BIOSAFETY AT THE TOP OF THE WORLD: UNEARTHING THE SECRETS OF SPANISH FLU

Kirsty Duncan

Eight years after beginning, I am still haunted by the same images: photographs of nameless victims lying in mass graves, funeral directors fumigating rotting bodies, and unknown victims half-eaten by wild dogs—images that spurred me to journey to the high Arctic in hopes of retrieving remnants of the causal agent of the 1918 influenza pandemic. The pandemic, which killed twenty to forty million people worldwide, remains the deadliest disease in recorded history. Incredibly, the 1918 influenza killed more people than the bubonic plague of the Middle Ages, more people than all the fighting of the First World War, and more people than acquired immunodeficiency syndrome (AIDS) has to date; and unlike the latter, the 1918 influenza killed in a period of only one year.

Remarkably, the cause of the 1918 influenza (flu) pandemic re-mained unknown for almost eighty years. The Institute of Medicine (IOM), United States of America, has called the 1918 influenza or Spanish influenza the second-greatest medical mystery of this century. The Atlanta-based Centre for Disease Control (CDC), has stated that any information on the cause of the lethal 1918 pandemic would be invaluable. Finding the cause and describing the causal agent might allow scientists to explain why the disease killed so many and why the disease disappeared so quickly. Moreover, describing the causal agent might also allow scientists to improve current influenza vaccines and test present anti-viral drugs against such a deadly flu.

Development of improved preventive and therapeutic products is of the utmost importance because influenza remains the biggest unconquered threat to human health today. Each year, influenza out-breaks infect one hundred million people in the USA, Europe, and Japan. Each year, influenza infection is responsible for twenty to twenty-five million visits to physicians and millions of days lost from work in the United States alone. And each year, the annual economic cost associated with influenza epidemics in the northern hemisphere is ten billion dollars. These figures reflect only the regular yearly out-breaks of influenza in which between ten and twenty percent of the population are affected. These figures do not mirror the global epidemics, or pandemics, in which fifty percent or more of the population are affected; pandemics, such as those in 1918, 1957, and 1968, usually result in widespread loss of life. Development of better vaccines and drugs is therefore paramount, because leading influenza experts predict another fatal flu in the future. It is not known when a pandemic will occur, but as time passes, the likelihood increases. The possibility exists that the pandemic could be as virulent as the 1918 influenza.

These predictions forced me to announce to my family in 1992 that I needed to find the cause of the Spanish flu. And sometimes, a need is enough to start someone on a journey, an odyssey. This article is the story of a need and the voyage that followed.

Quest for Samples

My first task in determining the cause of the Spanish flu was to locate samples from victims of the flu. I telephoned leading flu experts and simply asked if archival samples remained from the 1918 flu pandemic. I was informed that no samples existed. (Archival samples would, however, surface later.)

I required another way of attacking the problem. I reasoned that if I could find bodies of victims that were buried in permafrost, the frozen ground might have preserved the bodies and fragments of the causal agent that killed them. My next task was, therefore, to find bodies of victims buried in frozen soils.

Search for Victims

My first thoughts were of Alaska, as the Alaskan population had been decimated by the flu, and there had been two previous expeditions in the 1950s to that region. And so I purchased and examined over two thousand death certificates from the frontier lands of Alaska. Unfortunately, the depth and extent of permafrost were difficult to correlate with burials of individuals who had died of the 1918 influenza.

My next thoughts were of Iceland, which had also been decimated by influenza. Geothermal energy, however, would not allow for preservation of tissue or viral material. Later, I thought of Russia, which like Alaska and Iceland, had been devastated by Spanish influenza. I wrote to leading medical authorities informing them of my interest in tracking down victims of the great flu. There were no responses to any of my requests. I have since learned, however, that Russian scientists are communicating with American scientists in the hopes of under-standing the causal agent of the 1918 influenza. After two years of searching, I still had nothing. And then came a break. In 1994, a colleague mentioned his recent trip across a glacier in Svalbard, and permafrost. Permafrost! I became excited. I knew that the flu had hit Norway. I guessed that if people had travelled from Norway to Svalbard, one thousand kilometers north of the Norwegian mainland, they might have brought the

disease with them. And I guessed that if people had died of the disease, they might have been buried in permafrost soils.

