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Data Coordination and Career Stimulation in Polar Biomedical Research

Committee on Polar Biomedical Research
Polar Research Board
Commission on Physical Sciences, Mathematics,
and Resources

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Preface

Today, the world is becoming increasingly aware of the strategic, commercial, and political importance of the polar regions. The United Nations and many previously uninvolved second and third world countries are giving greater attention to Antarctica; the World Health Organization continues its special concern with issues and problems of arctic circumpolar health; and the United States recently enacted an Arctic Research and Policy Act and prepared an Arctic Research Plan, and continues its active participation in antarctic research and policy as well.

As this high latitude concern grows, and as population and activity in polar regions increase, so, too, do the awareness of biomedical problems, many unique to these high latitudes, and the need for polar biomedical research to assist in meeting these problems. Therefore, the Polar Research Board (PRB) of the National Research Council's Commission on Physical Sciences, Mathematics, and Resources established an ad hoc Committee on Polar Biomedical Research in 1980 to review and report on research needs as part of a broader PRB effort to develop a strategy for polar research over the coming decade or so. The committee published its findings and recommendations in fall 1982, together with an appendix listing and summarizing selected literature on hypothermia. The Department of Defense, which had supported this study, encouraged a follow-up effort to provide more specific guidance on ways to improve access to biomedical data, to facilitate application of data, and to attract more people to the field. In response, this appendix to the committee's initial report further considers U.S. polar biomedical research needs--particularly for more effective coordination of

data collection and data access, and the stimulation of careers in polar biomedical research.

The committee received aid and encouragement from the PRB and its staff. The generous collegial exchanges with representatives from a number of private and governmental agencies were also of great benefit. The committee further acknowledges the sustained support and interest of the Department of Defense (DAMD17-83-6-4110/R), which made this study possible.

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Executive Summary

The United States allocates relatively little support to biomedical research in the high latitudes. Yet, the increasing strategic and commercial importance of these areas will lead to ever-increasing activity in them. This trend, coupled with the possibility of contributing new knowledge to medical science, strongly suggests the need for greater emphasis on polar biomedical investigations.

Rapid, effective development of polar biomedical research is limited critically by the lack of awareness of and access to polar biomedical research data and by lack of awareness of career opportunities and satisfaction that this field can provide. The Committee on Polar Biomedical Research considered these two problems (data coordination and career stimulation) to be interrelated. Improved data coordination could stimulate careers in this field, and a greater number of qualified people doing polar biomedical research could improve data collection and application. The committee further assumed (as is true elsewhere in medicine) that attention to service needs would lead to crucial research and attract more people to the field to conduct it. In biomedicine, in contrast to the earth sciences and engineering, consideration of service needs is closely linked to and generally precedes research effort and the stimulation of careers in research.

Data coordination problems in polar biomedicine include (1) identification of data that have been collected, (2) identification principal investigators, (3) notation of limitations or qualifications for use of data, and (4) determination of accessibility. The committee reviewed issues related to age and applicability of existing data, and data needs and the

people and skills required to address these needs.

With regard to career stimulation, the committee recognized a need to make students and established medical science organizations more aware of the potential and attractions of polar biomedical careers.

The Committee saw the need for the establishment of a circumpolar health research advisory center that would provide advice on the coordination and consolidation of research design; sources and levels of support; data collection, data storage, and data analysis; and publication and other means of data dissemination. In practice, such a center could operate as a kind of switching station for the coordination of data collection and use. This type of an advisory center would have a small permanent staff but would rely on many advisers to fulfill its mission. It could be a part of an already existing agency with experience in the collection and dissemination of health research data.

Additionally, the committee saw need for establishment of a multiservice, multidisciplinary, and multipurpose circumpolar health career center. This center would be concerned with dissemination of career information, curriculum development, vocational counseling, and community development. Numerous advisors would supplement its staff. The committee suggests that there be core funding for the proposed center but that the center also raise supplementary funds for the conduct of specific projects. Many considerations, including ease of providing field experience, suggest Alaska as a natural site for this center.

The committee did not address the issue of whether there should be a single polar biomedical research center encompassing the functions of both data coordination and career stimulation. The functions are linked, but a decision in operating a single entity with a broad, diverse program of two somewhat more narrowly oriented units would be more appropriate to the agencies that would be concerned with support and organization.

Background

OBJECTIVES OF THE REPORT

In September 1982, the Committee on Polar Biomedical Research of the Polar Research Board issued Polar Biomedical Research: An Assessment and an appendix, Polar Medicine: A Literature Review.[1,2] These publications are part of the board's "Polar Research--A Strategy" series of studies organized to recommend research directions and priorities to guide the evolution of polar research over the next decade.

To supplement the 1982 documents, the committee prepared the current follow-up effort, which develops further two sets of recommendations that were of special interest to the sponsors of the initial study. They are as follows:

1. to improve awareness of the polar biomedical data that exist, facilitate access to these data, and foster their wider application; and
2. to strengthen polar biomedical curricula and encourage more people to pursue polar biomedical research.

Among the conclusions reached in the 1982 report were the following:

1. Psychocultural factors, as compared with purely biological factors, generate a disproportionately large share of polar medical problems, and will continue to do so; therefore, greater research attention to them is essential as development and population growth accelerate in polar regions.
2. Many data resulting from or useful in biomedical

research already exist, some in the data banks of private organizations; top priority, taking precedence over even the initiation of new research, is to foster awareness of these data and to apply them.

3. In view of the rapid population increase in polar regions over the past decade and the likelihood of continuing population growth, greater emphasis on polar biomedicine in educational programs and professional society activities and publications is urgently needed.

RECENT STATEMENTS ON POLAR BIOMEDICAL RESEARCH

Several recent publications prepared by the World Health Organization (WHO), the Inuit Circumpolar Conference (ICC), the National Research Council (NRC), the Scientific Committee on Antarctic Research (SCAR) of the International Council of Scientific Unions (ICSU), and the American Public Health Association (APHA) present information related to the goal of this study.

