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CRYONICS

FOCUS ON ETHICS

FALL 2006 · VOLUME 27:4

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Recent Developments in the Ethics of Life-Extension

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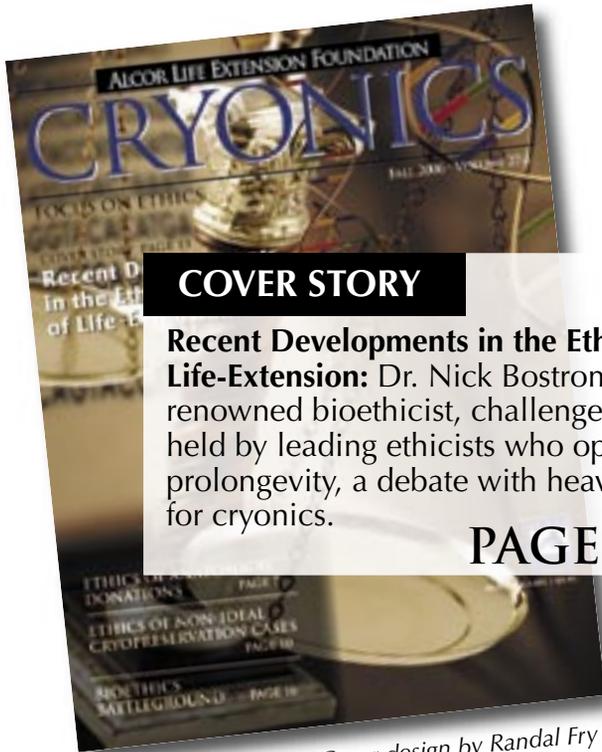
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CRYONICS

FALL 2006 · VOLUME 27:4

ETHICS OF CRYOPRESERVATION



COVER STORY

Recent Developments in the Ethics of Life-Extension: Dr. Nick Bostrom, a world-renowned bioethicist, challenges the opinions held by leading ethicists who oppose prolongevity, a debate with heavy implications for cryonics.

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Cover design by Randal Fry

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FROM THE EDITOR

Ethics: intangible, and yet so powerful. It is a guiding force that leads humans to draw conclusions—make life and death decisions—and yet it guides each person differently. And the most difficult part is that the force guiding one person is intertwined with the force guiding others. Talk about a tug of war.

With the recent restoration of democrats to power in the United States government, the “gravity” of the ethical pull is likely to change in terms of the legality of potentially life-saving research, namely research into therapeutic stem cells and other life extension technologies. Dr. Nick Bostrom, co-founder of the Institute for Ethics and Emerging Technologies and a world-renowned bioethicist, has definite opinions about such research. In his article (pg. 13), Bostrom extends opposing viewpoints held by leading ethicists on the subject of life-extension. It is a social debate with heavy implications for cryonics and other cutting-edge research endeavors.

Anytime a radical new approach to solving a problem is suggested, it is prudent to question the consequences. Sometimes it means taking on an emerging debate, as is seen in Tanya Jones’ article exploring evolving organ donation laws and how those new laws coincide with today’s accepted medical edicts and cryonics practice (pg. 7). Or sometimes it means questioning your own ethical boundaries. Dr. Brian Wowk, an Alcor Board Director, scrutinizes when cryonics—which is seen by its proponents as a life-saving attempt—could be rightfully deemed unethical (pg. 10). And if you ever wondered how bioethics became such a prominent topic, Deborah Johnson succinctly sizes up the landscape of bioethics and how it has changed over the years (pg. 16), creating a platform for new ideas.

It’s an inescapable debate. We felt it was important to touch on some of the challenges and share some perspectives. Opinions are not hard to come by, and your opinion matters to us. Until January 31st, 2007, the Alcor News blog will be open for questions and comment on these articles and ethical questions that are of interest to our readers.

Our Blog. Your Opinion.

Until January 31st, 2007, the Alcor News blog will be open for questions and comments on the articles in this issue and ethical questions that are of interest to our readers.

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EXECUTIVE DIRECTOR'S REPORT

DEVELOPMENTS UNVEILED AT THE 6TH ALCOR CONFERENCE

As this issue goes to press, we have just completed the 2006 Alcor Conference in Scottsdale (October 6-8). Much more detail will be available in the next issue of *Cryonics* magazine, but I can tell you now that it was probably the most successful conference Alcor has sponsored. In the words of former Alcor president Steve Bridge:

"I had a great time at Alcor the past week. The conference was probably the best overall I have attended, and the combination of people there was inspiring. I was especially impressed that we had three elected Arizona officials as speakers, all of whom appeared to be pleased to be there.