Svalbard Becomes the Focus of the Research

I knew very little of the environs or history of Svalbard. Svalbard, an archipelago extending over sixty-five thousand square kilometers, is a beautiful part of the world. Two-thirds of the land mass is covered by glaciers, and permafrost extends to a depth of five hundred metres in some places. Polar bear (isbjorn), reindeer, caribou, and polar fox roam freely.

Today, a total of four thousand people live in Svalbard; however, in the seventeenth century, ten to twenty thousand men lived and worked in the whaling industry in the Svalbard area. The largest community today is Longyearbyen with twelve hundred people. Most of the people are engaged in coal mining. Since the mines lie beneath the frozen ground, the miners work at -4oC.

Difficult Task Ahead

After having learned about Svalbard, I wrote to the Norsk Polar-institutt in Longyearbyen, Svalbard, Norway, and briefly described my research interests. Several weeks later, a letter came, postmarked Norway. I eagerly tore into the letter and quickly skimmed the much anticipated letter. "Yes, yes, thank you for your request. Yes, interesting. Difficult task ahead." Apparently, few records were available from 1918. There were no governmental records. There were no medical records. There were no Church records. The situation seemed desperate. I continued to skim the letter. There were diaries, "Sigurd Vestbyes Dagboker," kept by the coal company.

Diaries

I telephoned the coal company in Longyearbyen. Unfortunately, the coal company no longer had the diaries; however, the local school teacher did have them, and he would translate the diaries for me.

Several weeks later, another letter arrived postmarked Norway. The diaries record the names of seven young men who died of *Spanskesy-ken*, or Spanish flu, in 1918, and who were buried in Longyearbyen. At last, two years of searching, and I had found victims. I was excited from a scientific viewpoint, but saddened too. Suddenly, the great pandemic had become personal. Suddenly, the great pandemic had a face—seven faces. I would spend the next many years thinking of the young Norwegian miners, aged eighteen to twenty nine years old. In fact, the memory of these young men will ever be with me.

Were the Graves Marked?

Finding the records of the victims was, however, only the first step in a long process. It was next necessary to determine if the graves were marked and if the graves had been disturbed. I was informed that the graves were marked and that they had not been disturbed. The news was encouraging. If the graves had not been marked or if they had been disturbed, the search in Svalbard would have ended.

What were the Burial Practices of the Time?

The next step was to determine the burial customs in 1918. I contacted archaeologists, historians, the Lutheran Church, local funeral directors, and governmental authorities, in order to learn what the burial practices were in 1918. I was informed that bodies without embalming fluid were placed in simple wood coffins and buried. This was promising news; if cremations had been undertaken, the investigation in Svalbard would have been abandoned. The fact that embalming fluid was not used is important, as a preserving agent might have altered the structure of the virus.

What were the Depths of the Burials in 1918?

It was important to learn what the depth of burials was in 1918. All sources agreed that the miners would likely have been interred at a depth of two metres, according to Norwegian law. This was favourable information, as a deep burial would mean cold ground temperatures and a good chance of tissue preservation. However, it is important to note that Svalbard was "no man's land" in 1918. Svalbard did not belong to, and thus was not governed by, any country; the only regulations were those of the coal companies. Therefore, it was impossible to know at what depth the young men were interred. There was some good evidence to suggest that the miners

were buried rather deeply:

- the men had died in October, the time of the greatest melt of the permafrost, and thus, the time of easiest digging.
- the bodies had not floated to the surface of the ground, which suggested that the bodies were buried deeply in the permafrost.
- Svalbard miners knew how to dig in the permafrost.
- the inhabitants of Longyearbyen, who already knew Spanish flu and were likely very afraid of the disease, would have wanted to bury the men deeply to prevent their resurfacing in the future.

What were the Ground Temperatures over the Last Eighty Years?

Next, it was important to learn whether ground temperatures had been cold enough to allow the preservation of biological material over the last eighty years. I contacted Mr Alan Heginbottom of the Geo-logical Survey of Canada, a permafrost specialist, in order to determine the ground temperatures at an assumed depth of one to one and a half metres. Mr Heginbottom determined that, at a depth of one to one and a half metres, the ground temperatures would have ranged between minus 10.0 and minus 4.0oC over the last eighty years. These temperatures are considerably lower than the temperature of a standard morgue (4oC) and would thus allow biological preservation.

The Miners Could Provide the Answers to the Pandemic

After investigating for two and one half years, I had constructed an ideal case: (1) the resting places of the seven miners, which had been undisturbed for eighty years, were marked; (2) the burial practices were appropriate to allow sampling of tissue; and (3) the depth of the burials and the temperatures at those depths were appropriate to allow biological preservation.

