BIOETHICAL ISSUES IN ANTARCTICA

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ABSTRACT

This paper describes the Antarctic environment, the mission and work setting at the U.S. research stations, the general population and living conditions, and the healthcare situation. Based on my experiences over 15 months living and working “on the Ice,” during both the summer and winter seasons, it also dispels some common misconceptions that persist about this environment and about the scope and quality of medicine practiced there. The paper then describes specific ethical issues that arise in this environment, incorporating examples drawn from both my experiences and those of my colleagues.

The ethics of providing health care in resource-poor environments implies two related questions. The first is: What can we do with the available resources? This suggests that clinicians must not only know how to use all available equipment and supplies in the standard manner, but also that they must be willing and able to go beyond standard procedures and improvise, when necessary. The second question is: Of all the things we can do, which ones should we do? This paper addresses both questions in relation to Antarctic medical care. It describes the wide range of activities required of healthcare providers and some specific ethical issues that arise. Finally, it suggests some remedies to ameliorate some of those issues.

Key Words: Resource-poor environments; Improvised medicine; Antarctic medicine; Disaster team training; Public health ethics; Evacuating patients

INTRODUCTION

The ethics of providing health care in resource-poor environments is a complex topic. It implies two related questions.[1] The first is: What can we do with the available resources? This suggests that clinicians must not only know how to use all available equipment and supplies in the standard manner, but that they also must be willing and able to go beyond standard procedures and improvise, when necessary.[2] The second question is: Of all the things we can do, which ones should we do? All clinicians face the identical question during every patient encounter. Yet, those working in resource-poor environments are more sensitized to the limitations and risks involved in patient care decisions.[3] This paper will address both of these questions in relation to medical care in Antarctica. The examples regarding patients, personnel, activities and equipment stem from my work as Lead Physician at McMurdo Station and a visiting consultant at the Amundson-Scott (South Pole) Station. This involved a total of 15 months, in both cases from the summer and extending into or through Winter seasons that nearly precluded medical evacuations. Patient identifying information has been obscured to protect confidentiality.

The first part of the paper necessarily begins with a discussion of the Antarctic environment, the mission and work setting at the U.S. research stations, the general population and living conditions, and the healthcare situation. I hope to also dispel some common misconceptions that persist about this environment. The second part of the paper describes specific ethical issues that arise in this environment, and incorporates examples drawn from both my experiences and those of my colleagues.

ANTARCTICA—THE BIG PICTURE

Antarctica, the only continent without an indigenous species larger than a small worm, presents an often completely white landscape, awesome snow and ice formations, towering mountains and active volcanoes, as well visiting penguins, sea lions, and skua (scavenger birds). The perpetually dark skies of winter present vast star fields and, often, dazzling auroras. Summer skies, with 24-hour sunlight, sometimes contain the magical sundogs, an optical phenomenon created when sunlight refracts off ice crystals in clouds.

As history has proved, this austere environment can easily prove deadly. Wind chills, especially at the South Pole Station, can drop the temperature below -100ºF. Massive storms can reduce visibility to just arm's length, and bare skin can freeze almost instantly. Ice fields hold other unpleasant surprises, the most dangerous being the hidden deep crevices that can swallow an unsuspecting person or vehicle. At the continent's edge, venturing onto the thin ice over the Southern Ocean also occasionally claims vehicles and lives.

Accessible only in good weather, the closest U.S. facility at McMurdo Station requires a 6- to 8-hour flight by military aircraft and much longer reach the South Pole Station. Reaching the Palmer Station on the Antarctic Peninsula is slow and only by sea. From a medical provider's viewpoint, there is a constant tension between reassuring the station population that the medical team has the capability to treat their needs and the knowledge that no small medical team has the ability to evaluate and handle every patient disorder or major health crisis.

Its weather-dependent/seasonal isolation from the rest of the world makes Antarctica an inherently medically resource-poor and dangerous environment. Yet the richness and diversity of the continent's scientific opportunities requires that we provide healthcare support for researchers and other support personnel.

