Big fish in a big pond:
The potential contribution of Antarctic medicine
to New Zealand’s international research profile.

Abstract

By providing a unique environment in which to carry out internationally funded collaborative projects, Antarctica is a strategic research asset which could allow New Zealand to develop an Antarctic medical research portfolio, and “punch above its weight” in international medical research. General fields of study would include the psychology of small groups, the physiological response to extreme seasonality and isolation, the potential of bioactive substances from Antarctica’s living resources, and the development of a telemedicine service to both base staff and the increasing number of Antarctic tourists. Viewed as an industry, medical research in Antarctica has the potential to benefit New Zealand without adversely affecting the Antarctic environment.
Introduction

Viewed as an industry, research in this country is in desperate need of innovation and multinational investment to counteract ever decreasing Government subsidies. Because the industry is small by international standards, industry leaders (our researchers) need to create a competitive advantage by basing future development on the industry’s unique assets and skills.

In this paper, I will argue that Antarctica is a strategic asset that we have the research and logistic skills to capitalise on. In particular, the development of a medical research industry has the potential to benefit New Zealand without adversely affecting the Antarctic environment.

General strategy for New Zealand research

As a relatively small player in international research, New Zealand could usefully focus its research effort on work that fulfils one of the following three criteria:
(1) Research that is desirable because of its potential applications in the field (eg for medical research, reducing morbidity and mortality).
(2) Research that is cost effective given our country’s constraints on size, population, research infrastructure and funding.
(3) Research that is only possible in New Zealand because of unique issues, environmental situations, or availability of expertise.

For researchers, the optimal strategy would be to identify and give priority to research projects which fulfil all three criteria - a recent example from the New Zealand medical literature is an epidemiological (cheap) study of acute bronchitis (morbidity) in the area of ashfall of the 1996 Mt Ruapehu eruption (unique) (Hickling et al 1999).

An additional consideration is whether the research fits into one of the “research portfolios” promoted by MRST following its recent foresighting exercise. “Portfolios” are large bids by multidisciplinary groups that generally incorporate several projects with a common theme and often include international collaboration - good from an industry perspective, but anathema to gifted individual researchers with fundamental hypotheses to test.

Antarctic medical research, I will argue, fulfils all of the above criteria as well as providing an opportunity to create a high profile research portfolio that could attract significant international collaboration and funding.

Why Antarctic medical research?

With the tensions developing around Antarctic territorial claims and the cold war in the 50’s, science led by example to undermine political considerations and established the Antarctic treaty in 1959. Scientific research has become the major industry on the continent since that time, and has led the way in demonstrating that responsible self regulation is possible.
The development of tourism and other profit-oriented industries in Antarctica is likely to be a slower and more controversial process than the establishment of scientific research programmes in Antarctica. Changes in thinking will be required both in the conservationist camp and in the development camp to achieve an environmentally sustainable compromise. Apart from its intrinsic value, scientific research can again lead the way in such development: It can show how profit can be made without adversely affecting the Antarctic environment - rather, contributing to our understanding and appreciation thereof, ultimately improving the chances for effective conservation management.

For New Zealand, the opportunity to be a significant international player in the process of sustainable development of Antarctica requires us to lead by example. Research, as illustrated here with particular emphasis on Medical research, offers New Zealand the opportunity to capitalise on its established position in Antarctic affairs. New Zealand should take a strategic lead in the next stage of the Continent’s history by commercialising research in the Ross Dependency, to the benefit of both New Zealand and the longer term viability of an ecologically intact Antarctica.

Antarctica. New Zealand, the Government agency responsible for planning and managing New Zealand’s activities in Antarctica, states as a strategic goal to “ensure that an ongoing science programme of international quality is undertaken in relation to the Antarctic and Southern Ocean that maximises benefits to New Zealand” (ANZ 1998). Two key words in this goal are international and benefit. I have already argued, from a Medical perspective, that the key to maintaining New Zealand research outputs of international quality is international collaboration: In the long term, New Zealand researchers are too few and too ill-resourced to make significant waves on this large and competitive ocean on their own. The idea of benefit to New Zealand raises the issue of commercial exploitation of the Antarctic continent - something that New Zealand and World public opinion is currently against. What tangible benefit then, other than research results per se, could accrue from a significant New Zealand Antarctic Medical research thrust? I would argue that the opportunities are many.