I should have been elated; instead, I was depressed. I was finding the project (to take small samples from the seven miners in order to molecularly characterize the Spanish flu virus) that I was planning extremely difficult, as I believe that a person's final resting place is sacred and that a body should not be disturbed during its long rest. Should I proceed with the exhumations or not? This was the first of many difficult ethical decisions to make along the way. On the one hand, there was a chance that the results of the planned project could better human health internationally. On the other hand, my code of ethics was challenged. Months of debate with my family ensued. Finally, my father spoke; he said that if he held the secrets to this deadly virus, he hoped that someone would come along to unravel those secrets. It was my father's words that allowed me to make the next step—to put together a research team to collaborate with me— and complete the project.

Research Team

I chose leading experts in the following fields of research: geography, geology, geophysics, medical archaeology, medicine, micro-biology, pathology, and virology. The team represents four countries, Canada, Norway, the United States of America, and England. The work required a multi-disciplinary research team. I wanted a multinational team, as flu had raged in Europe, North America, Asia, Hawaii, the Philippines, etc. I wanted the team to reflect the world devastation.

Permission

After I had put together a research team, I asked permission to ex-hume the remains of the young miners; I requested permission to undertake the project from the Governor of Svalbard. I then offered to go to Longyearbyen in order to assure the Governor, the church, and the community that the project would be undertaken with the highest safety standards and respect and dignity for the deceased. It was important that the people of Svalbard and Norway knew that this project was not just about cold, hard science. Rather, the project was about seven young men, who died tragically like twenty to forty million others in the world's worst pandemic, and whose families still lived in Norway. It was also important that I become a part of the community, and not just a foreign researcher.

When in Longyearbyen, I did not go to the cemetery until I had the blessing and permission of the church. The long walk from the church to the cemetery was one of the longest walks of my life. It was a beautiful day—the sun gleaming on the white snow, the white glacier, and the white crosses of the cemetery. I knew that the graves in which I was interested were in the last and highest row of the cemetery. I slowly climbed up the slope, reading all the names on the crosses, until I reached the last row. And there I stood reading the names of the

young men about whom I had thought so long and often. I was roughly the age that the miners were when they died. And it was at the crosses that I made a promise to the young men: I would do everything in my power to learn the cause of the Spanish flu and do it safely and ethically.

In total, it would take two years to receive all the necessary per-missions—from the families, the church, the town council, the church council, the bishop, the Norwegian Science Council, the State Health Authorities, and the State Directorate of Cultural Heritage. I am still overwhelmed that the families gave their blessing. They gave me a very great gift in allowing my research team to undertake their work. It is a gift that I will always treasure.

Workshops

After receiving verbal permission, I chaired the research team's first workshop at the University of Windsor, Windsor, Ontario on August 23-24, 1996. Three guiding principles emerged from the meeting: (1) the project would be undertaken with the highest safety standards; (2) the project would be undertaken with the highest ethical standards; and (3) the project would be undertaken according to Dr Charles Smith's Principle, "You do not know what you have until you actually do the work." Dr Smith, Hospital for Sick Children, Toronto, Ontario, cautioned that although the evidence might suggest that the bodies should be preserved, it was entirely possibly that the bodies might have decayed.

A second workshop was held at the Centres for Disease Control and Prevention, Atlanta, Georgia on April 8, 1997. A key question of the workshop was whether or not to proceed with the project in light of Dr Jeffrey Taubenberger's results published in the March 21, 1997 edition of *Science*. He managed to recover partial sequences of some viral genes from archival samples. It was agreed that we should go ahead with the project because:

- more information was needed;
- Dr Taubenberger's samples might have been altered by the formalin in which they were preserved;
- samples from Svalbard might yield different results than Dr Taubenberger's samples from North America. Dr Taubenberger agreed to join the research team.

It was also decided that the project would be undertaken in two Phases: (first) a Ground-Penetrating Radar (GPR) Study (a non-invasive procedure); and (second) the actual exhumations (if warranted by the GPR Study). A GPR Study was thought necessary in order to determine the depth of the active layer of the permafrost (the surface layer of the ground which thaws each summer and refreezes each winter) and the depth of the burials.

Funding

Drs Robert Webster and I were awarded National Institutes of Health (NIH) support for the Phase I GPR study with provisional funding for Phase II (the exhumations) after evaluation of the GPR results. NIH funding was awarded for Phase II. Professor John Oxford and I were awarded funding by a pharmaceutical company.

