics of Alcoholism (COGA), making comparison across different ethnic groups possible. In particular, identification of possible ethnic and cultural differences is likely to have implications for improved treatment outcomes for Native Alaskans.

NIAAA-supported investigators also recently looked at local policy changes in Barrow, Alaska, and their effects on alcohol consumption. During a 33-month period, referenda passed by the citizens at first imposed, then withdrew, and finally re-imposed a total ban on alcohol sales. Research findings indicated significant decreases in emergency room visits (including those for assaults) when alcohol was banned, increases to levels of the pre-ban period when the ban was lifted, and significant declines again when the ban was re-imposed by Barrow voters. The contrasts between periods when the policy was in force and periods when it was suspended makes this a revealing study of the effects of public policy on drinking.

Looking ahead, NIAAA and the National Institute of Child Health and Human Development are preparing to collaborate in studying the role of prenatal alcohol exposure in sudden infant death syndrome (SIDS). Recent findings suggest a strong relationship between alcohol use during pregnancy and SIDS, adding to the established risks of fetal alcohol syndrome and alcohol-related neurodevelopmental disorder. The high incidence of both alcohol problems and SIDS in Alaska lends itself to such research.

Another study is designed to understand how Alaska Natives maintain or achieve sobriety, such as factors that protect individuals from alcohol dependence and facilitate recovery. Spirituality is thought to be a critical element in the recovery process, and investigators will explore its role in promoting resiliency to abusive drinking behaviors.

The National Institute on Aging (NIA) continues to fund the Native Elder Research Center, located within the Division of American Indian and Alaska Native Programs of the Department of Psychiatry, School of Medicine, and University of Colorado Health Sciences Center in Denver. The Center coordinates a research career development program targeted at American Indian (AI) and Alaska Native (AN) investigators, focusing on aging, health, and culture. The Center augments ongoing partnerships with AI/AN communities to ensure involvement of elders, their families, and local systems of care in aging research. The aim is to increase the pool of talented investigators committed to research.

The Alaska Native maternal and newborn blood monitoring program will measure persistent organic pollutants, heavy metals, and micronutrients in the blood of women entering prenatal care and in the umbilical cord blood of their newborn infants.

The program was developed at the request of Alaska Native communities to provide data on human tissue levels of contaminants that are transported to the Arctic from lower latitudes, entering the food chain of subsistence species, and being ingested by rural Alaska Natives pursuing their traditional diet.

The data will be utilized for several purposes:

- It will be used to provide trend data on human tissue levels over time.
- It will allow, over time, for examination of health outcome data, to see whether correlations with contaminant levels exist.
- Combined with a subsistence dietary history in each woman and micronutrient levels, the data will be examined for correlation of subsistence food intake with micronutrient levels and examined for positive health outcomes in women and infants.
- Communities will be able to perform their own risk-benefit assessment and formulate community-specific strategies to reduce exposure and maintain the traditional diet.
- The data will be shared with state and Federal agencies with responsibilities for contaminant risk assessment, and reduction of pollutant release.
- The data will be shared with the other Arctic countries as part of the AMAP protocol.

At present the monitoring program covers approximately 75 villages along the Arctic Ocean and Bering Sea, as well as the Yukon and Kuskokwim Rivers. The monitoring program is funded by the EPA, the Alaska Native Tribal Health Consortium, the CDC National Center for Environmental Health, and the State of Alaska.

Behavioral Aspects

Supported by a grant from the National Science Foundation, a researcher at the Food and Drug Administration is investigating cognitive performance related to extended residence in Antarctica and seasonal mood alterations. The project has two specific objectives. The first is to determine whether long-term exposure to low temperatures and/or dim light, both characteristic of polar winters in high-latitude environments, are associated with significant changes in cognitive performance and emotional well-being. The second objective is to determine whether decrements to mood and cognitive performance can be effectively prevented or minimized through the administration of pharmacological interventions and/or phototherapy.

The National Institute of Mental Health, NIH, is expanding its portfolio of research on the prevention of suicide in response to the recent Surgeon General's report on suicide. Included in these efforts are attempts to reach out to traditionally underserved populations such as Alaska Natives.