In 1978, a WHO presentation in Siberia at the Fourth International Symposium on Circumpolar Health indicated that research on health and medical problems in polar areas had been under way for many years, and stated that:

> Slowly the priorities have changed from interest in the impact of cold on human beings, physical anthropology and genetics, to studies of the entire spectrum of health and disease, 'the total man and his environment,' 'man in the biosphere,' and to decisive socio-medical factors of ill health.[3]

In 1981, a WHO Circumpolar Working Group addressed the following circumpolar issues:

1. requirement for comparative and comparable data;
2. identification of available data, with particular reference to the experience gained by the Nordic Council for Arctic Medical Research when trying to improve computerized literature searches in circumpolar health;
3. means of making data comparable;
4. methods of making comparative studies with the basic variables of epidemiological research (person, place, and time) as points of departure for the discussions;
5. priorities for research sponsored by WHO, with the working group attempting to identify the problems that

are most important and amenable to comparative studies and that would benefit most from WHO sponsorship;

6. Suitable areas for research, such as consideration of cancer among Eskimos; and

7. ethical considerations related to circumpolar health research.[4]

In addition a working group of the WHO meeting in Greenland in 1985 addressed the issue of family health care in circumpolar regions.[5]

The Inuit Circumpolar Conference, an international confederation of people indigenous to the high northern latitudes met in 1980 at Nuuk, Greenland, and discussed health related issues. They endorsed the following commitments:

1. to establish a registry of illnesses for several Inuit health authorities;

2. to study methods for training administrators, community health aides, paraprofessionals, and professionals;

3. to conduct research to increase the effectiveness of practicing paraprofessionals; and

4. to set forth clearly the criterion that all medical personnel have sufficient linguistic and cultural knowledge to render satisfactory care to the Inuit.[6]

During the Sixth International Symposium on Circumpolar Health, held in Anchorage, Alaska, the SCAR Working Group on Human Biology presented an extensive report of the International Biomedical Expedition that traversed a large segment of Antarctica.[7] This was the first antarctic expedition undertaken for pure medical research into human activity in the cold. The expedition members gave many examples of the difficulties experienced, even among a dedicated, highly trained group, in confronting relatively straightforward problems of language differences and the need to agree on data design, data collection, and data reduction. Many of these subtleties are presented vividly in an excellent film produced by one of the expedition members. This film documents such problems before, during, and after the expedition. (The film is available through the Australian Broadcasting Corporation.[8])

Also, the International Union on Circumpolar Health was established in March 1986 in Stockholm, Sweden. The objectives are as follows:

1. to promote international cooperation in the study of circumpolar health;
2. to encourage and support research and exchange of scientific information in the circumpolar health sciences;
3. to promote public awareness of the current situation of circumpolar health; and
4. to provide a means of communication with other organizations and encourage participation in the activities of the ICSU.[9]

In 1984, an APHA task force issued a statement, "The National Arctic Health Science Policy," prepared "to assure that the United States is prepared with adequate knowledge to execute its policies for national development, environmental protection, and national defense in circumarctic lands and seas and mid-latitude cold or mountain regions in a manner that protects and promotes the health and quality of life of people living and working in those regions."[10]

The statement recommended that arctic health research could be strengthened by:

- Development of "Arctic Desks" within the National Institute of Health (NIH), the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA), the Environmental Protection Agency (EPA), and the National Science Foundation (NSF).
- Convening of task forces within NIH, ADAMHA, EPA, NSF and other agencies to define arctic health research priorities within the mandates of those agencies. The statement notes that interagency collaboration and coordination are essential.
- Vigorously promoting international cooperation between scientists researching health issues in the Arctic.
- Improving mechanisms to publish, review, translate and abstract arctic health-related scientific literature.
- Developing a computerized directory of scientists with arctic health expertise.
- Developing and maintaining an arctic health information repository and clearinghouse to provide ready access to previously published and unpublished articles and reports pertinent to the Arctic and as a mechanism for rapid dissemination of new results.
- Convening a series of working groups to recommend standardized definitions and measurement parameters for

health and environment-related data collection in arctic areas; assure maintenance of a system for collection, analysis and prompt reporting of vital and other health statistics necessary to accurately monitor morbidity and mortality of arctic populations; assure a system of collection and reporting of demographic data of arctic populations that are timely, accurate and sufficiently detailed to provide baseline data to monitor health and to use as a guide for appropriate distribution of health-care resources and personnel; and develop a program to establish data and to monitor environmental factors such as ambient air and water quality data.

- Developing an arctic health research resource system to: maximize quality, cost-effectiveness, and productivity through a multidisciplinary international network of researchers affiliated with diverse institutions and assisted by an organization for coordination, logistic support, training and research in the American Arctic; maintain appropriately trained personnel and logistic support so that these personnel can respond rapidly to unusual reports of illness.

The roles of agencies, organizations, and individuals involved in arctic research are also addressed. These groups should:

- ensure health research in the Arctic is appropriate and addresses unique and/or important problems of the Arctic and its populations;
- ensure health research in the Arctic is done only with the participation, full consent, and approval of the people to be studied as well as the professionals and agencies involved in providing health care; and
- ensure that results of all research are reported back to all those involved in a timely and appropriate fashion.

The U.S. Congress enacted the Arctic Research and Policy Act of 1984 to establish national policy, priorities, and goals and to provide a federal program for basic and applied scientific research for the Arctic, including natural resources and materials; physical, biological, and health sciences; and social and behavioral sciences. The legislation states:

1. The Arctic is a natural laboratory for research into human health and adaptation, physical and

psychological, to climates of extreme cold and isolation and may provide information crucial for future defense needs.

2. Improved logistical coordination and support for Arctic research and better dissemination of research data and information is necessary to increase the efficiency and utility of national arctic research efforts.

3. The federal government, in cooperation with state and local governments, should focus its efforts on the collection and characterization of basic data related to biological, material, geographical, social, and behavioral phenomena in the Arctic.

4. Research into the long-range health, environmental, and social effects of development in the Arctic is necessary to mitigate the adverse consequences of that development to the land and its residents.

5. Arctic research expands knowledge of the Arctic, which can enhance the lives of arctic residents, increase opportunities for international cooperation among Arctic-rim countries, and facilitate the formulation of national policy for the Arctic.

GENERAL CONSIDERATIONS

The United States has major interests in high latitudes related to both defense and potential commercial development. In both hemispheres all inhabitants have the right to health care comparable to that which is available in other geographical areas of the United States. Distance, communication problems, or sparse (or nonpermanent in Antarctica) populations do not alter this expectation. In this sense, the nation should be prepared to provide such health service.

At a minimum, such provision will reduce stress on individuals and families living or working temporarily in these latitudes. There is compelling evidence that indicates stress can cause illness, and evidence is accumulating that family stress can reduce efficiency of an individual's performance.[11,12] Related research suggests that persons who undergo a major disaster are more at risk in terms of both morbidity and mortality.[13] This has particular importance in polar medicine because in some ways, a number of inhabitants in high latitudes live under constant "disastrous" conditions.