Phase I: Ground Penetrating Radar (GPR) Study

GPR uses radio waves to detect buried objects in any non-metallic materials, such as soil, ice, rock, and human-made structures. GPR has numerous applications in archaeology, buried tank location, concrete inspection, contaminant detection, mineral detection, and ordinance detection.

GPR can penetrate soil depths of a few metres to many tens of metres depending on soil conditions. Low radio frequencies are used for deep exploration. High radio frequencies are used for high-definition imaging.

A sensitive detector is dragged across the surface of the material under investigation. Radio waves are sent down through the material and are reflected from objects embedded in the material. The bigger the change in properties, the greater the signal reflected. The GPR data are reflected signals with respect to time and position. A computer records and merges the GPR data to create vertical sections.

A GPR study of the cemetery of Svalbard Kirke was undertaken between October 10 and October 14, 1997. The GPR survey included 109 GPR profiles (with 225 MHz, 450MHz and 900 MHz antennas) across the graves of the seven victims of the Spanish flu and adjacent parts of the cemetery.

GPR showed that the ground was disturbed to a depth of two metres and was frozen below one metre. GPR also showed the most probable location of the graves of the influenza victims. The data suggested that the bodies of the young victims should be well preserved.

More Workshops

A third workshop was held February 3, 1998 at the National Institute for Medical Research, Mill Hill, London, England in order to discuss the GPR results, develop protocols for Phase ll, the exhumations, and to discuss the need for the project in light of Dr Taubenberger's new results. After joining my research team, Dr Taubenberger was approached by Dr Johan Hultin, a retired pathologist who had unsuccessfully tried to recover infectious virus from the lungs of Spanish influenza victims buried in the Alaskan permafrost in 1951. In 1997, Dr Hultin offered, with only one week's preparation, to return to Alaska and collect samples from influenza victims buried in the frozen ground, for Dr Taubenberger. When the results of the expedition were announced, my team had to once again decide if we should proceed with our work in light of the new findings. The team decided to proceed because more information was needed. A fourth and final workshop was held at the University of Toronto in order to further discuss Phase ll.

The possibility of obtaining infectious material in Svalbard was deemed extremely low because the ground temperatures over the past eighty years had not been ideal for influenza viruses. The infectivity of influenza viruses is not stable for extended periods in the temperature range of -18oC to -4oC. At a depth of burial of one and one half metres, the actual range of ground temperatures was probably between -4 and -10oC. Viruses are conventionally stored at -70oC to maintain infectivity.

Despite the extremely low risk, every safety precaution would be taken. The safety protocols were planned over two years and were approved by an Expert Panel for the National Institutes of Health and the State Medical Authorities of Norway.

The Svalbard excavation and exhumations were under the general direction of the Medically Responsible Officer (MRO), a licensed physician. The MRO was to have the statutory duty to supervise the entire work (digging, sampling, back filling), ensure the existence of proper working conditions, document exhumed remains, and fulfill any conditions laid down in the enabling license. The MRO was to ensure that: all excavation and exhumation staff took the latest influenza vaccine recommended by the World Health Organization and all staff fully understood the nature of the work involved with the project and understood the potential risks involved.

Prior to beginning the project, the MRO undertook safety assessments, based on current, international strategy regarding work and procedures associated with infective agents with which the team might come in contact. The MRO also informed Longyearbyen Hospital of the project; the hospital, which supported the Project, was consulted on both surgical and medical emergency procedures should they have been required. The Hospital contained a suite for epidemic disease which was furnished with an air lock. Tromso Regional Hospital was also informed of the project and was prepared to assist in any urgent diagnostic work.

Phase ll: Exhumations

Preparing the Site

Phase ll, the exhumations, began on August 14, 1998. The team's first task was to make detailed records of the seven graves. Accurate recording later allowed the excavation team (Heginbottom and the Necropolis Company, the United Kingdom's principal exhumation engineering company) to restore the site to its original condition, as required by those granting permission. The permission stated that "all excavated soil shall be replaced and the surface reconstructed, so that there are no visible traces of the graves having been opened."

The team's second task was to erect fencing around the site in order to make a safe working environment. Health and safety considerations were paramount for staff involved in the preparation of the site, excavation, and exhumations. All excavation and exhumation staff required tetanus immunization, and all staff were warned about pos-sible musculoskeletal injuries and minor skin breaks. Every accident or illness requiring time off work was to be documented and reported to the MRO. Incidents were also to be recorded in the log book, which included a daily time log of all persons entering and leaving the exhumation site.

