

CIRCUMPOLAR VOICES

ARCTIC PEOPLES AND BEYOND: RESEARCH OPPORTUNITIES IN NEUROSCIENCE AND BEHAVIOUR

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ABSTRACT

Objectives. Arctic and northern peoples are spread across Alaska, Canada, Russia and the Scandinavian countries. Inhabiting a variety of ecosystems, these 4 million residents include Indigenous populations who total about 10% of the population. Although Arctic peoples have very diverse cultural and social systems, they have health issues related to environmental impacts and knowledge/treatment disparities that are common to other minority and Indigenous peoples around the world. Research that explores the neuroscience and behavioural aspects of these health disparities offers challenges and significant opportunities. As the next generation of neuroscientists enter the field, it is imperative that they view their contributions in terms of translational medicine to address health disparities.

Study design. A workshop was designed to bring neuroscientists together to report on the current directions of neuroscience research and how it could impact health disparities in the North. This workshop produced research recommendations for the growth of neuroscience in the North.

Methods. On May 31, 2006 the National Institute of Neurological Disorders and Stroke, the Burroughs Wellcome Foundation, the Arctic Division of AAAS and the University of Alaska co-sponsored a workshop entitled "Arctic Peoples and Beyond: Decreasing Health Disparities through Basic and Clinical Research." Also, the role and goals of the International Union for Circumpolar Health (IUCH) were presented at the meeting.

Results. A set of recommendations related to research opportunities in neuroscience and behaviour research and ways to facilitate national and international partnerships were developed.

Conclusions. These recommendations should help guide the development of future health research in circumpolar neuroscience and behaviour. They provide ideas about research support and informational exchange that will address health challenges. (*Int J Circumpolar Health* 2007; 66(3) 264-275).

Keywords: health disparity research, stroke, brain disease, SIDS, behaviour, international collaboration

INTRODUCTION

A major characteristic of contemporary biomedical science is complexity. This has been obvious for arctic medical science over the last 20 years and is especially true for neuroscience. There are many theories that try to account for the complexity of disease syndromes (1). The range of factors and interactions that shape human health have led to a questioning of the mechanical model of disease that has dominated the scientific approach guiding research on human health. The role of neurological mechanisms interacting with social and cultural influences are key to behaviour (lifestyle) and to life expectancy (Fig. 1) (2-4).

Clark (4) emphasized that, in the dynamic process for preserving health or combating disease, a person or population's environment can shape the behaviours associated with disease. Although recent research demonstrates the importance of socio-economic factors in producing disease, there is recognition that these socio-economic factors in combination with physical environments (light, tempera-

ture, seasonality, contaminants) and biological phenomena (neurochemical and endocrine feedback mechanisms) are very important (5, 6). People in extreme environments, like the Arctic, as well as the marginal environments inhabited by many under-represented minorities, need to be studied and understood in both historical and current contexts to develop a comprehensive medical model that addresses both health maintenance and chronic disease processes in the underserved populations (7-11).

The key medical question relating to diverse populations in extreme environments is, "Why are some people healthier than others?" This question prompts investigators to ask how neuroscience and behaviour research can improve the health of these populations. In relation to the brain, emerging evidence emphasizes the embedding of life experience and points to the lifelong impact of health experiences on the foetus and child during the important developmental stages identified as critical periods or sensitive stages (5). Neuroscience research in the Arctic needs to combine the advances in understanding the molecular mechanisms of disease with the identification of environmental and lifestyle factors that influence health (3, 4, 11, 12, 29).

To address the objectives outlined in Healthy People 2010 (18) and Alaska's goals as stated in Healthy Alaskans 2010 (17), neuroscientists and the community must join together to make recommendations for neuroscience research priorities that will lead to the reduction of health disparities. More basic research is needed on the complex disorders of stroke, sudden infant death syndrome (SIDS), depression, suicide, seasonal affective disorder (SAD), alcoholism and drug abuse in minority populations. Research on these disorders and