The National Institute on Drug Abuse, NIH, supports evaluation of the benefits of needle exchange programs (NEPs) and/or pharmacy distribution of syringes by intervening with injection drug users to reduce hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV); this research has been underway at the University of Alaska Anchorage (UAA) since 1996. Data being monitored include results of urine testing for amphetamines, cocaine metabolites, and morphine, as well as serological testing for HBV, HCV, and HIV. An objective is to refer drug injectors recruited into the study for a free HBV vaccination series, with success in enrolling over half of the active drug users participating. The subject population includes Alaska Natives, whites, African Americans, and Hispanics. NIDA anticipates that such efforts will continue in the future, with the possibility of cooperation with other countries (Canada and Russia) holding Arctic territory adjacent to Alaska.

A First Independent Research Support and Transition (FIRST) Award (1997–2001) at the University of Alaska Anchorage (UAA) is identifying subgroups of women and their risk behaviors and potential for diseases relative to use of drugs and condoms. The study uses individual level predictors, contextual variables related to sexual decision making, psychosocial constructs, and selected demographic variables to develop subtypes of women and to better understand their pattern of drug-using and sexual behaviors (particularly among Alaska Native women) that put them at risk for sexually transmitted and other blood-borne infectious diseases. Plans include expansion into full-fledged research aimed at expanding knowledge of drug use, sexual risk, and infectious disease risk of Alaska Native women.

In May 2000, NIDA staff co-organized the Eighth International Conference on AIDS, Cancer, and Related Problems in St. Petersburg, Russia, and co-chaired sessions devoted to drug abuse and AIDS epidemiology and prevention/intervention, with participants from Siberia, the Russian Far East, and the Arctic. A large symposium is planned for May 2001 in St. Petersburg.

Delivery of Health Care

The National Institute of Mental Health, NIH, currently supports a number of telemedicine grants that are testing the delivery of mental health interventions through this technology. The NIDA-supported extramural research initiatives at the UAA have benefited from UAA's Telemedicine Project that helps to bridge the geographic expanse of Alaska in a series of "research at a distance" projects using desktop video teleconferencing technology. In collaboration with the NIDA-supported research, the Telemedicine Project is continuing to explore the uses of narrow-band telecommunications and information technology to improve the delivery of health care to all citizens of Alaska. It is anticipated that these efforts will be expanded to include countries with Arctic territory adjoining that of the U.S. (Canada and Russia).

Capacity Building/Health Disparities

The National Institute of Neurological Diseases and Stroke is funding a Specialized Neuroscience Research Program at the University of Alaska Fairbanks (UAF) that establishes an Alaskan Basic Neuroscience Program (ABNP) to expand, facilitate, and stimulate neuroscience research, to facilitate the collaborative research, and to stimulate the active participation of Alaska Native students. The ABNP will carry out interdisciplinary research to study mechanisms of neuroprotective adaptations via four specific aims: 1) develop an administrative core directly under the Provost that will provide the most effective environment, 2) develop a research program around the theme of neuroprotective adaptations and increase collaborations with other neuroscientists, 3) develop an emphasis on neuroscience graduate education, and 4) upgrade an existing tissue culture/imaging facility to state-of-

the-art standards. The proposed research focuses on neuroprotective adaptations associated with hibernation and signal transduction in the control of cell death, neuronal regeneration, circadian rhythms, and thermoregulation.

The National Library of Medicine (NLM), NIH, has in the last two years created several Web-based information services that serve the public directly. MEDLINEplus and ClinicalTrials.gov are two notable resources that together are receiving more than 50 million page hits per year. NLM is prominently featuring outreach to minority and underserved communities so they may make maximum use of these services. For the Native American communities in Alaska and the Pacific Northwest, these activities are centered at the Regional Medical Library in Seattle at the University of Washington. "Tribal Connections in the Pacific Northwest" (www.tribalconnections.org) connects American Indian/Alaska Native communities to health resources on the Internet, including MEDLINEplus. This highly successful program is connecting hospitals, clinics, libraries, and remote villages via the Internet and thus reducing the isolation from quality health information and health care of this vulnerable population. Related to the Tribal Connections program is a series of telemedicine projects in rural Alaska that collectively is serving as a testbed strategy for cost containment and for raising the quality of health care for a minority population that is scattered across a vast area.

The National Cancer Institute (NCI), NIH, through its Surveillance Research Program, Division of Cancer Control and Population Sciences, supports the "Network for Cancer Control Research among American Indian and Alaska Native Populations." Established in 1990, this network of researchers working among American Indians and Alaska Natives developed a National Strategic Plan for Cancer Prevention and Control Research in FY 92. The NCI shares support for Network meetings with the Mayo Comprehensive Cancer Center, Rochester, MN. With additional NCI support, the Network has convened three national conferences to discuss research and training and to disseminate results.