But how to maintain the safety and sanctity of the site while still providing open access to all media (except during the excavation beyond the first few centimetres, and during the exhumations), as required by the Norwegian authorities? It was necessary that both the scientific community and the public know about the project and have the right to discuss the merits and drawbacks of the work.

The next task involved transporting two shipping containers from England, with seventeen tons of supplies, up to the cemetery from Longyearbyen's harbour. The team held a short ceremony to honour and remember those buried in the cemetery. Next, Smith led the team in prayer and the team held a minute of silence.

And then the actual work began. The six white crosses and one headstone marking the graves of the seven influenza victims were removed, wrapped in burlap, and carried down the steep slope of the valley for safe storage. (Although the team was allowed to exhume only six victims, the headstone marking the seventh victim's resting place had to be removed in order to prevent damage to the marker.)

Protective walkways were laid in order to prevent the team's trampling the fragile Arctic tundra, as those granting permission required that, “The work must be carried out with due respect to . . . the environment." After the walkways were put into place, the team began transporting the seventeen tons of supplies up the 1-in-4 slope. The supplies included two tents, one weighing half a ton and the other a quarter of a ton. It took ten people working over five hours to manually winch the tent up the valley side, as the Norwegian authorities required that: "No wheeled or tracked machines will be allowed." The large tent, measuring 6.5m by 5m by 2.5m, was then laid along the ground, and required approximately fifteen minutes to inflate.

After a week of preparing the site, the team was ready to begin the excavation. Pastor Jan Hoifodt of Svalbard Kirke blessed the graves and cut the first piece of turf. He explained the Christian perspective on the ethical issues of disturbing a cemetery, and then indicated why the expedition must continue. He said that if the six miners knew that their bodies held the key to such a terrible plague, they would say, "Of course, take samples of my body for research."

Excavation

Following the blessing, the layer of turf covering the graves was removed. Each piece of turf was carefully stored on a protective structure so that each piece could later be returned to its original position. Next, the soil was excavated and stored in a temporary container, built by the team to protect the fragile environment.

Excavation of the soil continued inside the tent until the team reached the coffins of the victims at less than one metre of depth. The team was prepared for such an eventuality because of Smith's continuous cautioning: "You do not know what you have until you actually do the work." The team was prepared for many different eventualities: victims in coffins; victims in shrouds; one burial pit; commingling of bodies; and burials at different depths.

Exhumations and Sampling

It is important to draw distinctions between what was planned, and what actually took place. Prophylactic anti-influenza drugs starting the day before first possible viral exposure and continuing seven days after the last possible exposure were to be given to those in close contact with the cadavers. A new neuraminidase inhibitor, with both preventive and therapeutic efficacy in laboratory tests and small clinical studies, was also to be used. During sampling, only the minimum number of people required for the work were to be permitted inside the tent. The autopsy team was to consist of three workers: Dr Charles Smith and two assistants. Smith and his first assistant, Mr Barry Blenkinsop, Office of the Chief Coroner of Ontario, were to carefully open the coffins and obtain samples, and were to be considered contaminated. A second assistant, Dr Rod Daniels, National Institute for Medical Research, London, England was to act as a circulating nurse and was to be regarded as clean. The latter worker was to be responsible for transferring the samples into appropriate transport containers. The autopsy team was to have worn the following clothing: Tyvek suit; a water-impermeable barrier (e.g. apron); rubber boots; hand protection (latex or Kevlar gloves); and a mask and air supply system.

When the coffins were discovered at less than a metre of depth, the team held a meeting to discuss biological risk and safety procedures. It was agreed that the 10^{-18} estimated risk of finding live virus was even less, as the bodies had been found in the active layer of the permafrost; the bodies had, therefore, been exposed to freezing and thawing, both detrimental to biological preservation. Protocols regarding preventive drugs, the number of people allowed in the tent, and the need for air supply were therefore modified.

The coffin lids were to have been carefully removed if the bodies had been placed in coffins; the cloth was to have been opened if the bodies had simply been wrapped in cloth. There was to have been no attempt to remove the bodies from the pits in order to perform an examination. Samples were to be taken from only those bodies for which permission had been granted.