Firstly (and accepting the collaborative international nature of an Antarctic medical research portfolio), there are the injections of capital into the local economy associated with hosting any international visitor, tourist or scientists. Secondly, the regular presence of leading international medical researchers would stimulate and encourage our local research community in an opportunistic and therefore cost effective way. Thirdly, spare capacity in our existing Antarctic infrastructure could be sold for profit to institutions and researchers in other countries where research dollars are less limited, but access to Antarctica is. The Dutch for example currently operate all their Antarctic research programmes by purchasing space from gateway nations, and have no bases or Antarctic infrastructure of their own. Finally, and most obviously, there are the longer term benefits of both pure and applied research. Pure research satisfies the basic inquisitive nature of the human spirit as well as providing the basis for unimagined and profitable applications downstream: the example of antifreezes is a case in point (below). Applied research can be beneficial to New Zealanders and others in for example understanding and improving performance levels in shiftworkers (also discussed below), or providing a telemedicine service to scientists, support staff, and tourists in Antarctica and the Southern Ocean.

Antarctic Medical research generally exploits the unique environment provided by isolated humans working and living in some of the remotest and harshest settlements on Earth. Research contributions therefore relate mainly to the psychology of small groups, the physiological response to extreme seasonality and isolation, and the potential of bioactive substances in Antarctica’s living resources. Technological advances have also allowed
improvements in diagnosis and treatment by remote control - skills which are becoming more important as more and more people visit and/or live in Antarctica.

Major fields of Antarctic medical research and potential directions

Psychology

The first psychologists in Antarctica were the expedition leaders of the heroic area who selected the teams to accompany them. Their art has grown, through research and practice, into the modern screening procedures of clinical psychologists who help to select winter-over staff. Constant improvements in these procedures have contributed numerous manuals and reviews to the Antarctic medical literature, including major works by New Zealand authors (eg Taylor 1987). The psychology of small groups has been the subject of an equally prolific and closely related literature focusing on performance, emotional stability and interpersonal relations. This cause has most recently been championed by the Americans, with Palinkas (1996,1998) providing a leading edge - he has quantified decrements in performance with time spent in isolated and confined environments, and helped put Seasonal Affective Disorder on a solid scientific footing. French (review in Rivolier et al 1995) and New Zealand (Taylor 1987) researchers have also contributed significantly, but current New Zealand involvement is restricted to the work of Steel: with the assistance of students in the University of Canterbury's Graduate Diploma in Antarctic Studies programme, he is currently assessing the effects of isolation on humour (G Steel, Lincoln Univ, pers. comm. 1999).

Extreme seasonality and isolation

In Antarctica, summer staff experience continuous daylight, and winter-over staff continuous night. Such light regimes have the potential to seriously disrupt circadian rhythms (daily biological cycles), which are generally kept in phase with the 24 hour clock by morning exposure to sunlight. Research in Antarctica has monitored the effects of these disruptions on quantity and quality of sleep and subsequent adverse effects on performance (Gander 1992). The research has ramifications well beyond base staff in Antarctica: shift workers worldwide have benefited from roster changes based in part on Antarctic research, and with the combination of small group isolation and circadian rhythm disruption operating, Antarctica is now being used as an analogue environment for space crew research. These extreme light regimes also disrupt endocrine function, and thyroid hormone and melatonin levels have been analysed in relation to their effect on sleep patterns and seasonal affective disorder (eg Owen and Arendt 1992, Midwinter and Arendt 1991). Vitamin D synthesis (which occurs in the skin in the presence of sunlight) decreases in winter-over staff, with possible implications for bone metabolism (Oliveri et al 1994).