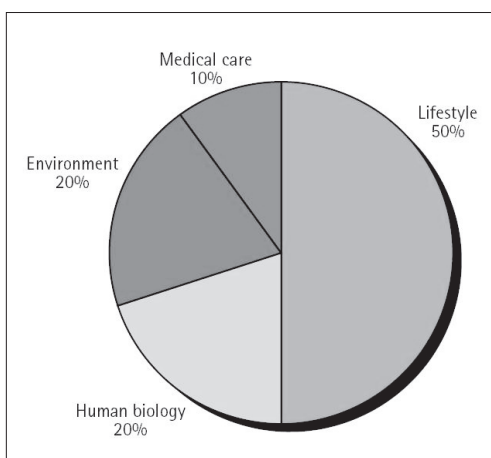


Figure 1. Factors that could help avoid premature mortality (2).

pathologies need to include a neurochemical context. A focused review of neuroscience advances in relation to the diverse population of the circumpolar north is needed to support researchers entering these areas.

In developing neuroscience research to address these health issues, especially concerning health disparities such as stroke, depression and developmental deficits related to environmental contaminants, researchers in Alaska and the Arctic could learn from experienced scientists and program leaders from lower latitudes. The aims of our workshop were:

1. Bring leading neuroscientists to Alaska to interact with our neuroscience faculty and the community.
2. Develop recommendations for Alaska neuroscience research priorities.
3. Expose graduate and undergraduate students to a scientific research meeting.
4. Begin to develop programs for the International Polar Year's Arctic Human Health Initiative.
5. Expose neuroscientists to the International Union for Circumpolar Health and to the 13th International Congress in Novosibirsk, Russia.

MATERIAL AND METHODS

Alaska Specialized Neuroscience Research Program and Conference Organization

The Alaska Basic Neuroscience Program (ABNP) was initiated in 2000 when UAF received one of 12 Specialized Neuroscience Research Program (SNRP) awards, funded by the National Institutes of Health, to develop and coordinate the growth of neuroscience

research and education in Alaska. Partnering with local communities, the state and federal government, the program's goal is to provide high-quality research opportunities that address identified state and national needs, including health problems impacting Alaska Natives.

One focus of ABNP is the education and training of the next generation of neuroscientists, especially Alaska Natives. Many Alaska Native students begin their undergraduate degrees at rural University of Alaska campuses and then transfer to the Fairbanks campus to complete their science degrees. The neuroscience program has significantly expanded the number of undergraduate students engaged in research as a result of student interest in biomedical careers. One goal of the ABNP is to demonstrate how cultural diversity strengthens the scientific milieu in the university, by diversifying the faculty and students' perspectives and approaches to research problems. Biomedical meetings in Alaska are important because the meetings expose large numbers of Alaska Native students and Alaskan media to state-of-the-art biomedical research and encourage the development of translational medicine.

During the last 5 years, the Alaska SNRP has held 2 summer neuroscience conferences. UAF neuroscientists organized research-centred symposia to highlight relevance of neuroscience in the Arctic. Due to the success of these conferences, the Arctic Peoples and Beyond workshop was organized to allow leading researchers to assess where biomedical research in the Arctic should focus its future neuroscience effort. This meeting, due to the IUCH presence, allowed participants to focus on both neuroscience and behavioural health disparities before the 13th International

Congress in Novosibirsk, Russia. The timing of the IUCH meeting, immediately preceding the International Polar Year, leaves a legacy that enables future arctic neuroscience investigators to plan their research based on current, state-of-the-art neuroscience research recommendations.

During the year preceding the meeting, the organizing committee (Table I) and its subcommittees met via teleconference and email on a regular basis to discuss the logistics of this first national neuroscience meeting in Alaska.

RESULTS

Presentations

After welcoming remarks from university and government officials, Dr. Allison Kelliher of the Norton Sound Health Corporation and the Genetics of Coronary Artery Disease in

Alaska Natives (GOCADAN) research study stressed the importance of building partnerships and collaborations that could integrate traditional knowledge and biomedical research. She suggested that the common interest in the health of Indigenous people of the North offers a unique opportunity. She acknowledged the success of current projects in the Arctic, but noted that more could be done. She wished the participants success in identifying and prioritizing those research opportunities. Finally, she expressed her belief that neuroscience research would lead to further collaborative efforts with Indigenous communities and pointed out that both neuroscience research and medical education can grow together and incorporate traditional knowledge and culture. Traditional knowledge of foods such as berries and marine fish can be a starting point for bringing Native students into the medical sciences, including research.