The state of coffin/wrapping contents was to have determined the next stage. If the remains had been encased in ice, time would have been given to allow the ice to thaw so as to view the skin through the ice. If the remains had not been encased in ice, collection of material for examination could have been undertaken soon after exposure of the preserved remains. A protective barrier (eg a thick rubber sheet) with small openings was to have been placed over the bodies, with the openings over the autopsy sites in a manner similar to the placement of surgical drapes.

Sampling procedures had been designed to avoid generating aerosols. Samples were to have been taken using a hollow coring device. The samples were to have been taken through the covering layer of ice. Core samples were to have been taken from the lungs, trachea, spleen, liver, kidneys, and heart by a low speed drill to avoid aerosol formation. Tissues were to remain frozen throughout the sampling; however, it had been recognized that around the bore surface, minimal melting caused by shearing might occur.

The bodies were in simple wood coffins as was expected. There was no ice. Coring was not possible due to

the state of preservation, and alternative autopsy techniques had to be developed in the field.

Over one hundred samples were collected, safely and ethically, from such sites as the lung, liver, kidney, and brain. While the graves were opened, site security was provided on a twenty-four hour basis.

Decontamination

After samples were taken from the bodies, chemical decontamination of the equipment and clothing was performed using standard, commercially available solutions. Disposable equipment and clothing were incinerated when possible. All other potentially hazardous materials (e g sharps) were disposed of using appropriate containers, consistent with the practices of the medical community in Svalbard.

Reburial

Once the samples had been taken, the bodies were reburied in a safe and respectful manner. Every precaution was taken to prevent frost heave of the bodies and to maintain the permafrost. Independent geologists and permafrost specialists were consulted in order to ascertain the best method of burial to prevent re-surfacing of the bodies in the future. The coffins were covered with fifteen centimetres of fine soil, prepared from the excavated soil, to provide a layer of padding. Excavated soil was then replaced in fifteen to twenty centimetres thickness, dampened and tamped into place. The pit was filled to the original grade level, equivalent to the level of paths surrounding the grave site. Reburial and backfill procedures had the approval of the local authorities. Since the expedition in 1998, the Governor of Svalbard's Office has been monitoring the site for any deterioration. The site was inspected most recently on August 1, 1999, and September 21, 1999. "On both occasions the site looked as if . . . [the team] had not been there . . . and further need for horticulture or refill/removal of ground mass is not necessary at this time." Nevertheless, monies have been set aside should restoration be required in the future.

It is important to note that changes in climate may alter the thermal regime of the ground, which may in turn lead to frost heave of the bodies. Global temperature is expected to increase by 1.0-3.5oC by the year 2100. Global climate change is likely to have a profound effect on permafrost, the thickness of the active layer of the permafrost, and the existence of extensive areas of discontinuous permafrost in Arctic regions. Loss of permafrost will trigger erosion or subsidence of ice-rich landscapes.

Transportation of the Samples

Transportation required that the core samples remain frozen at -70oC; therefore, samples were placed in containers providing multilayer mechanical protection and thermoprotective encapsulation. The sample material was transported by air, on separate planes, to a Biosafety Level 4 (BL-4) laboratory at the National Institute for Medical Research (NIMR), London, England.

Results

The team has brand new results, never before known, about the 1918 influenza virus. Short fragments of the virus have been recovered from the lung, liver, kidneys, and brain. This suggests that the virus may have gone systemic in some cases, and did not just attack the lungs as had previously been shown. Moreover, the fragments were different from the cases reported by Dr Taubenberger in the United States. The differences may suggest that more than one virus was involved in the lethal 1918 pandemic. More exciting results are ex-pected in the future.

The Future

My hopes for the project are as follows. First and foremost, I hope that we will be successful in retrieving all traces of the Spanish flu virus in our tissue samples. If we are successful, I hope that we will test the possible relationship between Spanish flu and encephalitis lethargica as this was a key aim of my initial project in 1992. En-cephalitis lethargica, also known as von Economo's disease, epidemic encephalitis, and sleeping sickness, which appeared suddenly in 1915 and disappeared sometime between 1927 and 1930, took or ravaged the lives of an estimated five million people worldwide.

Second, I hope that we have set both safety and ethical standards which will have to be matched by future expeditions. And finally, I hope there is a recognition that there has to be humanity in science. It is imperative to recognize the sensitivities involved when working with human remains. It is also imperative to recognize the sensitivities involved when working in a foreign country and culture. When we are a country's invited guests, we

must work within the rules and regulations of the host country. We must recognize that our views are not necessarily held by those around us. And we must appreciate the different views and accommodate our practices as necessary.