U.S. ANTARCTIC RESEARCH STATIONS: MISSION AND SUPPORT

The United States maintains three permanent bases and two research vessels in Antarctica. Scientists with National Science Foundation (NSF) grants use these platforms to perform a broad array of biological and physical scientific research.[4]

The largest of these bases is McMurdo Station, which swells from fewer than 200 people in the winter months to more than 1,200 in the summer. Located on the Ross Ice Shelf and geographically closest (5 to 8 hours flight time) to New Zealand, the station is home to the largest population center on the continent. A common misconception is that all staff and facilities are housed in one large building. In reality, McMurdo consists of multiple buildings that personnel must walk between to eat, sleep, work, attend meetings, get medical care, and enjoy recreation. It serves as the base of operation for diverse science teams scattered across Antarctica, the base for ingress and egress for nearly all personnel working at the South Pole Station, and, occasionally, as a medical resource center for patients evacuated from the South Pole and the stations of other nations. McMurdo also serves as the primary medical facility for New Zealand's Scott Base, a small station of between 11 to 100 persons located two kilometers away.

In the winter (late February to late September), about half of McMurdo's small population consists of staff needed to maintain, repair, and prepare buildings, airfields, an "ice

pier" for the two annual supply ships and escort icebreaker, and equipment before the large summer population influx. Among others, this winter staff includes mechanics, welders, plumbers, heavy equipment operators, maintenance workers, carpenters, electricians, science technicians, and engineers. The other half of the population supports this contingent, providing food services, power, potable water, waste management, fire protection, safety, management, computer and communication services, weather monitoring, and, of course, healthcare. A handful of scientists, including NASA satellite trackers, also remain on station to continue ongoing data collection. A similar situation exists at the South Pole, although their small science contingent includes a uniformed National Oceanic and Atmospheric Administration (NOAA) officer to oversee one of the world's few clean-air monitoring stations.

In the summer, the population at all Antarctic stations mushrooms. Aside from the influx of science teams, many flight and support personnel accompany the military and non-military aircraft used to ferry people to and around Antarctica. Concomitantly, support departments substantially increase their personnel to support the larger population.

The Amundsen-Scott Station at the South Pole consists of one large building on stilts to accommodate massive snowdrifts and a few smaller surrounding research facilities, which house telescopes, subatomic particle detectors, and the clean-air monitoring station. The station generally has the same types of, but fewer, support personnel. Of the three U.S. stations, this is the most isolated, with the longest winter period (about 9 months), during which the cold and the constant storms permit flights to the station for only the most serious medical emergencies. These are very dangerous, costly, and, thankfully, rare missions.

The two research vessels operate out of Punta Arenas, Chile, also transporting station personnel to the small Palmer Station. Both ships have fewer than 40 personnel. Palmer Station, located on the warmer and more northerly Antarctic Peninsula, operates with a small population of scientists and year-round support personnel.

HEALTHCARE AT THE STATIONS

To avoid as many healthcare problems as possible, both support staff and science teams must undergo extensive medical screening before the NSF will permit them to travel to U.S. Antarctic stations or ships. The screening generally includes a physical and dental exam, multiple laboratory exams, a chest radiograph, and any special tests to evaluate a person's chronic medical conditions. Some older personnel also must have an electrocardiogram and cardiac stress test.[5]

Ideally, this should eliminate personnel with significant (i.e., potentially unstable) medical issues. However, increasing leeway in applying these requirements coupled with the variable quality of physical and dental examinations has increased the number of personnel arriving on station with significant health issues.

This leeway has been most obvious for those personnel holding senior positions and for visiting government "VIPs" (that they call "Distinguished Visitors" or "DV"s) occasionally leading to medical crises and emergent evacuations. For example, VIP visitors with obvious medical issues have refused to forego trips to the South Pole, despite medical advice to the contrary. Some of these visitors have deteriorated so badly when at the South Pole's altitude

(atmospheric pressure ranges from the equivalent of 10,000 to 15,000 feet) that they had to be immediately evacuated to sea level. In other cases, those tasked with assessing physical qualifications have seriously considered allowing applicants to work at a station despite the presence of significant safety issues (e.g., blindness) or active, potentially life-threatening, diseases due to threats of legal action or personal connections.