COOPERATION

The committee concludes that data coordination is essential to strengthen the ability to conduct polar biomedical research. Enhanced computer skills are an important ingredient in this effort. In both curriculum and education, it is essential to identify and facilitate formal and informal pathways for agencies and institutions to share and support polar biomedical research. In no field is this facilitation more critical than in biomedicine. Such involvement is necessary to ensure the provision of adequate health care, the identification of research goals and improvement of research design andtechniques, and the application of research results. Many natural allies might be encouraged to increase cooperation and outreach in polar biomedicine. Organizations mentioned above are part of such a natural constituency that fosters cooperation and outreach but not always as effectively as is needed. Cooperation and outreach need to be enhanced.

All the organizations now working together in various ways (including many polar projects) cannot be listed in this brief report. Some that might have greater impact if brought into increasing collaborative effort in polar biomedicine are National Science Foundation, all branches of the U.S. armed services, U.S. Public Health Service, National Institutes of Health, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, Environmental Protection Agency, and many departments of the government of the state of Alaska.

A partial list of potential allies can also be offered. It would include, at a minimum, organizations of deans at medical and other graduate schools, organizations of professors in both clinical and basic sciences, foundation executives, vocational counselors, editors of research and clinical journals, executives in large medical and basic science societies, science writers, and data bank and general administrative managers in a variety of public and private organizations (especially those concerned with fishing, lumber, mass media, construction, travel, mining, oil, climate, and medical supplies). Such a list of actual or potential allies in polar biomedical research should include Canadian counterparts, because historically, Canada has made a more deliberate effort in these areas.

Others with whom the U.S. biomedical research community might seek even greater integration of effort include WHO, SCAR, ICC, Nordic Council for Arctic Medical Research, and the International Union for Circumpolar Health. If more international projects and the standardization of data and protocols are to be realized and to have maximum effect, consideration should be given to including international medical and behavioral science societies in such planning.

U.S. polar biomedical effort could profit from awareness and assertive cooperation with ongoing international biomedical efforts. For example, earth scientists, but not medical scientists, have taken advantage of agreements encouraging international research on Svalbard. Also, the United States is involved in ICSU's International Geosphere-Biosphere Program, which will complement other international programs, but to date has shown little concern about human health and behavior. Another example is the scant U.S. representation in a high-quality research project dealing with the physiology of diving in cold water, undertaken by the Comite Arctique, the Society for Underwater Technology, and the Nordic Council for Arctic Medical Research.[14]

SOME SPECIAL CONSIDERATIONS

The committee was fortunate in having productive interchanges with invited experts from a variety of agencies. The Committee also undertook some computerized data searches to become better acquainted with the scope of data problems. Several questions resulted: How much is known and available? What are some of the chief obstacles to polar biomedical research? Are there little-used or underdeveloped research opportunities? Are there links between the two aspects of the committee's study?

Attachment A lists selected data sources for polar biomedicine. Computerized searches of the results of polar biomedical research were conducted over a four-year period by means of the ERIC, BIOSIS, MEDLARS, and Dissertation Abstracts systems. From these searches, plus the inspection of other major data sources, the committee concluded that the widely circulated opinion that some areas are oversearched should be reconsidered.

For example, the search revealed only 28 biomedical or social science articles or theses in those computerized data bases that deal with northern studies in Canada, Alaska, or Greenland. Yet perceptions that data are abundant and accumulating rapidly have some basis in fact. Much material that escapes computerized data base services may be available in so-called "gray literature" such as technical reports, unpublished in-house communications, and unanalyzed raw data held by agencies and investigators. The committee believes much "gray literature" data pertain to inquiries about delivery of services, and the need to identify ways of accessing and utilizing these data is pressing.

Expert testimony identified some of the obstacles to polar medical research. An overriding issue is that structurally, at present, polar biomedical research falls between assigned mission objectives of major government agencies. In part, this seeming lack of relevance may reflect an absence of a subspeciality in polar medical research, which means that researchers must compete for available funds with a broad range of excellent proposals not specifically addressing polar issues.

Submission of greater numbers of high-quality proposals in polar biomedicine to funding sources should be encouraged, as should reviewer sensitivity, both to the growing need for polar biomedical research and to the extra burdens such research can entail as a result of logistical and sampling problems.

For at least 15 years the Polar Research Board has urged more participation by native populations in research at all levels. Perhaps this participation is nowhere as necessary and as easy to accomplish as in biomedical investigations. There is a need to reinforce the rights of individuals and communities to participate in research, including research design, data collection, and handling problems of confidentiality. Efforts should be made to expand representation of concerned minorities on study sections and site visit groups. Such native participation could lead to a shift in research goals, with a new and greater emphasis on positive strengths and prevention in contrast to studies of pathology and attempts to find cures. The Alaska Native Health Board, the Alaska Area Health Service, and the Indian Health Service can provide insight on "native" concerns. Presentations to the committee revealed that the public sector does not known how to make use of the available expertise of those who live and work in polar areas. At

the same time, the need for more proposals from nonnative investigators was also stressed.

New research opportunities may occur in a wide range of private and public organizations. The committee was told, for example, that the tourist industry, which now views both polar regions as within its province, might welcome more biomedical advice. This help is needed on medical and cultural preparation for trips and management of emergencies, including injury or death of tourists. Policy advice may require new research and provide new career opportunities.

Improvement of collection, accuracy, and accessibility of demographic data is crucially important to polar biomedical research and to the rendering of service and the discovery of needs for investigation.

INTERRELATIONSHIP BETWEEN STUDY OBJECTIVES

(Education and Career Enticements for Research and Service and Coordination of Information Systems for Research and Service)

Improved education and career enticements for polar biomedical research and service should lead to increased coordination of information systems for research and service. Similarly, the increased coordination of information systems for research and service should lead to improved education and career enticements for polar biomedical research and service. These activities are complementary and mutually beneficial.

A tradition in the history of medicine is that clinical service cannot be separated from research inquiry. With the weight of this tradition in mind, recommendations must take into account that a cadre of part-time or full-time researchers is unlikely to develop in the absence of focused attention on clinical needs and problems. For that reason, educational and career enticements must first center on clinical service. To make clinical service smoother, more effective, and thus more enticing, the availability, accessibility, and usefulness of information systems can be persuasive.

Ideally, information handling should be geared to the broad range of practitioners and investigators, as well as of agencies and countries, each with its particular missions and interests. Data systems should be consistent, comparable, and easy and inexpensive to use.