In research of this nature, New Zealand has a great advantage over several other Antarctic gateways because its proximity and time zone synchrony with the Ross Sea Region. Studies of the effects of light on sleep and endocrine systems can therefore be initiated immediately upon arrival in Antarctica, without the confounding effects of 'jet lag' experienced by expeditioners from many other countries. We also have one of the world's leading research groups in sleep/wake physiology (Sleep/wake Research Centre, WSM, University of Otago), the leader of which has indicated a keen interest to become involved
in research in Antarctic Medicine (P Gander, WSM, pers comm. 1999). A natural collaboration building on our established expertise in Antarctic psychology could study the role of social cues in entraining (synchronising) circadian rhythms in the absence of the normal light cues that usually serve this function.

The physiological effects of the cold and dry Antarctic environment on humans has received some attention, with New Zealanders contributing early work on olfactory and gustatory dulling; apparently sense of smell (Barabasz and Gregson 1978) but not sense of taste (Simmonds 1974) can undergo transitory changes in winter-over staff. Extreme isolation also has consequences for the immune system. There is evidence that in the absence of repeated exposure to the antigens of respiratory viruses, the body’s capacity to mount an immunological response against them wanes. Coughs and colds are consequently worse in winter over staff when viruses are reintroduced at winfly, and their spread also offers the opportunity to carry out fundamental research in epidemiology (L Jennings, CSM, pers. comm. 1998).

Bioactive substances

The biochemical adaptations of Antarctic’s living resources have been studied for their potential to harbour new pharmaceutical products or their precursors, and are undoubtedly under the ubiquitous eye of the pharmaceutical industry. With the intense competition for terrestrial niches which are both ice free and harbour free water, one might expect strong selection pressures on Antarctic fungi to produce novel and potent antibiotics. Chinese studies have recently identified antitumour activity in extracts of Antarctic fungi (Su et al 1995). Researchers at NIWA have isolated biologically active compounds from Antarctic marine invertebrates (CN Battershill, NIWA, pers. comm. 1999), and micro-organisms have been screened for pharmaceutical properties (including cyanobacterial toxins) at the Cawthron Institute in Nelson (H Kaspar, Cawthron Inst., pers. comm. 1999). However, the development cost for such products are astronomical, and even with international pharmaceutical industry backing, the direct benefits to New Zealand of any targeted research are likely to be very small (R Pridmore, NIWA, pers.comm. 1999). Having said that, however, it is important to labour the point that any investigator driven research has the potential to result in economically important spin-offs at some (later) stage. An excellent example is provided by the various antifreezes in Antarctica’s living resources: these were researched for decades by scientists driven purely by interest, and now suddenly show great potential to the organ transplant and food storage industries.

Diagnostic and Treatment Services

As a result of extensive Arctic experience and two World Wars, the pathophysiology of cold injury is well understood. Koerner (1982) reviews the literature under headings of local cold injury, systemic cold injury and immersion hypothermia. Other acute medical conditions that might arise in Antarctica include accidental injury, snow blindness (UV keratitis), and skin fissuring because of the extremely dry atmosphere. Despite stringent medical screening of expeditioners, emergencies do arise, and are responsible for most of the modern day heroics on the continent: In 1961, a Russian physician removed his own appendix at Novolazarevskaya, and the Americans carried out a midwinter evacuation of an Australian with the same condition in 1991 (Herrick 1997).
A major advance in the diagnosis and treatment of medical problems in Antarctica is tied to advances in communication technology. Most bases now operate remote advice systems to experts off base; the key to their reliability lies in the substitution of satellite communication for over-the-horizon radio, which was prone to blackouts in Antarctic atmospheric conditions. X-rays and ECG’s are now routinely transferred electronically from Mawson to Australia (Lugg 1993), and another dimension is added by the now imminent prospect of medical teleconferencing with Antarctic Bases (whereby base staff could be shown rather than just told what to do). A science fiction scenario of surgeons operating on patients in a virtual reality environment may soon become an aim! Ship based tourist operators make similar arrangements for remote advice, and also maintain a common list of on-board pharmaceuticals and medical expertise that could be shared in the event of a medical emergency (A Kershaw, Adventure Network Int., pers comm.1999).