Table I. The organizing committee.

Committee member	Institution
Lawrence Duffy	University of Alaska Fairbanks
Vesna Eterovic	Universidad Central del Caribe
Marie T. Filbin	Hunter College of City College of New York
Jose E. Garcia Arraras	University of Puerto Rico
Edgar Kenton	Morehouse School of Medicine
Edmundo Kraiselburd	University of Puerto Rico Medical Science Campus
Peter MacLeish	Morehouse School of Medicine
V. John Massari	Howard University
Hubert Rucker	Meharry Medical College
Cecilia Shikuma	University of Hawaii, Manoa
Joachim Spiess	University of Hawaii
Charles Wilson	University of Texas San Antonio
Alfred Gordon	National Institute of Neurological Disorders and Stroke/ National Institutes of Health
Michelle Jones-London	National Institute of Neurological Disorders and Stroke/ National Institutes of Health
Debra Kulik	Masi Max Resources, Inc
Kathy McCauley	Fairbanks Convention and Visitors Bureau
Mary van Muelken	University of Alaska Fairbanks

Four plenary presentations summarized the state of basic and clinical research in areas the data suggested to be of particular importance to northern peoples.

In the area of stroke and brain injuries, Dr. Michael Chopp discussed the remodeling of the brain after neural injury. The neuropsychiatric effects of the human immunodeficiency virus (HIV) were the subject of Dr. Igor Grant's presentation, while Dr. Cindy Ehlers discussed efforts to understand and treat the risk factors for alcoholism. Dr. James Berner concluded the plenary session by reviewing the current health disparity data for rural peoples in Alaska and the Arctic and the potential to improve Indigenous health care in these rural areas. The attendees then organized into separate sessions for panel discussions to develop research recommendations regarding stroke, substance abuse, neurological complications of acquired immune deficiency syndrome (AIDS), sudden infant death syndrome, dementia and depression. The role of nutrition and exposure to environmental contaminants and their effect on the disease process was discussed as well as the new perspective on health policy from the field of neuroethics.

The workshop attendees reviewed the current state of knowledge and identified the research problems addressed by their research. During the panel discussions, panelists related how advances in their neuroscience research areas affect Arctic peoples and how that research might be clinically translated. Panelists suggested strategies for drawing minorities, especially Alaska Natives, into biomedical research. The ethical treatment of diverse northern populations both in research projects and in health delivery systems was

identified as a critical issue for expanding educational programs.

Neuroscience, as a field, has not previously focused on the Alaska community with the exception of stroke and seasonal affective disorder. The Arctic Peoples and Beyond workshop exposed the community (Native Health Corporation members, students and support groups) to experts rarely present in Alaska.

DISCUSSION

The Arctic regions provide a seldom explored environment in which to study neuroscience-related health disparities. As circumpolar countries continue to develop their neuroscience programs, it is essential to develop an integrated medical model (Fig. 2). Neuroscience in the circumpolar north must consider the concept that extreme conditions, isolation and the related socio-economic impacts that Arctic people experience are factors in the presentation of disease.

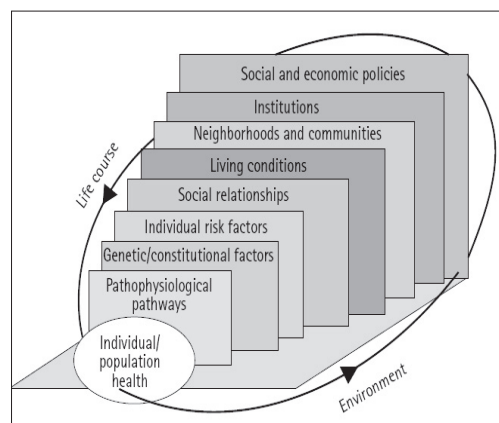


Figure 2. U.S. Department of Health and Human Services depiction of an integrated medical model.