Under the same constraints is the objective of recommendations for career enticement and education. Here, the task is to attract, select, train, and retain a larger number of people in polar biomedicine. From this larger number will emerge those who will conduct research and produce new data.

The first step in improving information systems is to improve coordination of polar data activities. The first step in career enticement and education is to stimulate awareness of the opportunities and needs that characterize the polar regions.

SOCIAL SCIENCE ASPECTS

Both data coordination and career stimulation in polar regions can be facilitated by contributions from social science. In both cases there are some critical questions. Who enjoys working in cold environments? Who can function well in cold environments? How can functions in cold environments be improved? How does one endure and perform under extreme duress such as cold and isolation? What is the influence of social environment on cold-weather performance? How do coexisting cultural and subcultural groups maintain both integrity and peace in polar environments?

Some of the answers to these questions relate to classical social science studies on compliance, public opinion, motivation, habitability, and quality of life. More than other disciplines represented on the Polar Research Board, medicine operates within a behavioral context and social matrix. However, the other disciplines share a concern about data coordination and career stimulation in polar regions. In that sense, as well as in terms of broader features of acceptance of results and implementation, all polar science and engineering disciplines might be interested in contributions from behavioral and social sciences. The Polar Research Board through its newly formed ad hoc Committee on Arctic Social Sciences will examine the need for additional behavioral research in the Arctic and the related data needs and coordination.

Data Coordination

Perhaps the greatest problems are to know what data have been collected and who has them. Often, the results of research in polar biomedicine are reported in technical reports that are not widely known nor readily accessible. A directory or listing would not solve the problem. Rather, some kind of structure is needed to guide users to data resources; to determine the appropriateness of the data in relation to a researcher's objectives; to provide information on reliability and validity of the data and on factors related to sampling, mode of collection, format, and so on, that would impose limitations on their use; to facilitate access to the data; to identify gaps in coverage; and to identify future research needs.

Another major problem in polar biomedicine is the relative lack of data-processing capability. In addition, especially in the Arctic, there are not enough people capable of scientific programming and analysis. Scientific programming requires a variety of specialized skills, but there has been little effort to attract people with these skills to the field. For example, we know of no centrally located processing and analysis facility that offers a fellowship program to encourage field work or foster data-collection experience. However, the University of Alaska in recognition of this need has recently designated one of its campuses for "health and bio-medical research," which should alleviate this problem.

Lack of awareness of and access to international research is a problem. More translation programs and networks to facilitate the exchange of data are needed.

Guidance is needed in establishing priorities for data collection, in developing criteria to improve the quality

and comparability of data, and in identifying factors that affect the validity and use of data.

The principal objectives of data coordination should be to maximize the use of existing data, to guide the acquisition of new data, to eliminate redundancy, and to identify needs and priorities to increase the return on investment in polar biomedical research.

PRACTICAL NEEDS AND ISSUES

Planning to improve polar biomedical data handling must take into account several general and specific issues.

- Life Span
  - Which data sets should be removed or modified?
  - How can data banks be evaluated for the reliability, validity, and importance (uniqueness, relevance to need applicability) of their collections?
  - How can such monitoring (evaluation) be conducted, and to what depths should evaluation reach?
  - How can advice be provided on the construction of research protocols, for example, for disaster response?
- Social and Ethical Issues
  - Investigator concern about loss of control of data.
  - Concerns of investigators, subjects, and communities about confidentiality of data.
  - Ethical concerns about modes of data collection and use.
  - Concerns about uses and misuses of qualitative sources (for example, diaries).
  - Concerns about the definition of polar conditions, restricting the generalization and application of results. Data collected in polar regions can apply widely. They can, for example, contribute to the understanding of problems in space research, in high-altitude settings, and in other low-population high-density, hostile, and severe environments.

- Investigators' Needs
  - Organizing and systematizing data.
  - Checking data for reliability and validity.
  - Sources of support for data collection,processing, and archiving.
  - Availability of equipment, personnel, buildings, and space.
  - Use of computer services, including graphics.
  - Opportunity for collegial relations.
  - Access to communities.
  - Knowledge of available "gray literature" (prepublication copies, technical reports, limited-circulation in-house reports, sets of raw data, other unrefereed literature).
  - Logistics.
  - Advice on problems and constraints in circumpolar health research.

IDEAL NEEDS AND ISSUES

Beyond what is practical and necessary for the immediate future, there are long-term data issues. The Committee did not attempt to design an ideal data system that would meet both pressing immediate needs and all foreseeable long-term concerns. However, the need for better management of and access to medical information and data is obvious. Given the state of the art in medicine and the popular expectations concerning health care, speed and accuracy are essential for a wide-scale, automated information network to be effective.

The core of such a network would be a center drawing on a common set of data elements. Network members would define their needs and what they would enter. Members who contributed information would be able to draw on the data resources regardless of computer language used. Such a system would have to take into account such limitations as confidentiality, and it would be user-friendly, flexible, and able to process and retrieve data easily. Most important, it would be interactive, that is, a bit in the system could be obtained and exchanged.

Economic benefits as well as delivery of service benefits would result, especially in diagnosis, treatment, prognosis, and prevention. Improved standards and efficiency in practice, planning, and staffing would be expected to result. Research would be encouraged and

its impact enhanced. Medical service and research in polar regions would be an excellent field in which to experiment with the introduction of widespread data-management networks. Compared to other fields of science, it would be a relatively small-scale operation, with tremendous potential impact.

AN APPROACH TO SOLUTION OF DATA-COORDINATION PROBLEMS

One approach to polar biomedical data problems would be the creation of an information switching center and research support facility. This would consist of a small group of permanent employees, including people with scientific programming and biostatistical capabilities, and might also include research personnel. It could be an incremental activity, beginning with perhaps three or four people in an existing agency or university, preferably one involved in this field.

The proposed center would not store any data; it would not be a repository. It might better be described as a network of relationships, an advisory and switching center. The staff should be supplemented as needed. For example, a task force to deal with a particular problem, such as data validity, could be enlisted. Perhaps, a review group composed of representatives of sponsoring agencies and users might be assembled. This kind of center or research facility could assist in many ways--from putting interested individuals in touch with one another to providing help with data formatting, analysis, and graphics.

A facility of this sort is not a bricks and mortar entity but an information resource and advisory center. Hence, it could be located anywhere in the United States. One possibility would be the National Library of Medicine. The library is politically neutral, would have the required expertise, could facilitate the development of a file of researchers and data resources, and has formal and informal affiliations with critical governmental and private medical resources.

The proposed center would encompass the following:

1. Facilitate the performance of polar biomedical research by using a network of scientists to advise about what is feasible, what problems have or have not been

explored, and the content, format, and inherent limitations of data.