New Zealand has an international reputation both in mountaineering medicine (inc search and rescue), and in communications technology. It would seem a missed commercial opportunity not to combine these skills into a state of the art remote medical advice service to the Antarctic and Southern Ocean, serving both bases and the growing Antarctic tourist industry. Importantly, such a venture has the potential of benefiting New Zealand without adversely affecting the Antarctic environment.

**Discussion**

The key feature of research in Antarctica, medical or otherwise, is that it can be done in and on an environment with qualities available nowhere else in the world. Such conditions facilitate ground-breaking achievements in a wide range of fields (ANZ 1998). Further, such research is becoming increasingly cost effective as technological and infrastructural advances improve the intensity of data collection per person as well as remote and direct access to research projects on the continent. Costs are further reduced (and profit possibly generated) by undertaking such research in collaboration with other interested Nations with larger research budgets. In terms of cost effectiveness, it is also worth noting that the “commercial value of Antarctic Science to New Zealand is worth many times the value of the Antarctic vote each year” (Howard-Williams 1998, p23).

This leaves us with only the criterion of addressing research issues with a potential impact or morbidity. Firstly, any fundamental research has the potential to make such a contribution in the long term - the example of antifreezes in Antarctica’s living resources has been mentioned above. Secondly, the results of Antarctic medical research can contribute to the improved health (or survival!) of people in many other situations, including shift workers and space travellers: the understand of small group dynamics and how to improve performance is central to many of today’s occupational health issues. Thirdly, and perhaps of most interest to governments and businesses who invest in medical research, is the looming explosion of medical needs on the Continent itself. As long as 25 years ago Lugg (1975) predicted the need to expand medical services and research in Antarctica, based on likely population increases with the exploitation of natural resources. Those natural resources now look more likely to be ecotourism than mineral and marine resource exploitation, but the argument remains the same. More research is required on the possible health effects of the antarctic environment of short term visitors, and on the logistics of providing limited or remote medical services to large number of visitors.

In 1997, Antarctica New Zealand (ANZ) hosted the “Antarctic Science Beyond 2000” Workshop in Christchurch to “review the Antarctic knowledge base and identify gaps and
opportunities” (ANZ 1997). In the report from this workshop (ANZ 1997), Antarctic medical research fails to gain any recognition in the “Knowledge Base Reviews”, falling somewhere between the Biological Sciences (Section 4.2) and the Social Sciences (section 4.3). This oversight is surprising given New Zealand’s contributions to the field in the past (e.g. Taylor 1987, Rivollier et al 1988), and the significant international knowledge base of Antarctic Medicine accumulated since Cook in 1775 (see Lugg 1975 a,b and summary above). In its subsequent science strategy document (ANZ 1998), Antarctica New Zealand has happily remedied this situation and now lists “Human physiology and social interaction” as subheading B in the third of 5 major science themes: “Life in Extreme Environments”. However, from a national perspective and through no fault of Antarctica New Zealand, Antarctic medical research remains a largely unoccupied niche in New Zealand. There are no existing Antarctic Science Funding commitments to projects in category “3B”, and I could identify only one research active in the field (G Steel, Lincoln Univ, pers.comm. 1999). Our leadership and involvement in Antarctica provides the opportunity for New Zealand researchers to carry out significant Antarctic Medical research in collaboration with leading international teams. This opportunity should be viewed as a huge asset - an asset that can be exploited to the benefit of New Zealand without adversely affecting Antarctica. As such, Antarctic Medical research constitutes an asset that can be exploited with both conservationists and developers being satisfied - should it not then be given high priority in the current political climate of advancing New Zealand’s interests in Antarctica without jeopardising national and international public relations?

If we plan strategically and develop our activities in Antarctica well, we have the opportunity to steal the prize, like Amundsen. If we make things up as we go along like Scott (Bowden 1996), New Zealand’s Antarctic involvement could also end up in the History books for all the wrong reasons.

References


Antarctica New Zealand (1998) New Zealand’s future in Antarctica. Christchurch, Antarctica New Zealand


Barabasz AF and Gregson RAM (1978) Effects of wintering over on the perception of odourants at Scott Base. NZ Antarctic Record 1 (3): 14-23.