In 1997, NCI assisted the Network and Mayo in establishing the Native CIRCLE, a clearinghouse for information and resources developed through research (http://www.mayo.edu/nativecircle). Many useful, culturally sensitive materials, including school curricula, videos, pamphlets, and survey instruments, are catalogued and made available to researchers and communities for application in areas of smoking prevention, cancer screening, and dietary change.

Ongoing efforts for the Network include collaborative efforts with the Indian Health Service and the Centers for Disease Control and Prevention, expansion of cancer surveillance among American Indian populations, and pursuit of new studies in patterns of care and cancer survivorship. Members successfully competed to become one of NCI's new Special Population Networks. This large, five-year project will address comprehensive tribal cancer control using partnerships between populations, tribes, multiple cancer centers, the NCI, and the American Cancer Society and will also develop, assess, and implement cancer education among community members.

The NCI supports the Native American Student Research Program, a cancer control research training program for American Indian and Alaska Native graduate and post-doctoral students. Spanning six years, the program has provided training to 53 trainees of diverse Native groups, including Alaska Natives. A substantial proportion of the trainees have been awarded NCI funds (17 of 43 eligible, or 40%) to carry out community-based cancer control activities among Native groups. The training program has been awarded another five-year grant. The projects require implementation of a research plan within an established timetable and a report utilizing analytical skills.

The Office of Intramural Research, Office of the Director, NIH, is pursuing an initiative called the Arctic Health Disparities Research Dissemination Network (AHDRDN), envisioned as a central point of recognizance for U.S. human health efforts, including research, surveillance, education and training, communications, and outreach activities, particularly aimed at the Native populations. A starting point for the Network is the new Arctic Health Information web site, currently under development by the Specialized Information Services Division of the National Library of Medicine, NIH. The AHDRDN could be proposed to the Arctic Council as a new project under its Sustainable Development Working Group (SDWG).

The U.S. Department of State will continue to promote international cooperation on health issues in the Arctic Council. The Arctic Council is an intergovernmental forum for the eight Arctic nations and six indigenous organizations representing Arctic communities concerned with environmental protection and sustainable development. The U.S. raised the profile of Arctic health issues during its 1998–2000 Chairmanship of the

Arctic Council. The U.S. initiated projects on telemedicine and infectious disease, featured presentations by U.S. experts at Council meetings, and hosted the May 2000 International Conference on Arctic Development, Pollution and Biomarkers of Human Health. The U.S. also contributed to the Council's Human Health Effects Program in the Arctic Monitoring and Assessment Program (AMAP) and helped fund a new assessment of contaminants in the food supply of Russian indigenous communities in the Arctic.

At the Second Ministerial Meeting of the Arctic Council in Barrow, Alaska, in October 2000, Ministers welcomed and approved the report on Telemedicine in the Arctic prepared by the Institute for Circumpolar Health Studies and the proposal by the CDC's Arctic Investigations Program to develop an International Circumpolar Surveillance System (ICS) for infectious diseases.

The Arctic Investigations Program worked closely with Canada and Denmark/Greenland in setting up the ICS for *Streptococcus pneumoniae*.

As a follow-on initiative, the Office for the Advancement of Telehealth at the U.S. Health Resources and Services Administration (HRSA) will work with Sweden and Norway to organize an international workshop to develop elements of a common methodology for evaluating the varied telehealth programs in the Arctic.

The Department of State will facilitate U.S. participation as appropriate in all the health activities of the Arctic Council. Canada's program on Children and Youth, for example, will focus on data collection and analysis of health indicators by developing pilot projects in the four broad areas of health (socio-economic-cultural, health services, psychosocial well-being, and biophysical health). The U.S. has supported the Russian Indigenous Peoples of the North (RAIPON) proposal to moni-tor and assess the levels of contaminants in the indigenous food eaten by residents of the Russian Arctic. RAIPON has funding from the Global Environment Facility (GEF) for this research project.