2. Facilitate access to data by maintaining a file on who has collected what data and the scope and format of these data.

Categories of information that could be maintained include the following:

a. title of research project,
b. name of researcher(s),
c. telephone number of researcher,
d. name and address of researcher's organizational affiliation,
e. source of funds for project,
f. term of project and time interval for which funded,
g. amount of grant or contract (not mandatory),
h. scope of research project,
i. form of the data at completion of research project (digital, report, file, etc.), and
j. for digital data, information on the data format (kinds of information recorded, names of data fields).

This compilation should be maintained in a computer data base and updated annually.

3. Deal with the many aspects of data quality.

Data validity can be reviewed in different ways on different levels. This review can be of the scientific content, the digitization accuracy, or the digitized material for format compliance, code compliance, and individual field values. Some of these criteria, such as digitization accuracy and the checks of the corresponding digitized data can be dealt with in fairly straightforward ways. Review of the data or of a projected scientific content could pose additional problems. Who does the review? Why is the content being reviewed? How will the review affect the future work of the individual investigator?

4. Assist researchers with the design of data format and answer questions pertaining to that design.

Many of the errors that occur in digitized data can be resolved by proper format design prior to digitization and analysis. This is extremely important if the format is to be used for an extended time. The design should include individual fields, and the different types of records containing those fields, and should be set up in

such a way as to allow for present and future needs.

5. Checking data.

This task would check for accuracy of the digitization process and can be accomplished most effectively by computer check programs designed to review compliances with the data format, validity of coded information (e.g., organization codes and location codes), relationships among data fields, and compliance of individual field values with specified value range boundaries. The data checking service could be provided on request, providing data validation assistance prior to the analysis phase of a project.

6. Provide computer services to individuals.

The center could have a biostatistician and a computer programmer available, skilled in biomedical data, who could provide assistance in data analysis. The center could also have the computer hardware resources, or access to these resources, to help researchers with specific projects. In addition, the center should have access to international computer networks, which would allow it to access data from other circumpolar countries. Such assistance would have special value in encouraging clinicians and young scientists who might not have such services available in polar areas.

7. Supply graphic support.

Computerized graphics have become an inexpensive way to meet numerous graphics needs. Camera-ready quality graphics can be supplied for articles, reports, and presentations (overheads, slides), as well as analysis graphics to be used as a data-analysis tool. Such a service could be a great benefit to many researchers who do not have access to those services.

Career Stimulation

Polar biomedical research need not necessarily be conducted in polar regions. Much medical research applicable to populations in polar areas can be conducted elsewhere, just as is true of tropical medicine. However, to attract researchers, wherever the research may be done, greater effort is needed to bring to the attention of students and science organizations the potential and satisfaction of total or partial careers in polar medicine.

Merely providing opportunities in polar medicine has been sufficient to recruit some medical students and residents to service and research endeavors in the high latitudes. For example, a request for a second-year medical student to interrupt study for one year to work at the South Pole brought immediate and serious inquiry from a majority of students at one medical school.

Perhaps the best method of predicting whether such opportunities will be attractive is the amount of sustained funding made available by the federal government. This has been the customary method for controlling medical manpower. In the past, deliberate efforts to increase the pool of teachers, investigators, pathologists, family physicians, and other specialists has resulted from an avowed national interest, manifested by special funding programs. Such an affirmation on behalf of polar biomedicine would be appropriate in view of the Arctic Research and Policy Act of 1984, as well as the Presidential Memoranda of 1982 and 1983, dealing, respectively, with U.S. presence in the Antarctic and Arctic. This new federal interest could result in more activity in polar biomedicine. With these hopes and possibilities in mind, we considered a number of approaches to career stimulation.

TYPE OF PROGRAM

A flexible, multipurpose, multidisciplinary effort is needed to stimulate interest in polar biomedical careers. The program should be of sufficient scale and scope to affect general educational aspirations in the United States, in particular, the objectives of medical and basic science institutions and organizations.

Means should be found for direct, immediate recruitment into careers in polar biomedicine. A facility to foster short-term field experience, contact with relevant consultants and preceptors, and training in interdisciplinary methods could be valuable and could also provide a variety of educational and vocational counseling. The program could make use of many communication channels, could sponsor seminars and meetings, and exploit electronic as well as printed communications.

PARTICIPANTS

This program would seek to recruit more physicians, dentists, basic medical scientists, nurses, community and social workers, physicians' assistants, medical paraprofessionals, medical technicians, medical data computer specialists, reference librarians, epidemiologists, public health workers, medical planners and administrators, medical economists, and behavioral scientists for work in polar regions.

In order to mobilize target participants into entering this program, they must be made aware of the wide range of professional opportunities in polar regions. Additionally, the motivations and needs of the target participants must be considered in developing the program.

OPPORTUNITIES

Detailed information on the range of opportunities in polar biomedicine has been published.[1,8] This committee's 1982 report identified specific research needs in three fields of polar biomedicine:

> We recommend as highest priority for biological inquiries the integration of basic medical science with clinical medicine. In addition, biometeorological studies and studies on conservation of water supply and disposal of waste should receive special attention. In social science, the highest priority should be research dealing more precisely with the features that contribute to a positive 'quality of life' in polar regions. Such features will be instrumental in ameliorating problems arising in the workplace, workforce, and home life of polar inhabitants. Study of the impact of such features could be crucial in achieving a better understanding of behaviorally based diseases, which are prominent in the high latitudes.

The scope of opportunity can accomodate workers in fields a diverse as cross-cultural studies, public health, wilderness medicine, indoor microclimatology, stress, human ecology, social medicine, cold pharmacology, and cold physiology.

MOTIVATION

To attract and maintain exposure of target participants to high-latitude career options, the plan should include deliberate appeal to selected human sentiments and needs. Knowledge of the motivation that draws people to live and work in polar regions is important in stimulating greater interest in polar medical careers and graduate school curricula. This knowledge is necessary to provide effective service and to conduct research on polar inhabitants. Thus, attention to performance, satisfaction, and morale in program participants and their families and among polar inhabitants is critical to success in career enticement efforts.

The committee identified some basic criterria for motivational analysis for service or research workers in polar regions:

- Critical mass: How many are in the community? Who are they? What role does each play?
- Work load: Volume of work (it probably is better to be a bit overworked); feelings of usefulness and of exploiting one's talents and expertise; opportunities

for, and the quantity and quality of, positive feedback; time requirement per day; duration of stay.