Even more troublesome, applicants occasionally lie on their medical history form to get a job on the Ice, leading to problems when serious conditions only become symptomatic in the isolation and extreme conditions of Antarctica. Other personnel have had grossly inadequate dental examinations, dental radiographs, and subsequent treatments. Despite these being reviewed by a program dentist, they sometimes result in more complex dental problems that must be treated after they arrived on station.

MEDICAL EQUIPMENT, FACILITIES, and PERSONNEL

Another common misconception about U.S. Antarctic research stations is that they suffer from a dearth of equipment and medications. On the contrary, all three have most of the equipment found in a standard U.S. emergency department (ED).

All stations also have a laboratory with point-of-care tests, code carts, an ultrasound machine, a slit lamp, and digital body and dental radiology equipment. There is also significant disaster equipment, special equipment for aeromedical transports, oxygen generators and oxygen bottles, a wide variety of orthopedic and dental equipment, and physical therapy devices. Some of the equipment models are older, with many types and brands of some devices on station, each with unique operating requirements. When they first arrive, clinicians concentrate on familiarizing themselves with the lifesaving equipment, although they rarely need to employ them. This takes significant time given the multiple types of electrocardiogram machines, pulse oximeters, ultrasound machines, monitor-defibrillators, suction devices, ventilators, and IV pumps.

Clinicians see patients in standard ED-type cubicles, and the facilities include a few beds for inpatients. At McMurdo Station, the medical building is a separate structure that was built many decades ago when the U.S. Navy ran the base. Aside from the outpatient and inpatient areas, it includes a physical therapy room that was initially an operating room, a radiology room, a pharmacy, a laboratory, a hyperbaric chamber, a large storeroom, a full dental clinic, and multiple offices. At both Palmer Station and the South Pole, the medical facilities are smaller and are part of the main station building.

All stations have good internet connections, although the South Pole Station’s geographic position in relation to communication satellites often limits the hours during which they have access. Multiple communication modalities, such as radios, phones, and satellite phones, allow clinicians access to the remote scientific groups who travel away from McMurdo Station during the summer months. They are also used to contact medical consultants in the United States and New Zealand, the New Zealand clinics where patients at McMurdo and the South Pole can get appointments during summer months, and the Christchurch hospitals to which very ill or injured patients from Antarctica initially go.

The number of medical personnel varies widely at McMurdo Station between the summer and winter seasons. It also varies from year to year, based on financial considerations. At Palmer Station and the South Pole, a physician and a physician assistant staff provide care year-round. In mid-summer at McMurdo Station, the staffing, which includes personnel from the Air National Guard, comprises a pharmacist or pharmacy technician, an x-ray technician, a physical therapist, a part-time dentist, several nurses, and a varying number of physicians and mid-level providers. Mid-level providers also provide care at some of the largest scientific field camps. A biomedical equipment technician appears once or twice annually. During recent winter seasons at McMurdo Station, only a physician and mid-level provider were present, omitting the sorely needed physical therapist who had served this industrial community in prior years.

ANTARCTICA—ETHICAL ISSUES IN A RESOURCE-POOR SETTING

Ethical tension exists throughout the Antarctic healthcare system. In part, the strain is between what patients or healthcare providers see as optimal interventions and what is possible or permitted.

As in other resource-poor environments, medicine in Antarctica consists of the safe and effective interventions the on-site team thinks they can do to limit morbidity and mortality given the available clinical personnel, the available resources, and the environmental conditions, as well as the providers' knowledge base and skills. Their ultimate question is: Of all the things we can do, which ones should we do? Typical "on-Ice" healthcare interventions involve medical, dental, and surgical therapy; patient support; disaster team and paramedic training; disease or injury prevention; and patient evacuation.