It was also good for me to meet Barry Aarons, Cheryl Walsh, Deborah Johnson, and the newer Alcor staff that I hadn't met yet. I could go on about each one of them. The mood of action and accomplishment at Alcor was very strong. Directors and Advisors who have not been at Alcor during the past few months are missing the tangible excitement that real research and development are generating. Alcor has filed its first preliminary application for a patent, and several other major developments are taking place.

Tanya Jones has grown as a leader much more than I understood before; Michelle Fry is determined to make standbys and transports as professional as possible; Sergey Sheleg, Chana Wiliford, and Randal Fry are major additions to our ability to develop new ideas; and D'Bora Tarrant, Jennifer Chapman, Sheila Kimbrell, and Diane Cremeens handle their own areas with both competence and a friendliness that makes guests and members welcome. Along with old standards Hugh Hixon, Michael Perry, and volunteer Jerry Searcy (who ran his legs off gophering at the conference), this is the best staff overall that Alcor has ever had."

The "preliminary application for a patent" that Steve Bridge refers to is for a new partial liquid ventilation system that we are developing. The partial liquid ventilation system is based on

work at Critical Care Research, Inc. that we are in the process of licensing. Our system is intended to rapidly induce hypothermia in cryonics patients by partially ventilating the lungs with a chilled breathable liquid. It utilizes the large surface area of the lungs to rapidly extract heat and prevent much of the structural damage caused by higher body temperatures. In addition to increasing the early cooling rate of cryonics patients, our system will simplify the task for our first responders who will access the lungs through an airway, a non-invasive skill common among paramedics and nurses. This technology has the potential to save thousands of heart attack and stroke victims annually.

This is just one of several new developments demonstrated at the conference. We also showed attendees the early stages of a new Air Transportable Perfusion system; a lighter, and more efficient portable ice bath; the beginning stages of the new whole body vitrification system; our new lab space, and some research regarding fracturing in cryopreservation. Watch for more details regarding these projects in a later issue of *Cryonics* magazine.

One word here on Alcor's intellectual property policy. Alcor has, in the past, done very little to protect its intellectual property, preferring to broadcast its work everywhere even in the most preliminary stages. This, however, I think, is irresponsible. It is unlikely that the vast majority of our developments will have much value outside of cryonics, but it is still possible. More important, though, is protecting our own access to technology we develop or help develop.

With this in mind, we are conducting formal IP reviews of the projects we undertake. It is likely that most of these reviews will result in being told that it is not financially worthwhile to pursue legal protection. When this is so, we will then openly discuss our projects. If we do seek patent protection, we will announce our projects as soon as we can.

It will take time for us to engage in these reviews. Just remember that this does not mean we are not accomplishing much. We prefer to approach these matters professionally and would rather announce projects only after conducting proper IP reviews and making *some* tangible progress. Alcor has his-



torically announced grand plans in these pages and elsewhere, only to never be heard of again. I prefer to spend time talking about Alcor's accomplishments, not its dreams.

The best place to experience our accomplishments firsthand is at the annual conference. So, if you attended this year, plan to go again next year. There will be much more to see and hear, and you can again connect with both old and new friends. If you didn't go this year, well, you missed out. Luckily, if you act fast you can pre-order your copy of the conference DVD set at a special Early Bird rate (*see inside cover for ordering instructions*). The DVD set will include footage of the conference presentations, social events, and tours of the Alcor facility. It's the next best thing to being there in person. And you still have the 2007 conference from October 5-7 to look forward to. I know we look forward to seeing you there.

Sincerely

A handwritten signature in black ink that reads "Stephen J. Van Sickle". The signature is written in a cursive style.

Stephen J. Van Sickle
Executive Director

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AFTER VIRTUE (SECOND EDITION)

by Alasdair MacIntyre ~ Notre Dame, Ind.: Notre Dame Press, 1984.

BOOK REVIEW BY R. MICHAEL PERRY, PH.D.