- Location: Access time (for reasons of health, work, or recreation); opportunity to get to urban and/or familiar places.
- Career ladder: Chances for acceptable responsibility, authority; remuneration; satisfaction with job design and assignment.
- Prestige: Perquisites such as travel opportunity; opportunity for peer recognition, including chances for publication and meeting presentations; control of one's time.
- Altruism: Awareness of importance of one's contribution to quality of life or to science; feeling of being needed and wanted.
- Adventurousness: Challenge; excitement about ability to make pioneering contributions; feeling of doing something different.
- Avocational interests: Chance to pursue personal inclinations and desires such as hunting, winter sports, mountain climbing, camping.
- Availability of mentors: Opportunity for support and encouragement from interested, knowledgeable, and perhaps well-connected persons; opportunity for work-related informal interaction and exchange of information.
- Community facilities: Type and quality of available food, housing, schools, recreational facilities, child care, recreational facilities, health facilities, ease of communicating outside the community.
- Community support: Formal and informal group solidarity and quality and amount of interaction among various demographic components; job opportunities for spouse; special written or oral language needs.
- Impersonal support: Reliable, effective, up-to-date equipment, maintenance manuals, and spare parts; on-site references and audiovisual aids that describe basic procedures and their contraindications and complications; teleconferencing possibilities; availability of standardized protocols.
- Orientation: Opportunity for pre- and postdeployment briefings, especially in instances of culture shock and climatic and physical environmental changes; preparation for special requirements, such as family separation-reunion cycles.

AN APPROACH TO CAREER STIMULATION

A more aggressive and organized effort is required to promote significant increase in polar biomedical careers and to ensure quantity and quality of polar biomedical work sufficient to meet national need. There is virtually unanimous agreement that there will be increasing human activity in the polar regions. Medical science should not lag behind other sciences that are actively involved in planning and implementing a national antarctic and arctic research policy.

Accordingly, a multiservice, multidisciplinary center capable of fostering information dissemination, community development interest, vocational counseling, and curriculum development would prove economical and productive. The facility would have as its mandate (1) to increase the number of people entering polar biomedicine and (2) to increase the polar biomedical presence in undergraduate, graduate, and postgraduate curricula in medical and allied specialities.

If the facility had some basic, continuing core funds from governmental and private sources, it could supplement these resources through contracts for the performance of special projects. The core funds would support a small staff, allow the provision of rent and basic equipment, and permit limited amount of travel and community coordination.

Initially, the staff could be as small as two full-time equivalent positions. A director, probably an M.D. or Ph.D. in medicine or social science, would work half-time. Other half-time positions would be a vocational counselor, a communications expert, and a secretary. With the pressure of increasing work, staff could be augmented as required for effective operations.

The initial effort would be to develop liaison and affiliation with medical schools, universities, polar researchers, clinicians, professional societies, governmental agencies, and natural allies in private industry. Simultaneously, interaction would be initiated with communities that are or could be sites for medical practice and research.

Funds could be sought from the private sector; however, the facility would need access to and support from a number of federal and state agencies with an interest in polar medicine. Polar desks at governmental health and social science agencies could aid this facility. Such aid would encompass not only financial

support but also, and equally important, exchange of information about agency needs and plans, technical development assistance, review panels to guide and assist research, and other forms of support and encouragement.

Alaska, as the only U.S. arctic state, would be the logical location for such a facility. Practical experience in polar biomedical service and research would be available in Alaska. Further, it is more accessible, has more human service needs (more people), and more commercial activity than the Antarctic. Yet a facility located in Alaska could stimulate career interests in both hemispheres.

The need for the facility to have affiliations and liaison with numerous academic institutions, societies, and government agency personnel would suggest that the location be at a university; it is most likely that a branch of the University of Alaska would have the necessary facilities and personnel.

Regardless of the location of the center, core funds devoted to travel would be substantial. The staff could not effectively stimulate careers at locations throughout the United States by remaining on site. It would be necessary to go to universities, society meetings, concerned agencies, and possible sources of funds. The advice the center would require from individual consultants, task forces, or review groups (even if many of the members of these groups were in Alaska) would demand a substantial travel budget.

Recommendations

1. The committee recommends that consideration be given to the establishment of a circumpolar health research advisory center.

Circumpolar health research has never received intensive, continuing support. Despite this neglect, the data from circumpolar health research are beginning to define many problems. To deal constructively with these problems, the United States needs to develop an integrated, carefully considered approach to the collection and dissemination of circumpolar health research data. This could be achieved through creation of a circumpolar health research advisory group. Similar ideas have been expressed recently in other forums; the committee presents its recommendation in a spirit of cooperation and endorsement, with the goal of amplifying not negating or superseding them. The committee emphasizes the need for collaboration and cooperation with mission agencies and other organizations; fragmentation and parochialism must be avoided.

The charge of the proposed center would be to stimulate and facilitate the conduct of humane, timely, high-quality research on circumpolar health problems and to foster the dissemination of the resulting information and data. This need has also been recognized by the Soviet leader Mr. Gorbachev, who in a recent speech in Murmansk called for greater scientific cooperation in biomedical research.

The center would function only in an advisory capacity. It would not assume primary responsibility for research design, fund raising, data collection, data storage, data management, data analysis, or publication. However, it would be available to advise on these and other problems and to promote the interaction with and

access to people and data that are vital to research planning.

From eight to twelve experts in such fields as medicine, public health, information management, environmental studies, and social science would be the guiding force of the center. This group would meet periodically to review progress and to plan for future action. The daily chores, activities, and communications would be carried out by a permanent full-time staff. In addition, a large group of specialists would provide expertise as needed on an ad hoc basis.

Many agencies already have the potential to perform and contribute to some of the proposed functions of the center. Such an agency could organize or sponsor the center and thereby enlarge the scope of its present activities to include those that have been outlined. It is estimated that 5 years would be required to establish a smoothly operating center. An additional 10 years would be needed to evaluate fully its efficiency and impact. Thus, the committee suggests that a commitment be made for operation from the late 1980s through 2000, with a reevaluation to be made at the end of that time. For the proposed center to achieve its goals, it should deal with five principal sets of problems: (1) research policy, (2) research design, (3) research funding, (4) data management, and (5) information dissemination. In practice, the center would be a reference service for interaction in research planning, coordination of research activities, and facilities of access to data.