With the high percentage of Indigenous people in the North, neuroscience research efforts offer a special challenge to investigators who wish to conduct culturally sensitive research that is scientifically meritorious and of true benefit to the participants and the overall community. Similar obstacles have been identified and are being overcome by more established programs in Canada. Workshop attendees observed that while population centres in Alaska and Canada fit a developed country, rural northern and frontier areas were more similar to a model for developing countries. This difference leads to disparities in research infrastructure and treatment delivery.

Since Alaska is the only Arctic state within the United States, U.S. neuroscience research must increase its focus on Alaska. Factors facilitating international comparisons should also be addressed to determine how countries could promote a common neuroscience research agenda that will be mutually beneficial for their circumpolar populations. Facing similar obstacles, researchers in Hawaii and Puerto Rico have developed model programs that exemplify global cooperation and cultural sensitivity. In a similar way, arctic health disparities should guide the direction of neuroscience research. In turn, basic and clinical neuroscience research results need to be translated into medical protocols. Both research and medical practice should be integrated with the cultural values such as connection to the environment and spirituality. An integrated arctic medical model, which includes neuroscience and behaviour research in extreme environments, is needed.

Barriers and solutions

Formidable obstacles to health research in the Arctic, especially with Indigenous peoples, account for the dearth of epidemiological data documenting health problems and solutions to those problems. Physical obstacles include low population density, weather conditions and the difficulties associated with transporting personnel, equipment and samples to and from rural communities. Research is additionally hampered by the shortage of Indigenous researchers and trained technicians, housing, laboratories and clinic space and associated infrastructure. Lack of neuroscience degree programs hinders outreach and efforts to communicate efforts with rural communities.

Cultural differences and prior negative experiences of minorities involved in past research studies can be a barrier to participation. Research on some issues (alcoholism) may be seen as harming the community (by inciting prejudice) and the group benefits are difficult to identify. In minority communities, distrust increased in the past when investigators did not share the results with the community or appeared to negatively impact the community (11, 15). Lack of educational programs to train students interested in biomedical research is also a barrier to partnerships (14, 17, 19).

In Alaska, Native communities have made progress in developing and controlling their health care system. They now want their children to become researchers and health care providers. Establishing community-based research and developing an integrated health policy is needed (17, 19). Policy priorities should be focused on health disparities such as alcohol and tobacco use and suicide (20, 21). Most Alaska Native communities prefer a research

model that is based on building long-term relationships between researchers and community members, who serve as research subjects. Such a model helps to empower the community and is one factor underlying the Alaska IDeA Networks for Biomedical Research Excellence and Center for Alaska Native Health Research, which are NIH-funded research initiatives addressing disease within the Alaska Native population (19). Alaska Native health corporations have implemented changes to help establish a greater role for community members in research oversight (14). Native leaders have assumed responsibility for the careful review of all proposed research projects. Research project proposals are reviewed by multiple institutional, community and governmental entities (16, 17, 19, 30).

Other major obstacles to the existing and future research efforts include the lack of synchronization and of common protocols among studies across national boundaries and the need to standardize protocols within a given country with respect to previous work (23). International leadership, such as IUCH, is needed to develop collaborations. Neil Murphy represented the American Society for Circumpolar Health and the IUCH at this meeting. He explained that the IUCH, established in 1986, offered an existing organization and journal devoted to collaboration among the 8 countries with interests in the Arctic (16). He reviewed the history of international collaborations in the Arctic and the development of the IUCH. He noted the coming International Polar Year in 2007, and he opined that it may be a perfect opportunity to establish health as a focus for that meeting.

Since alcohol and substance abuse are common problems in Arctic communities (17), NIH and state/rural community health organizations should work to expand the research infrastructure. Problems associated with substance abuse cross social and neuroscience disciplines so inter- or multidisciplinary research teams, including anthropologists and ethnobiologists, should be encouraged (19). In child-development and age-related studies, community-based research on health prevention efforts present opportunities for collaboration (8, 14, 28). A focus on developing common methodology would allow comparison among diverse Arctic populations and identify factors affecting risk and vulnerability. Multidisciplinary consortiums, like GOCADAN, should be created to develop research projects and include active networks of researchers, especially neuroscientists. Drug studies should use holistic approaches embracing neuroethics and cultural perspectives. Successful research in this area could have a quick translation to clinical practice. Behavioural and mental health research should be more prominent in northern neuroscience research programs.