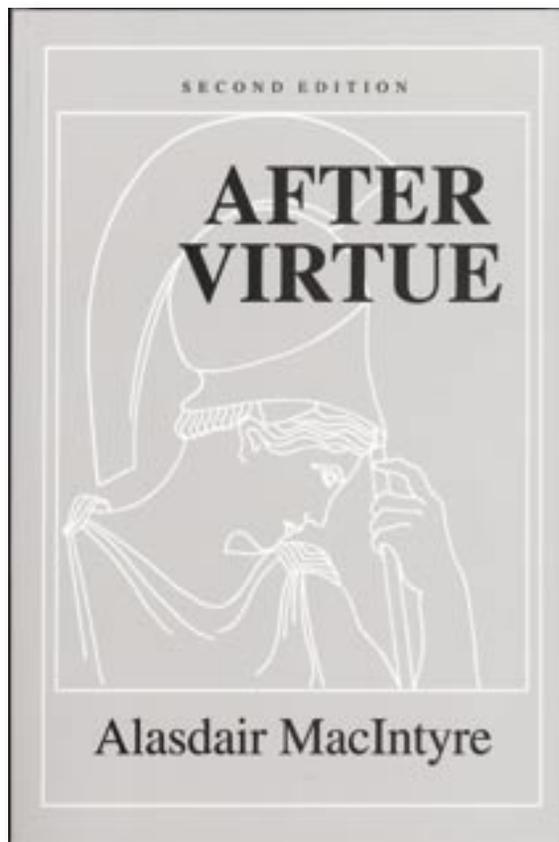
The times we live in are justly famous—infamous may be the better term—for the challenges we face. An important case in point is in the field of morality or ethics. Here there are many issues that remain unresolved, on topics such as the right to choose, the right to privacy, and medical, scientific, and religious questions. The deep differences in values and world views held by the various opposing sides tell us that resolving these matters will be no easy task nor will it happen soon. Yet we must not stop trying—there is too much at stake. *After Virtue* by Alasdair MacIntyre offers one attempt at a starting point for a resolution of our moral fragmentation, based on virtue ethics.

Virtue ethics starts mainly from Aristotle's theory developed in *Nicomachean Ethics*, and focuses, not on what makes a good action, but on the larger and more difficult issue of what makes a good person. Despite its ancient pedigree, this approach had fallen out of favor following the Enlightenment and, more recently, Nietzsche's emphasis on a "will to power." But careful consideration, I think, shows the superiority of virtue ethics over alternatives.

A good person will exercise good judgment and thus possess a superior capacity for good actions than can be captured in a theory that focuses only on the actions themselves. We thus are led to considering a human life as a whole and what its "aim" or purpose may be.

To achieve a good life, which is what we are aiming for (the Greek term is *eudaimonia*, roughly, "happiness"), we must be good, which in turn requires virtues. The book references Aristotle's consideration of virtues under two headings, intellectual virtues, such as theoretical and practical wisdom; and moral virtues, such as justice, prudence, and courage.

In a moral theory such as virtue ethics, it is the moral virtues which, not surprisingly, receive the most attention. For Aristotle each moral virtue is a mean between unvirtuous extremes. Thus courage is a mean between



cowardice and foolhardiness. The courageous person will find the golden mean between these latter extremes and stand firm against a threat when called for, but with due caution, respect, and careful preparation.

For virtue ethics to be meaningful, MacIntyre emphasizes, it is necessary to have some notion of an overall aim of life—the Greek word is *telos*. The author ponders what the appropriate *telos* for a human being might

be. We can focus on a natural life well-lived, as a secular humanist might, and nothing more. This should at least help considerably in grounding our virtues and helping resolve our moral dilemmas. Or

we can go farther to a theological view, in which this life is but a preliminary and the *telos* is something far grander. This is as far as MacIntyre (who himself is Catholic but

carefully avoids imposing any religious views in his arguments) is able to go.

A third alternative, not found in the book but deserving mention, is provided by transhumanism: a hope that life can be extended beyond its present limits through science. (In particular cryonics today offers a possible entry path to this form of life extension.) A careful approach here would avoid Nietzsche's discredited, egocentric Superman, yet at the same time provide a rational tie-in to something beyond our present existence. So a form of virtue ethics seems right for transhumanism. Aristotle and his successors such as MacIntyre have not managed it or attempted it, but their work could serve as a useful starting point.

The book does make an effective case for turning to the approach it advocates, but more is needed, I think. If you are a strong transhumanist, like me, and your time is limited, you will naturally be impatient with an approach that does not acknowledge the great new possibilities for life extension through technology. You will find excellent summaries of the various ethical theories, including virtue ethics, on the Internet (for example, in Wikipedia), and you may wish to go no farther. If you do want to go farther, Aristotle's *Nicomachean Ethics* would be a good start, supplemented by a modern treatment such as the volume under review. ■

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*"To achieve a good life...
we must be good,
which in turn
requires virtues."*

ADVANCES IN CRYOPRESERVATION

By Gregory M. Fahy, Ph.D. ~ Chief Scientific Officer ~ 21st Century Medicine, Inc.

THE EMERGENCE OF VITRIFICATION

Last time, we reviewed some of the evidence showing that ice formation tends to be unkind to large living systems and is best avoided. Now we'll have a quick look at the emergence and successfulness of vitrification (glass formation) as an alternative to freezing.