Such a center could influence circumpolar health research policy in two ways. It could ensure communication and formal working relationships with other agencies involved in research policy, for example, the state of Alaska, Centers for Disease Control, Bureau of Indian Affairs, and Washington Alaska Montana Iowa Medical Program. A member of the center might meet regularly with these agencies individually or collectively to discuss research perspectives. Similarly, representatives from these agencies could be invited to participate in sessions at the center. The center would serve not only as an impartial voice among those groups formulating research policy but would also stimulate and bring about effective research planning.

More specifically, it could influence research policy through yearly publication of a listing of current research projects modeled on the Current Research Profile formerly published by the University of Alaska's

Environmental Information and Data Center. A simple listing of current projects could be quite effective in stimulating research, in avoiding redundancy, and in facilitating cooperation among researchers. The need for and usefulness of such a listing are obvious; however, none is yet available in polar biomedicine.

The center could assist investigators in research design, especially in providing information about logistic support needs and resources. Because of the "exotic" nature of the circumpolar zones, geologic, climatic, social, and economic factors all place enormous constraints on the conduct of research and tend to impede it. Members of the center advisory group might have personal experience with problems confronting researchers or be able to put them in touch with others who have coped with such difficulties and could serve as ad hoc consultants.

By helping investigators identify potential problems during the design of research, the center would help to ensure the quality of circumpolar health research. Such specialized technical assistance also would make polar biomedical proposals more competitive in peer review.

Although the center would not necessarily have funds to support research, it could influence the availability of funds for circumpolar health research by calling attention to needs and opportunities. Conversely, if funds became available, such as in agency requests for proposals, it might facilitate the linkage of agencies with investigators capable of performing the needed research. Finally, through its role in suggesting research policy, the center would have an indirect voice in the allocation of funds for research.

A crucial role for the center would be to advise researchers on data management. The center could maintain a file on details of past and ongoing projects. Information such as source of funds, term of project, location of project, sample size, population size, type of data collected, format of data, and type of data analysis could be useful to other researchers. It would allow researchers to interact and cooperate, and maximize the sharing and the usefulness of data.

If requested by researchers or funding agencies, the center could perform validity checks or statistical analyses in an effort to ensure the high quality of circumpolar health research. Critical ancillary services for individuals such as computer service consultation or graphic analysis would be a valuable contribution. The

center could inform investigators about on-site limitation or availability of equipment, personnel, buildings, or space and how these factors could affect their research planning, and it could advise on solutions to the problems posed by these limitations.

Another vital aspect for which the center could provide useful advice is information dissemination. In its permanent offices the center could maintain an index of papers, published as well as unpublished technical reports, manuscripts, and the like, dealing with topics in or closely related to circumpolar health. In addition to references, it might provide information on how to obtain specialized technical reports or other privately held data and information. The center could also assist by suggesting publication outlets for researchers and could aid publishers by recommending experts to serve on editorial boards or as referees for papers dealing with polar biomedicine.

2. The committee recommends the establishment of a circumpolar health career center.

Here, too, the committee recommends creation of a multiservice, multidisciplinary, multipurpose center. Its function would be to recruit more people into careers in polar biomedicine. Intrinsic to its success would be finding ways to make polar biomedical concerns an integral part of mainstream medical educational efforts.

An energetic, dedicated staff would be required to foster interest in functions such as information dissemination, curriculum development, vocational counseling, and community development. Its core budget would have to be supplemented by funds from private and public sources. However, a commitment by a U.S. government agency--with a polar-health-related mission--to provide core funds for the center would be vital to its effectiveness, its prestige, and the influence it would have. Requests for funds would be guided by the center's particular needs and programs.

The center should have numerous formal and informal affiliations with universities, federal agencies, private organizations and individual authorities. Through these affiliations it would seek guidance, advice, consultation, and support in the accomplishment of its mission.

How the center functions would depend heavily on the background, acumen, talent, and interest of its staff and how the staff and its advisors and sponsors interpret

changing national needs and opportunities in biomedical career development and biomedical education.

The committee strongly suggests that the proposed circumpolar health career center be located in Alaska. The reasons for this choice include anticipated increasing service needs, in-place resources, and accessibility to clinical and research experience in a polar region.

As the center will be multipurpose and as its objectives will vary with emerging needs and opportunities, the full spectrum of the center's functions cannot be stated precisely. At a minimum, these functions would include information dissemination, advice on curriculum development, vocational counseling, and fostering a polar biomedical contribution to community development. Examples of how these functions might be carried out are illustrated below.

To attract workers into polar biomedicine, tasteful, careful outreach and public relations are necessary. Here, information dissemination includes distribution of career materials, continuing education programs, and promotional efforts with actual and potential allies. Funds might be sought for information dissemination efforts such as (a) producing and distributing films and videotapes about various polar biomedical research and service possibilities, (b) compiling and distributing career lists and brochures, and (c) publishing and circulating a newsletter about opportunities and needs. The size of these efforts would be determined by the center's decision on how to exert its influence most effectively within the limits of available funding. The possible audience and relevant organizations could be anywhere in the United States.

An array of continuing educational activities could be the focus of much of the center's program. Funds solicited from public and private sources would be sought for activities such as the following:

- Computer and data-handling courses.
- Polar biomedical courses, for example, for continuing medical education credits. These courses could be sponsored at the center, at various sites in the northern or southern high latitudes, and in various institutions in the United States, not only those in Alaska. (The center would contact and coordinate the experts who would be the faculty for whatever course it proposed.)

- Sabbaticals in research or service in the northern or southern polar regions or for those currently working in polar regions to go elsewhere (thus providing some comparative data and helping to foster broader application of findings).
- Guest lectureships at the center and at universities, professional gatherings, and community forums throughout the United States.
- Exchange programs for U.S. polar biomedical workers with workers from other countries.
- Travel, especially for young investigators to present their work at national and international meetings.

In promotional outreach, the center would work to establish and use mutually beneficial liaisons with as many organizations and experts as possible. To maintain relationships would require constant interaction, communication, and sharing of data and information. As noted previously, a list of those engaged in research and related polar health activities would be extremely useful, and many of those listed would welcome an opportunity to collaborate in some degree with polar biomedical efforts and to compare data or findings. The list could be elaborated and augmented as an ongoing activity. The nature and extent of specific collaborative efforts could affect the level of funding of a project. Investigators might need some additional support for travel to conduct programs and enhance communication.

Promotional efforts in which the center might engage include the following:

- Speakers Bureau: The center could provide names of persons who would be available to speak on polar biomedical topics. The speakers could be particularly useful in stimulating career interest at high schools, colleges, and universities.
- Education: The center could provide names of people who could present or publish polar-related material for specific organizations and agencies.