Stroke and brain injury

The rates of stroke and occupational brain injury are higher in Alaska and the Arctic (17, 19). However, in the North it is difficult to translate new knowledge between the clinic and the basic research laboratory. An Alaska Center for Stroke and Neurological Disorders (ACSND) should be established which can bring a focus on the situation by

- identifying risk factors and developing pre-stroke data

- developing community partnerships for appropriate tools and models for Indigenous and other minority populations
- evaluating all risk factors using epidemiology studies
- testing neuroprotective strategies through basic research

Such a centre could work towards the development of pharmaceuticals related to rural northern populations and have an emphasis on translational medicine. It should assist in expanding telemedicine techniques. Cultural and economic sensitivity in development of therapeutics is needed and should be a major focus. Studies on strategies to enhance community participation are needed as well as funding of culturally acceptable public service announcements, communication and educational training.

Complex disorders with a neuroscience component

The rates of suicide and alcoholism are also very high in Alaska and the Arctic (12, 17, 19, 20, 21). Again, both epigenetic and potential genetic risk factors need to be identified and the lack of epidemiological studies has been a major barrier. Depression is a known risk factor for suicide, while alcohol and drug abuse are known risk factors for depression. Animal models are needed in this area to develop laboratory paradigms for syndromes such as obsessive-compulsive disorder and seasonal affective disorder.

Child health and development

Among Alaska Natives, two major areas of health disparity with respect to neurological development are the high rate of unexplained infant death and the unknown effect of dietary

changes, including increases of contaminants. Traditional northern Indigenous people differ from people living in more temperate latitudes because of the greater reliance on “wild” foods in their diet (13, 19). Fish consumption among Alaska Natives is six times that of the general U.S. adult population. The difference in fish and sea mammal consumption among Alaska Natives accounts for higher levels of omega-3 fatty acid in their diets. Dietary sources differ by generation, with younger generations relying more on market foods. The younger generation has a diet higher in carbohydrates but lower in fat, polyunsaturated fatty acids and omega-3 fatty acid (22). Native foods are the primary source for omega-3 fatty acids, vitamin B-12 and vitamin A. Increasing levels of contaminants and whether those levels have neurodevelopmental impacts also need an expanded research effort (23, 24). Assessing vulnerability to nutrition in regard to effects on the brain and behaviour need to be initiated (25, 26, 29).

Sudden infant death syndrome is the leading cause of infant mortality in Alaska. In the U.S. in general, SIDS is the leading cause of mortality between the first and twelfth month of life. SIDS accounted for one-third of all U.S. infant deaths, or 0.72 deaths per 1,000 live births in 1997 (27). SIDS has a disproportionately high impact on U.S. minority populations nationwide with American Indians and Alaska Natives suffering the highest rates. Within the state of Alaska, SIDS claimed 2.23 infants per 1,000 live births among Alaska Natives and American Indians in 1996–1998 (27). SIDS constituted 25% of all infant deaths (of any age) in this area during this period. Thus,

Alaskan minority populations experience a significant health disparity: they experience SIDS at three times the national average and four times that of American Caucasians. To put this in perspective, the reader is reminded that Alaska has one of the nation's highest rates of work-related fatalities, averaging 0.22./1,000 worker deaths annually. This fatality rate is five times that of the overall U.S. work-related fatality rate of 0.04/1,000 workers per year. Alaska's annual SIDS-related mortality, however, is up to ten-fold higher than for Alaskan workers. So while Alaska has long held the reputation of being a dangerous place to work, it is also a very dangerous place to be born. Statistics for SIDS-related mortality from non-U.S. circumpolar populations have been difficult to obtain.