Father Basile J. Luyet was the first to suggest vitrification (glass formation) as a viable goal for cryobiology.¹ His approach was basically to cool so rapidly that ice would not have time to form. He was able to demonstrate, in 1950-1953, survival of chick embryo hearts² and brains³ after brief exposure to high concentrations of cryoprotectant used as a dehydrating agent followed by plunging into liquid nitrogen. Many others have followed almost the same approach to the present day to preserve very small samples, but it was Farrant, in 1965, who first opened the door to the avoidance of ice in whole mammalian organs.⁴

Farrant's ingenious and original method was based on the temperature dependence of the toxicity of cryoprotective agents. Farrant first added a non-toxic concentration of 10% v/v dimethyl sulfoxide (DMSO) to guinea pig intestinal smooth muscle (taenia coli) or uteri at 37°C (normal body temperature). This concentration was sufficient to depress the freezing point of water below the normal 0°C. Cooling these living systems to their new freezing point of -3.6°C allowed Farrant to increase the concentration further without engendering toxicity,

which in turn allowed him to then cool the uteri and taenia coli to an even lower temperature without freezing, and so on. By continuing this process he was able to get all the way down to the sublimation temperature of dry ice (-79°C) without allowing freezing to take place, and when the process was reversed, both the uteri and the intestinal smooth muscle were able to contract normally in response to drug stimulation!

Unfortunately, Farrant did not realize that simply cooling his uteri another 50°C or so would have brought them into the vitreous state, allowing him to achieve the first successful vitrification of mammalian organs in 1965! He believed that further cooling would freeze his uteri but that this would not be damaging, leading to the inspiring conclusion that "it may be that these new methods will form the basis for the successful freezing, storage and thawing of tissues which require 100 per cent cell survival in order to function."⁴

Farrant's method was soon applied successfully to hearts by Rapatz in Luyet's lab. When I was a graduate student, my father paid for a plane ticket that allowed me to fly to London for the annual meeting of the Society for Cryobiology in 1974. This allowed me to witness Rapatz's amazing movies, probably by now lost to history, of frog hearts beating normally after being cooled to dry ice temperature with the aid of at least 10 mo-

lar ethylene glycol in accordance with Farrant's approach.⁵ Heart areas that froze, in contrast to heart areas that did not freeze, failed to recover.⁶ Hearts transferred into liquid nitrogen and then rewarmed were found to be fractured.⁶ However, when the ventricle was cut open and tied, spread-eagled, to a metal frame, it was able to beat reasonably well even after prior immersion in 10M ethylene glycol and then in liquid nitrogen,⁷ and did not fracture (Figures 1A and 1B)!

Unfortunately, none of these spectacular successes could be duplicated with mammalian hearts,⁵ mammalian kidney slices,⁸ or frog sciatic nerves.⁹ The trick of using lower temperatures just wasn't good enough for most mammalian systems.

In the late 1970s, I was forced to confront this failure head on. In a collaboration with the US Navy, I froze dog kidneys with a high concentration of glycerol, stored them for a week at about -30°C, and found that they still responded to vasoconstrictors¹⁰ when thawed out and washed free of glycerol, suggesting preservation of cellular viability. However, when these kidneys were transplanted, they turned blue and passed urine that looked like whole blood! Their physical structure was obviously a mess, in keeping with my earlier electron microscope images showing physical disruption of the non-living portions of frozen-thawed kidney slices.¹¹

Looking for an alternative, I first looked into deep supercooling,¹² but storage at -79°C was too

Figure 1A: Frog heart cut open and distended, fastened on a U-shaped metal support. The surface exposed in this photograph is the external surface of the heart.

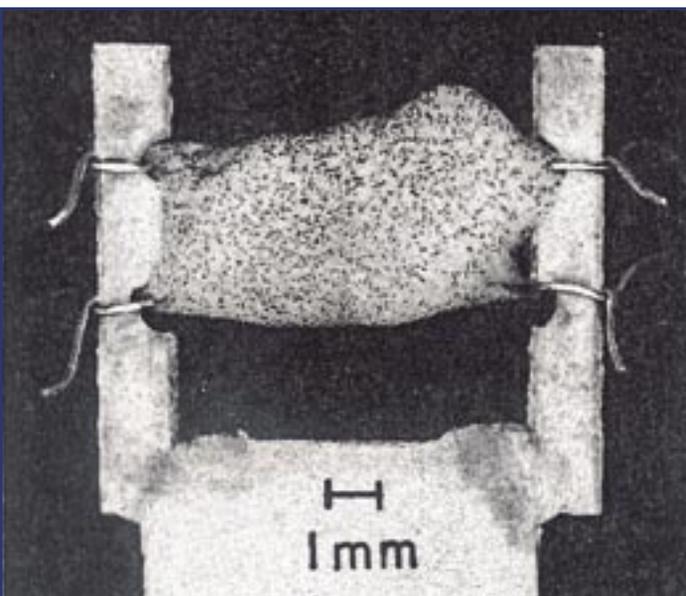
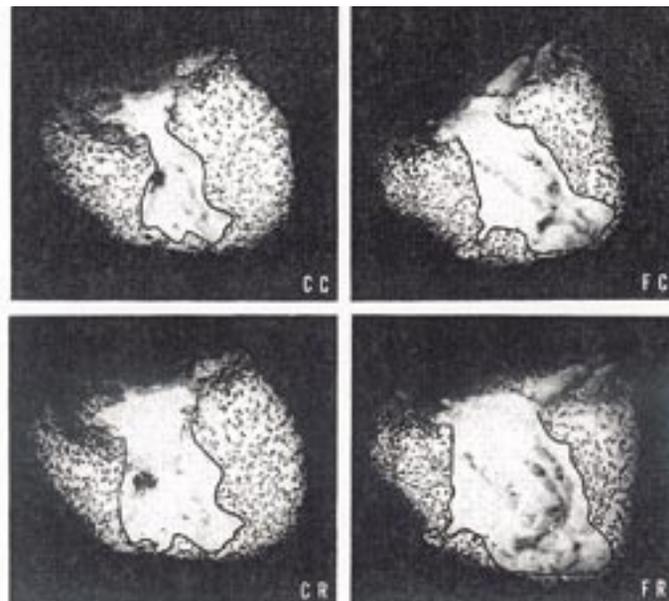