Report of Meeting

Interagency Arctic Research Policy Committee

16th Meeting: April 10, 2001

Committee Members and Agency Representatives Present: Rita Colwell (Chair), Karl Erb, Charles E. Myers, and Thomas Pyle, National Science Foundation; George Newton and Garrett Brass, Arctic Research Commission; Alan Shafer and Steven King, Department of Defense; Ari Patrinos and Wanda Ferrell, Department of Energy; Philip S. Chen, Jr., and Peter Hartsock, Department of Health and Human Services; Sarah K. Brandel, Department of State; CAPT Charles T. Lancaster, Joseph Bornstedt, and Jon Berkson, Department of Transportation; William Farland and Suzanne Marcy, Environmental Protection Agency; Waleed Abdalati and Jack Kaye, National Aeronautics and Space Administration; Tom Murray, John Calder, and David Evans, National Oceanic and Atmospheric Administration; Igor Krupnik and Robert W. Fri, Smithsonian Institution; Richard Cline and Steven Shafer, U.S. Department of Agriculture; James Devine, U.S. Geological Survey; David Radzanowski, Office of Management and Budget; and Louis A. Codispoti, Presenter.

Dr. Rita Colwell, IARPC Chair and Director of the National Science Foundation, convened the meeting at the National Science Foundation, Arlington, Virginia.

Review of U.S. Arctic Policy/Arctic Council

Dr. Colwell called on Sarah Brandel, Department of State, to report on U.S. Arctic Policy and the activities of the Arctic Council. Ms. Brandel noted that the U.S. had expanded its international cooperation in the Arctic during the year to include issues of sustainable development. Ms. Brandel said that the Arctic Council wants to bring environmental, human, and social issues together for study. Dr. Colwell agreed that it is important to study the human–environment interface, and she supports the Council in this effort.

Comments from the Arctic Research Commission

George Newton, Arctic Research Commission (ARC) Chair, provided an update on the ARC. The ARC has completed the biennial *Report on Goals and Objectives, 2001.* This year's report included four major research recommendations:

- Studies of the Arctic Region and Global Change. This topic is the subject of the Study of Environmental Arctic Change (SEARCH) program.
- Studies of the Bering Sea Region. The Bering Sea is very important, not only for the nation's fisheries but also because of the many species of mammals, birds, and fish it supports. Climate change and human activity both within the region and in North America and western Asia play an important role in the ecosystem of the area. The Commission recommends that IARPC organize an interagency program for the study of the Bering Sea region.
- Health of Arctic Residents. The Commission recommends that this become an interagency program with two objectives: the study of the major causes of morbidity and mortality among Arctic residents; and the study of environmental health, with the main focus on contaminant levels in humans and food, as well as their effects.
- Applied Research. This will include smaller projects in such fields as civil engineering and telecommunications.

Mr. Newton expressed his concern that the U.S. Navy's SCICEX (Submarine Science Experiment) program, which made a great contribution to our understanding of the Arctic Ocean, has ended. A similar program will continue and will be available to the community but on a more limited basis. The Arctic Research Commission is also studying other ways to collect data in the Arctic Ocean. These include long-range autonomous underwater vehicles.

Report from Study of Environmental Arctic Change (SEARCH) Working Group

Science Review. Louis Codispoti of the University of Maryland reported on the history of the SEARCH activity and its genesis in the recent observations of environmental change in the Arctic.

Progress Report. John Calder of NOAA reported on activities of the Interagency Working Group on SEARCH and noted that the plans for SEARCH for 2003 are to emphasize that:

- Arctic changes are national issues.
- A change in Arctic atmosphere strongly influences U.S. weather.
- There will be a great effect on Alaska.

SEARCH is a multidisciplinary, multiscale, and multiagency undertaking.

Action Item. Dr. Colwell requested that the group review a proposed action item to approve the following resolution:

> *RESOLVED, that the Interagency Arctic Research Policy Committee authorizes the Working Group on the Study of Environmental Arctic Change (SEARCH) to develop an interagency implementation plan for the SEARCH program, and budget proposals for each participating agency for fiscal year 2003.*

In discussion, David Radzanowski, OMB, said that the agencies should make their individual budget examiners aware that the SEARCH Program

proposal is on the way. He recommended that the agencies focus on their top priorities. The Committee approved the resolution.

Presentation on Integrated Assessment for a Sustainable Bering Sea

Suzanne Marcy, EPA, discussed the need to study human factors together with the ecological problems of the Arctic, especially in the Bering Sea. Those who are interested in this research include commercial interests (fisheries), scientists, environmental groups, government agencies, and Native Alaskans.

Action Item. Dr. Colwell asked the agencies to consider the following resolution:

> *RESOLVED, that the Interagency Arctic Research Policy Committee authorizes the establishment of an Interagency Working Group on Bering Sea Assessment and authorizes the working group to develop a coordinated approach to implementation of an integrated assessment for a sustainable Bering Sea.*

The Committee approved the resolution. EPA will chair the working group.

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