The most common ethical issues arise from the clinicians' incomplete knowledge and skills coupled with the wide range of their responsibilities, the often-limited ability to evacuate patients due to weather or location, the reliance on consultants unfamiliar with Antarctic limitations, and off-continent (and frequently non-medical) administrators, who request confidential information or make decisions involving patient care.

MEDICAL, DENTAL AND SURGICAL THERAPY—ETHICAL ISSUES

The physicians and mid-level providers tasked with healthcare at McMurdo during the winter and at the two smaller stations year-round have incomplete knowledge, skills, and experience for the diverse range of jobs they must perform. These duties include providing dental care; pharmacy management and medication dispensing; radiologic and ultrasound imaging; laboratory testing, blood banking, and quality assurance; physical therapy; basic equipment maintenance; and nursing procedures. Ethical issues naturally arise because no provider is able to practice competently in all these areas. For example, during a winter session at McMurdo, the healthcare providers often stretch their knowledge and skills to accomplish non-standard tasks, such as providing physical therapy programs and treatments, dental care, and public health programs. Relying on internet-based resources was often useful, while the varying quality, availability, and timely response of remote consultants were less helpful. Dental consultation was the exception, since the dentist had been part of the Antarctic medical team, was familiar with the equipment, and was readily available.

The dental clinic, housed in the medical building, contained the supplies and equipment that an experienced dentist would need. The clinic was equipped so well because, until recently, a dentist had been available for both McMurdo patients and those flown in from the South Pole throughout the summer. Without a dentist and with relatively minimal training and experience (although more than most physicians [6]) and lacking the ability to send patients to a dentist, we were sometimes forced to do dental extractions and to use powered dental tools to "adjust bites." While we tried to reassure patients, they understood we were not dentists. Nevertheless, all our procedures went well.

McMurdo Station has a well-stocked pharmacy, but problems with a very long supply line, New Zealand's import restrictions on controlled medications, and the high cost meant that, on occasion, we had to use expired medications. While expiration dates on most medications have little or no clinical significance,[7] this is not true with regard to vaccines (e.g., influenza, hepatitis, and tetanus), ophthalmic medications, and some antibiotics. To lessen this problem, we employed several strategies. First, we refused to administer any vaccines or ophthalmic medications that were expired (despite administrative orders/recommendations to the contrary). Second, we administered other recently expired medications, including antibiotics and analgesics, only after telling patients that they should experience no additional side effects but that the medications might be slightly less effective than normal. Unfortunately, when we identified a probable narcotic abuser and refused to provide opioids, we received negative administrative and population feedback. However, since it happened early in a winter season, the incident probably prevented others from requesting unneeded narcotics.

We also provided informed consent to most patients when we had to improvise to non-standard treatments for acute conditions. For example, when we could not evacuate a patient from the station, we decided to use an obsolete method to remove a soft esophageal foreign body (meat). Since no endoscope was available, we used a Foley catheter to push the object into the stomach. In another instance, a patient had an episode of almost constant hiccups, which he had experienced twice in the previous five years. When more benign treatments failed, we used an intravenous lidocaine infusion, which immediately solved the problem.[8] Similarly, we used improvisation for several episodes of acute psychiatric decompensation. While we had antipsychotic medications and benzodiazepines, their use in ambulatory patients could affect a patient's safety both when walking on the ice-covered terrain and when doing their job. Therefore, we opted to use hypnosis as a part of intense, short-term counseling session, an intervention that proved successful.

PATIENT SUPPORT—ETHICAL ISSUES

An issue common to any closed-group setting is a lack of both privacy and confidentiality. With their small isolated populations, Antarctic stations are especially vulnerable to this during the winter season. With all personnel working, eating, living, and playing together, and able to see anyone coming in and out of the medical facility, it is nearly impossible to maintain patient confidentiality, especially when the patient has time off work, is hospitalized, or has an obvious illness or injury. While the medical team maintains silence, patients' co-workers, roommates, or dining companions usually elicit, and then distribute, all but the most sensitive information.