Figure 1B: Frog heart ventricles contracting and relaxing. CC: control contracting. CR: control relaxing. FC: "Frozen" contracting. FR: "Frozen" relaxing. The "frozen" ventricles were either vitrified or largely vitrified and survived plunging in liquid nitrogen.



liable to end in freezing after only a few days, and solutions concentrated enough to get to this temperature unfrozen were just too toxic. But I then realized, at the end of 1980, that I might be able to vitrify using lower concentrations of

cryoprotectant!¹² Within a few months, I had enough data and ideas¹² to present the concept in public,¹³ and by 1983, I was invited to give a major talk on this new approach to cryopreservation.¹⁴

Progress over the ensuing 22 years has been steady, but with a host of new problems arising to replace old problems as they were solved. However, by 2005, my lab was finally able to report the permanent in vivo survival of the first vitrified kidney,¹⁵ a finding that will hopefully be published in more detail, and improved upon, before too very long.

Meanwhile, the survival of many simpler systems by vitrification or partial vitrification has now been achieved by many laboratories (Table 1), and over 600 papers on using vitrification as a method of cryopreservation have now been published.¹⁶ Next time, we'll have a deeper look at some of these results and what they may mean for the future. ■

Table 1:
Some Successes in Cell, Tissue, Organ, and Organism Cryopreservation by Vitrification

CELLS	TISSUES	ORGANS & ORGANISMS
Red blood cells (human)	Embryos (buffalo, cow, fly, human,	Schistosomes
Monocytes (human)	llama, mouse, etc.)	Tetrahymena
Embryonic stem cells (human)	Pancreatic islets (man, monkey,	Arteries (rabbit)
Hematopoietic progenitor cells	and mouse)	Veins (rabbit)
Oocyte cytoplasts	Cartilage (rabbit)	Hearts (chicken, embryonic)
Ova (mouse, cow, human)	Corneas (rabbit, human)	Brains (chicken, embryonic)
Osteoblasts	Peripheral nerves	Skin? (human)
Islet substitute cells	Plant tissues	Ovaries? (mouse)
Microencapsulated rat hepatocytes	Organ slices (liver, renal cortex,	Kidney (rabbit)
Spermatozoa? (no cryoprotectant)	renal medulla, hippocampus)	
Plant cells	Ovarian tissue (various)	
	Heart valves (human)	
	Embryonic kidney tissue?	

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THE ETHICS OF ANATOMICAL DONATIONS

By Tanya Jones

**Physicians take a Hippocratic Oath to observe medical ethics.
Complying with the same basic philosophies is a priority for cryonics.**



Ethics are a branch on the philosophy tree, responsible for analysis of concepts like right and wrong, good or evil and for developing systems that allow a person to judge how to respond to a situation. Medical ethics, in particular, are at the forefront of our society's moral consciousness. By comparing the ethical similarities between medicine and cryonics, the principles guiding cryonics are brought into focus. Yet, cryonics is more easily related to the organ transplant industry, in that both require an anatomical gift that takes effect after a person is legally deceased. The ethical standards in this arena primarily pertain to donor consent, end-of-life care, and when death has occurred so that the donation process can ethically ensue.

Faced with devastating organ shortages, the organ transplant industry is testing new approaches, including extracorporeal interval support and donation after cardiac death, or DCD. The motive is to increase the number of viable organ donations, thus saving more lives, but the ethics are tricky. Could the same end-of-life care given to organ transplant donors benefit cryonics patients? Are the same ethical principles that guide the organ procurement industry an

appropriate guide for the cryonics industry? This article explores the ethical similarities and differences between cryonics practice today and the practice of medicine, with specific emphasis on the organ transplantation industry.