In the early 1990s the American Academy of Pediatrics (AAP) released its first policy statement on reducing the risk of SIDS. The statement recommended that all healthy infants be placed on their backs to sleep. Subsequently, the National Institute for Child Health and Development, the AAP, the SIDS Alliance (now First Candle/SIDS Alliance), the Association of SIDS and Infant Mortality Programs and the Maternal and Child Health Bureau of HRSA launched the Back to Sleep campaign to help inform all parents and infant caregivers about the importance of an infant being placed on its back to sleep. The percentage of infants placed on their backs to sleep has increased dramatically, and the rates of SIDS in the U.S. have declined by more than 50% (<http://www.nichd.nih.gov/sids/>). However, the rates of SIDS in Alaska have not declined by 50% since the inception of the Back to Sleep

campaign. This warrants investigation; specifically, researchers and public health workers in Alaska need to determine whether the campaign failed to reach Alaska, failed to promulgate in Alaska because of culturally insensitive public service announcements, or if it failed in Alaska because placing an infant on her/his back to sleep fails to adequately address the underlying pathophysiology of SIDS among Alaskan infants.

Infectious Diseases and Acquired Immunodeficiency Syndrome (AIDS)

Infectious diseases present challenges in the high latitudes of the Arctic and sub-arctic. Often, the central nervous system is involved in later stages of the disease. The advances in the methodology to understand Neuro-AIDS can be used as a model for neuronal involvement in other infectious diseases.

HIV infection and AIDS are increasing causes of illness in some regions of Alaska as well as the entire United States. The barriers to effectively addressing sexually transmitted diseases are magnified by the problems of drug addiction, stigma and discrimination currently associated with HIV. Death rates due to HIV infection have declined in recent years, primarily as a result of advances in medical technology and treatment, and the number of persons living with HIV infection is increasing (17).

Conclusions

A series of recommendations were developed by the working groups and meeting participants to guide the focus of neuroscience research in the near future. These recommendations are summarized in Tables II to IV.

Table II. Recommendations for research priorities.

Recommendation	Health disparity
Primary prevention/intervention studies can be initiated immediately to reduce the incidence of stroke.	Stroke
Further epidemiologic investigation of pathologies with unusual prevalence/incidence.	SIDS, Substance Abuse
Further epidemiologic investigation of risk factors associated with metabolic syndrome, dietary constituents of unusual prevalence/incidence (i.e., berries, omega-3 fatty acids and contaminants).	Brain Cancer, Contaminants/Toxicity
Investigation of the additive effects of extremes in the physical and social environment.	SAD, Depression
Methodological research is needed to develop protocols and data collection instruments to standardize surveys of Native populations across countries for recruitment, dietary assessment, definitions of health status, physical activity assessment, socio-economic status and culturally sensitive interventions.	Stroke and Brain Injury, Depression, Suicide, Alcohol and Drug Use, Child Health and Development, SIDS, Infectious Diseases and Acquired Immunodeficiency Syndrome

Table III. Recommendations for effective research partnerships.

1. Assure that future research efforts are conducted in a culturally sensitive and respectful way.
2. Develop Ph.D. training programs that are easily accessible to minorities seeking to broaden their career goals to become research investigators.
3. Promote hiring and training of Native staff as a component of all research funded by Native populations as a way of building capacity within research populations and improving the conduct and quality of research studies.
4. Promote the sharing of data and cohorts among researchers and neuroscience research programs.

Table IV. Recommendations for facilitating international comparisons

1. Encourage the U.S. National Institute of Health's Fogarty International Center for Advanced Study in Health Sciences to lead an effort in organizing an international consultation for the purpose of establishing collaborative neuroscience research on health disparities of circumpolar populations.
2. Establish bioethical training and IRB courses, which include neuroscience issues, at universities accessible to minority populations.
3. Promote the development of community-based research partnerships.

Because of the mission of the sponsoring agencies, this working group focused discussion on the role of neuroscience in complex disorders. Larger, more coordinated efforts that expand the scope of health disparity investigations to include neuroscience education and training are needed. The effort, interest and leadership provided by the National Institutes of Health is needed on a continuing basis if these promising opportunities in translational health research are going to move forward and eventually eliminate health disparities. On an international level, the IUCH is the natural vehicle for national agencies to work through for coordination. The importance of global collaboration to address public health challenges cannot be over emphasized (28)

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