Areas of the world with long periods of darkness have found that a portion of the population does better psychologically if they use “SAD lights.”[9] Although they are an inexpensive method of ameliorating potential darkness-induced depression, the off-continent administrators resisted their use. Nevertheless, the ingenuity of station personnel and an offer to install them in an empty room without charge led to an often used and, anecdotally, very useful preventive health measure.

The healthcare team faced repeated ethical issues when corporate and organizational constraints tried to limit what we could do to benefit the population. Since Occupational Medicine regulations were used throughout the station, the healthcare team had to log every patient visit in terms of whether the illness or injury was job-related or would affect job performance. This led to many fewer personnel using medical services than needed to do so, or to patients delaying visits, sometimes with adverse consequences. As one friend who appeared one morning with a frostbitten tip of his nose said, “Please don’t say anything about this; I don’t want to lose my job!” He was treated outside the clinic without a report being generated. As with other remote sites, the presence of three bars and a store where most sales were for alcoholic beverages led to a number of significant injuries although, to avoid administrative fallout or the loss of their jobs, the patients always (initially) insisted they were not inebriated when the injury occurred.

TRAINING A DISASTER TEAM—ETHICAL ISSUES

To prepare for an event that could produce more casualties than the medical personnel could handle, McMurdo clinicians draft other station personnel each season to form part of a disaster team. While training people to act as scribes, stretcher-bearers, and security officers is routine, it raises some ethical issues when training non-medical personnel to perform phlebotomy and basic laboratory tests, take radiographs, and dispense pharmaceuticals.

The healthcare team normally selects people for these positions that have parallel knowledge and experience. For example, in the past, auxiliary laboratory personnel have included a science laboratory supervisor and the head of the waste treatment plant, who must do chemistry tests in the course of his job. Not only must volunteers learn to perform common lab tests and then practice using real samples, but they must also learn a new skill, how to do phlebotomy. As with intern phlebotomists in other clinical settings, implied patient consent (station personnel know who are not medical personnel) works as long as they hit the vein.

Radiology augmentees usually are individuals with a physical science background. In the past, these have included scientists doing laser-meteorological experiments and weather observers, who have a very technical job. Once they learn on improvised phantoms (usually a stuffed bear), they can take subsequent radiographs on clinic patients. Medical personnel provide initial supervision for routine films and always supervise films that are more complex. Our healthcare team also obtained explicit verbal consent when volunteers performed radiographs.

Personnel acting as supplementary pharmacy technicians often had a chemistry background or had been pharmacy technicians. Generally, these individuals were used only during the periodic mass-casualty drills, primarily for the obvious concern that patients might inadvertently receive the wrong medication. In addition, medication dispensing is less complex

and time-intensive than the other technical processes for which we needed to train auxiliary personnel.

DISEASE OR INJURY PREVENTION—ETHICAL ISSUES

Two public health tasks fall outside the role of most clinicians: managing the isolation of patients with an infectious disease and surveying food service practices.

Despite predeployment screenings administered just before flying out of New Zealand, recurrent episodes of the "crud" have been a recurring health issue, especially during the winter months at McMurdo, when the infrequent flights introduce new personnel (and germs) to the station. The obvious solution we recommended to stem viral illness was to impose isolation on ill personnel shortly after the new arrivals landed. While local station management was willing to try these limited isolation periods, there was enormous pushback from some senior supervisors and their companies. Nevertheless, in the interest of protecting the entire population's health, we confined anyone with an upper respiratory illness to a one-person room for an arbitrary three days. The result was a substantial decrease in upper respiratory symptoms throughout the season. Only one person was still febrile after three days; she tested positive for Strep.

Probably the most significant medical staff responsibility was inspection of the food service areas. After passing the national food safety course (ServSafe® Food Handler) and accompanying the professional U.S. Army veterinary food inspector on an inspection of our facilities, the lead physician did a monthly inspection of the dining, self-service, galley line, and food storage areas, as well as the enormous kitchen's preparation, cooking/baking, food holding, and food-receiving areas. Despite our limited training, we understood that missing big issues could lead to widespread food-borne illnesses and took the job very seriously. Fortunately, the food service staff was well trained and supervised.