Adherence to Medical Ethics

People in general are under no obligation to reveal their ethical beliefs, and most probably choose to keep them private. In the medical profession, however, ethics are distinctly public and, to a degree, standardized. Although cryonics is not subject to the rigorous standards of the practicing medical community, we understand their importance and attempt to comply with the same basic philosophies.

For instance, every person who contacts a cryonics organization for information about the procedure is informed that a cryopreservation is currently irreversible; that it causes damage through multiple mechanisms, not the least of which are cryoprotectant toxicity, ischemic injury, and low-temperature fracturing; and that there are no guarantees that re-

vival will be possible. By being truthful about the limitations we face, we are clearly adhering to a primary ethical tenet of medical research: honest disclosure of the risks.

We make no effort to compel people to join in this experiment and do little marketing at this time, instead providing extensive information on cryonics, so that people can make up their own minds. In this, we respect autonomy, a person's right to choose their own fate, which is in alignment with industry standards for anatomical donations.

Unfortunately, because a cryonics procedure is not currently reversible, we cannot claim to entirely adhere to the medical edict of "first do no harm". However, our philosophy mirrors that of the medical community in that we favor pursuit of the "greater good" in the interest of saving a life. Harm done in the preservation process, which stabilizes tissue as long as may be necessary to reverse the process, is potentially less than the harm of not acting at all. Similar decisions are made in medicine when doctors choose the toxicity of chemotherapy or the trauma of surgery over the greater harm of death due to inaction.

With close examination of the basic principles of medical ethics, it appears that cryonics adheres fairly well to them; but ethics are a moving target. Refinement of general medical ethics into a more specific framework became necessary in recent history, because fundamental human rights were being violated in serious ways.

Human Experimentation

Cryonics is scientific research involving human subjects. Even though the law currently recognizes cryopreserved individuals as deceased, Alcor sees them as potentially viable, potentially living "patients". Therefore, we feel it is important to heed the historical lessons of human experimentation and the resulting guidelines.

One of the most notable instances of ethical abuse in medical research occurred during World War II at Nazi concentration camps. Harmful research was carried out on prisoners without their consent and without offering means for refusing to participate. The Subsequent Nuremberg Proceedings, the war crime trials after WWII, were instrumental in the development of formal guidelines for ethical human experimentation.¹

In 1947, the World Medical Association (WMA) was founded initially to address the perception that medical oaths and ethics had been

marginalized over time.² Starting from the classic Hippocratic Oath, a modernized version was developed. The Declaration of Geneva was accepted in 1948 and an international code of medical ethics in 1949. Both have become an established part of the international medical community.

Ethics, with respect to research involving human subjects, was reexamined by the WMA, which issued the Declaration of Helsinki in 1964. Guidelines were added to ensure that research on humans was done in accordance with generally accepted scientific practices; protocols were carefully designed and subjected to an independent ethics review; only qualified personnel were involved; and patient confidentiality was respected, to name just a few of the expanded elements. Written consent forms were recommended for the first time.

In 1972, the world learned of the Tuskegee Syphilis Study, which was an investigation into the disease course of untreated syphilis. This study was performed without the consent of the participants, placebos were given in place of medication, and patients were actively prevented from receiving appropriate treatment. This led to the formation of a National Commission for the Protection of Human Subjects in Biomedical and Behavioral Research in 1974, and the commission prepared a report on ethical principles and guidelines entitled, The Belmont Report.³ Their findings declared that medical research on human subjects requires respect for

persons, beneficence and justice.

All of these ethical applications, and the many more that exist, attempt to reconcile conflict between the need to respect individual choice and the need to perform research on human subjects. Participants should be fully informed of the risks and potential benefits and be free from coercion in their decision-making process. Medical ethics consistently demonstrate the unchanging elements of respect for human life and the sanctity of patient choice. Following these precepts is a priority in cryonics.

Organ Donation Standards

When discussing the ethical standards of care in cryonics, the standards followed by the organ donation industry may be seen as more pertinent than medical practice. As with organ donation, Alcor's authority to act on an anatomical donation is only bestowed after the donor is declared deceased. Historically, death was declared with the cessation of heartbeat and breathing. The concept of brain death was introduced with the advent of advanced life support techniques, like respirators. Brain death may be diagnosed when there is an irreversible lack of response to stimuli, like pain or light, and no evidence of electrical activity in the brain in absence of factors known to suppress activity.⁴

In the case of organ donations for transplant, such as kidneys or livers, organs may

be removed following brain death in the presence of a beating heart. Care (e.g. respirators or circulatory support) can be provided until such time as a transplant surgical team is assembled, and then care can be removed. The onset of cardiac arrest can be timed with relative precision for optimal harvesting. The organs avoid significant ischemic injury, which in turn improves transplant survival rates. However, there is still a tremendous shortage of organs, with nearly a hundred thousand people in the United States waiting for organs, including 14 percent waiting more than five years. To address this, doctors are considering accepting donations after cardiac death (DCD), rather than after brain death.