If educational experience includes polar biomedical concerns, it is more likely that some part of a student's career will be devoted to this field. At present, in almost all pertinent career training, students have little or no awareness of polar biomedical research

problems and opportunities. The center could help develop and strengthen affiliations between relevant service and research needs and various university academic departments. To incorporate polar biomedical concerns into curricula, material to be used at a training site might be provided. Likewise, experience and training in a polar region might be facilitated. Accordingly, the center could seek funds for such projects as:

- Development, by experts, of polar modules that could be inserted into various educational programs. These might include audiovisual aids, case studies, a bibliography, a paper about needs and opportunities, a computerized program, or general information about polar regions. In medical education, for example, this could be distributed to residents in medical specialties, family practice, and anesthesiology and to graduate students in pharmacology and physiology.
- Facilitation of research or service experience in a polar region during graduate school--summer field trips and internships, electives, and fellowships in high latitudes.
- Facilitation of research or service experience as part of postgraduate training, for example, electives or preceptorships during residency, arrangements for a locum tenens, postdoctoral fellowships.
- Support for and advice on the function of a rotating university chair of polar health.

One way to increase the likelihood that people will enter polar biomedicine is to provide informed advice about what such a career offers and demands. This specialized counseling could be time-consuming, but it could also be the key to all efforts to enlarge the pool of polar biomedical specialists. This would include the following:

- Personal counseling on a one-to-one and group basis. Counseling would be performed not only at the center but throughout the United States (with the center's sponsorship and coordination). Innovative methods such as telephone counseling and group teleconferencing might be used, as well as sessions by specialists who assist the center at locations throughout the country.
- Developing and distributing information about

scholarships, fellowships, internships and traineeships.

- Maintaining a vocational resource unit with materials and resources about careers and career selection.

Basic to the success of the center is the good will of its neighbors and the willingness of nearby communities and individuals to be of substantial assistance. Integration and synthesis of many of the program goals will depend on coordination with communities. Included in this networking effort are:

- Locating and collaborating with mentors and preceptors (especially those living and working in the Arctic) who would accept trainees.
- Facilitating the entrance of workers into arctic communities and offering them continuing support.
- Working with various groups to develop and sustain favorable payback programs for people who will render service and research in polar areas during their career development.
- Providing incentives to Alaska natives and other minorities to enter health-related research in polar areas. The center could advise and assist them by some of the following means:

  - Helping minority institutions to train teachers, to provide on-site polar programs for talented youth, and to encourage faculty to submit grant applications.
  - Promoting early awareness of career pathways and improving science curricula in primary and secondary schools attended by minorities.
  - Urging the use of more representatives of minorities on review boards and committees.
  - Using indigenous people and the knowledge of their elders in the design and conduct of research and of the health services they receive.
  - Providing feedback, follow-up, and interpretation to communities in regard to health service and research.
  - Bringing local people into the work of a medical or research center and enabling them to share in the investigation of a particular problem or the provision of medical services.
  - Coordinating efforts with minority groups through offices and organizations at universities, relevant

governmental agencies, and national and international organizations.

The committee views its recommendations as ways to bring about an increase in the quality and quantity of polar biomedical research. The committee did not address the issue of whether there should be a single polar biomedical research center encompassing the functions of both data coordination and career stimulation--and there are strong reasons to locate a career-focused polar biomedical center in Alaska. If there are two centers, they should share many aims and resources, and work with many of the same people. Although the functions are linked, a decision to operate a single entity with a broad, diverse program or two somewhat more narrowly oriented units would be more appropriately left to the agencies that would be concerned with support and organization.

Additionally, the committee is aware of a National Aeronautics and Space Administration (NASA) panel that addresses a similar area of concern. Should this panel compile and distill information on analogous situations that might be useful in space missions, their results would be of general interest to polar biomedical researchers and of specific value should either or both the centers as recommended come to fruition.

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Attachment: Data Sources

1. Current Research Profile (CRP), 1973- , Arctic Environmental Information & Data Center (AEIDC), University of Alaska, 707 A Street, Anchorage, Alaska 99501.
   Covers environmental research in the Alaska regions. The 1981 volume contains some entries related to health. The 1982 volume introduced a health section.

2. The Arctic Bibliography, 1953-1975, Institute of North America, University Library Tower, 2920 24th Avenue, NW, Calgary, ALberta, Canada Y2N 1N4
   Abstracts and indexes 108,000 titles relevant to the Arctic.

3. SDC-Orbit COLD Data Base.
   An on-line data base on the cold regions with a retrieval service of bibliographic information.
   a. The Bibliography on Cold Regions Science and Technology. Prepared by the Library of Congress for U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire 03755
      Deals with arctic research. Available as part of COLD Data Base through SDC-Orbit as well as through manual indexes.
   b. Antarctic Bibliography. Prepared by the Library of Congress for National Science Foundation, Washington, D.C. 20550
      Contains and acknowledges "gray literature".

4. Naval Arctic Research Lab (NARL) Data. Reference Department, Alaska Polar Regions, University of

Alaska, Fairbanks Library.
Currently in manuscript form and in storage until funds are appropriate to catalog and make available to users.

5. NARL Daily Log Sheets. Information Services, AEIDC, University Of Alaska, 707 A Street, Anchorage, Alaska 99501
Log sheets of station's daily activities.

6. Barrow Research File. Reference Department, Polar Regions, University of Alaska, Fairbanks Library.
A brief inventory of the NARL data filed by research type.

7. Arctic Health Research Center Collection. Biomedical Library, University of Alaska, Fairbanks.
An information collection on arctic health from the now defunct Arctic Health Research Center.

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An on-line bibliography with a few citations in the areas of biomedicine or health.

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Collection of manuscripts some relating to health.

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A digitized health records system referenced by individual.

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    Listing of both small single-investigator research and large multi-investigator and multidisciplinary research programs supported by Arctic Research Program of Division of Polar Programs. Also those programs supported by Division of Atmosphere Sciences, Division of Earth Sciences, Division of Ocean Sciences, Directorate for Biological, Behavioral and Social Sciences, and the Directorate for Engineering.

16. Reference and microfilm collection on Arctic and Antarctic information. National Science Foundation, Washington, D.C. 20550.

17. National Science Foundation Grants. National Science Foundation, Washington, D.C. 20550
    A listing of grants beginning in 1959 is currently being compiled and digitized. Prior to digitization, the information is obtainable through publication, Science Review, but is not in a sorted form.

18. The Commission for Scientific Research in Greenland.
    Oster Voldgade 10, DK-1350, Copenhagen, Denmark.