EVACUATING PATIENTS (OR NOT)—ETHICAL ISSUES

Perhaps the most ethically challenging issue in delivering medical care to the Antarctic scientists and support personnel is whether we should evacuate patients to a higher-level diagnostic and treatment facility during inclement conditions (i.e., the winter season at McMurdo and the South Pole).

Evacuating patients for anything other than a clinic appointment or scheduled laboratory test is a complex and costly venture, even in the summer when planes routinely fly between Antarctica and New Zealand. It requires special airworthy (Air Force-approved) medical equipment and trained aeromedical personnel to be aboard the plane and monitor the patient. Authorizing an emergency transport when a plane is not scheduled to depart requires a decision not only from the station's chief medical officer, but also from the physician program director (off continent), the station manager and NSF representative (both non-medical on continent), and the NSF chief medical officer (off continent).

Furthermore, in winter conditions, many personnel must work to "groom" the ice runways to accommodate the plane, a process that can take multiple days, depending on the weather and field conditions. If a patient requires a rare winter evacuation from the South Pole, two special propeller-driven Twin Otter aircraft must fly in from their base in Canada, since they are the only airplanes capable of functioning in the extremely low temperatures. (The second

rescue plane stays at Rothera Research Station, the British station on the warmer Antarctic Peninsula, in case of emergency.)

These missions cost from tens to hundreds of thousands of dollars and, in the case of South Pole evacuations, put the crewmembers' lives at risk. While patients expect the best possible medical care, they understand and are told explicitly by the NSF before their arrival that evacuation may not always be possible. In making the difficult decision to evacuate, the clinician must balance patient desires, good medical decision making, and bureaucratic constraints.

In one case, off-continent bureaucrats balked at transporting a post-cardiac arrest patient from the South Pole using the standard medical equipment and personnel because he was a summer tourist. (Tourists may not even enter the station unless they have a life-threatening emergency.) Rather, they wanted him to leave the continent in a cramped tourist plane. Because the McMurdo's lead physician had helped direct the resuscitation effort via an audio-video link and was responsible for care at the South Pole, good medical practice required pushing for appropriate transport. Eventually, the bureaucrats agreed.

Even when everything is in place for a critical evacuation, the always-unpredictable Antarctic weather conditions may make it impossible, producing additional ethical issues. For example, when a VIP visitor developed a serious cardiac dysrhythmia and could not evacuate for a week due to weather, we had to enlist the entire medical staff and a set of fire department medics to monitor his cardiac rhythm, compromising care for the rest of the population.

HOW DOES ANTARCTICA COMPARE TO OTHER RESOURCE-POOR SETTINGS?[3]

In sum, Antarctic medical practice has ethical issues common to small, occupational, and resource-poor settings. The wide array of clinical and non-clinical functions required of medical staff may cause them to fall short of the optimum care they want to provide. Excellent communications increase the opportunity to receive current medical information for unusual problems, although most consultations fail to consider the stations' remote, resource-poor environment. If the medical staff had short meetings with the consultants prior to deployment and the consultants were briefed on the capabilities at Antarctic stations, this would greatly improve the situation.

The greatest ethical issues center around timely evacuation of seriously ill or injured patients, especially in inclement weather. The extreme weather is the reason that Antarctica is considered to be medically resource poor; we cannot change this. However, by limiting the decision-makers for emergency evacuations, especially during the summer season, to medical and Air Force personnel, the process could be streamlined and improved.

To answer the questions posed at the outset of this article, ethical issues revolve around clinicians being capable of using the widely diverse types of medical, dental, radiology, laboratory, physical therapy, and pharmacy equipment and supplies available to them. However, experience shows that if healthcare providers are willing to improvise when necessary, they can provide a wide variety of interventions to benefit patients. Their most important intervention may

to be to overcome bureaucracy to help patients, while being mindful to minimize the risks presented by the Antarctic environment.

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