Cardiac death is an easier criterion to satisfy than brain death, but are the results as effective? In one study at the University of Wisconsin, the results of kidney transplants in cardiac death cases were compared to brain death donors. Between January 1984 and August 2000, there were 382 renal transplants done after cardiac death and 1089 after brain death. The survival rates of either transplant method at 5, 10 and 15 years were comparable.⁵

Even if it can be done, should it? The organ donation industry is already facing the potential for some ethical conflicts from DCD:

- Non-heart-beating organ donation opens the door for patients or families to forgo possibly beneficial treatment in order to provide organs.

Principles of Medical Ethics

Beneficence

acting in the best interest of the patient

Non-maleficance

"first, do no harm"

Autonomy

allowing the patient to choose or refuse treatment

Justice

deciding where medical resources may be deployed

Dignity

ensuring a patient's dignity (and the person treating the patient)

Truthfulness and honesty

lying and withholding information from patients about their illness and treatment options.



- Hospitals with large transplant facilities have an economic or academic interest in having less of an organ shortage.⁶

In some cases, organ retrieval has gone one step beyond the simple declaration of one form of death or another, beyond the maintenance or removal of life support. A new technique has been occasionally deployed called extracorporeal interval support. This new method for securing organs for transplant can include systemic or localized administration of heparin and the placement of cannulae into the femoral artery and vein prior to the pronouncement of death to facilitate rapid extracorporeal support. Medications are administered to prevent accidental revival of the patient during the procedure. This represents a significant departure from conventional organ procurement methods, in that pre-mortem treatment is provided to ensure greater viability in the organs.⁷

The debate surrounding DCD and extracorporeal interval support represents a major change in the end-of-life care decisions that individuals, families and health care providers face, as well as the definition of death, all of which has interesting implications for cryonics.

Impact on Cryonics

Might these kinds of care seen in the organ transplant industry converge with those in the cryonics industry? If extracorporeal interval support, a pre-mortem procedure, is used to ensure greater viability in organs, could it be applied to a cryonics patient and would the ischemic injury be significantly lessened in our patients? To know whether DCD is worth doing, we would have to compare our total body ischemic insult to the standards of these professional transplant teams.

As it evolves, organ donation after cardiac death may sound increasingly like the ideal cryonics stabilization. Cardiac arrest is rarely so well timed. Stabilization teams have typically been deployed days—and in some cases, weeks—prior to cardiac arrest. It is the rare case where a member's condition has them on life support that may be withdrawn on the basis of written health care directives.

No one really knows right now whether these accepted organ harvesting protocols will eventually be accepted in cryopreservation protocols, and speculating would not be wise. Few articles have been published on this topic yet, and changes in this type of procedure could come to pass. But the present situation can still

help the cryonics community in general, as these debates raise awareness of cardiac death as a potential element of anatomical donations and facilitates open discussions about the ethics involved.

Alcor would certainly require the involvement of a patient's medical team to implement these protocols, since an Alcor stabilization team cannot be involved in pre-mortem care. Medical professionals already have an understanding of many of the practices of cryonics, especially cooling, medications, and cardiopulmonary support; and we can raise awareness of the fact that our donations are ideally enacted in a fashion similar to the transplant industry.

The debate about donation on cardiac death now going on in the medical community might also work against the needs of cryonics. In conventional medicine, there is concern that DCD procedures begin too quickly after death and maintain the viability of the brain, which might be considered unethical.⁸ A backlash against DCD that imposes longer waiting times to assure more brain injury could also result in the same restrictions being extended to cryonics. Waiting until ischemic brain injury passes certain thresholds may be ethically desirable for organ donations, but completely circumvents the point of cryonics.

Conclusion

Modern medicine hasn't given up yet on saving more lives, and neither will we. Ethics will always be a factor in this on-going evolution of medical and research practices involving human subjects. It is incumbent upon us stay informed of trends, of procedures that have been tried and discarded or tried and widely adopted while still tackling the challenges associated with improving the general circumstances under which our patients are preserved. Overall, cryonics can be perceived as an ethical practice, since we certainly respect the primary principles in medical ethics. Our protocols and procedures are starting to sound a lot like the cutting edge in anatomical gift practices. We can hope that one day, our cryopreservation patients will be preserved under ideal circumstances, no matter where those patients are; and we will be watching the resolution of this debate with keen interest, hoping that the debate ultimately resolves in a way that is conducive to the rapid implementation of a cryonics stabilization protocol. ■

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Ethics of Non-ideal Cryonics Cases

By Brian Wowk, Ph.D.



Cryonics can be defined as the low temperature preservation of people who cannot be saved by medicine today until they can be revived and treated in the future. While the idea is simple, it involves many complex issues. This article will address only one of them: the question of to whom cryonics technology should be ethically applied, and when.

Ideal Cryonics

A truly ideal cryonics case might consist of a patient with a terminal disease consenting to placement in reversible suspended animation until treatment is possible. However such perfected “medical time travel” is still hypothetical since no technology exists for long-term suspended animation that is demonstrably reversible. In that sense, all cryonics cases today are “non-ideal” because the preservation method itself is not proven to work.

Nevertheless, even if the final result of cryopreservation is uncertain, an “ideal” cryonics case can still be defined as one in which the survival status of the patient is not in doubt at the time cryopreservation begins. This could be achieved by connecting an anesthetized living patient to a heart-lung machine to maintain blood circulation as temperature was lowered. In practice this

cannot be done because cryonics is not an approved medical procedure.

Cryonics deals with this problem via the mechanism of legal death. When an illness is terminal, legal death may be declared on the basis of cardiac arrest (heart stoppage) even though resuscitation is still possible. It is therefore possible to be legally dead, but biologically viable, for a short period of time. It is during this period of several minutes that “ideal” cryonics cases can be performed under existing law. This window of time is also used by conventional medicine for harvesting living organs for transplant in cases of donation after cardiac death (DCD).¹

The cornerstone of ideal cryonics is the idea of “Standby.” Standby is the process in which a team of cryonics technicians wait at bedside for the heart of a terminal patient to naturally stop beating, at which time legal death is declared. Legal death in this context means that further care by conventional medicine is not appropriate. The team then artificially restores blood circulation and begins cooling. This stabilizes the biological viability of the patient. Although difficult to achieve in practice, the goal of standby is to maintain the same biological viability in a cryonics patient as would exist if cryonics were an elective medical procedure, not a post-mortem intervention.²

Non-ideal Cryonics

A non-ideal cryonics case occurs when cryonics stabilization procedures, such as cooling, are begun long after resuscitation by contemporary medicine is impossible and thus biological viability is believed to have ceased. Such cases, which account for more than half of all cryonics cases, are often the result of unexpected legal death. Non-ideal cases may involve hours, or even a day or more, of clinical death without intervention.

In extreme cases, a non-ideal cryonics case may involve salvaging and freezing brain tissue that has been subjected to both trauma and decomposition. Use of chemicals to prevent freezing damage (cryoprotectants) is often impossible for non-ideal cases, which adds freezing damage to damage already caused by a lengthy period of clinical death.

Interestingly, the general public perception of cryonics seems to be that all cryonics cases are “non-ideal” as described above. It is widely believed that cryonics companies receive patients the same way that funeral homes receive bodies, many hours or days after legal death. The concept that cryopreservation can ideally be begun at bedside, with little or no brain injury by conventional criteria at the start of the procedure, is generally unknown.

Rationale for Non-ideal Cases

The biological rationale for non-ideal cases is that death is a process, not an event. It is generally known that clinical death can be reversed for up to 4 to 6 minutes after the heart stops before the brain is believed to die. It is less well known that this limit can be extended to as long as 15 minutes using experimental resuscitation methods.

In some animal models, up to 60 minutes of clinical death at normal temperatures has been reversible, with most damage confined to a particular area of the brain (CA1 region of the hippocampus). Even hours after blood circulation stops, living cells can still be retrieved from brains assumed to be long dead by contemporary medical standards. The brain does not suddenly fall apart when it is deprived of oxygen. These facts have been discussed at length in cryonics literature.³⁻⁶

Why, then, is it believed that people go out “like a light” when the heart stops? Many important functions do stop suddenly. When the heart stops beating, the brain runs out of energy, and all brain electrical activity stops after about 30 seconds. But people can and have recovered after far longer periods without any brain activity. This is because people are not really light bulbs. The structure and chemistry of the brain ultimately determines whether someone can be revived. Brain function does not matter. The brain is like a computer hard drive, not volatile electronic memory.

Whether a clinically deceased person can be revived depends on whether whatever is wrong with the structure and chemistry of their brain can be set right. Today nothing can be done about repairing structure, and setting chemistry right is limited to re-supplying oxygen, nutrients, and a few simple drugs. Whether a patient lives or dies when blood circulation is restored depends on whether the brain can naturally recover from damage that accumulated during the interval without oxygen.

Future technologies for molecular repair of the brain will be able to directly reverse structural and chemical changes caused by long periods without oxygen, making resuscitation after hours of clinical death theoretically possible. A century from now, doctors may speak of the critical need to treat cardiac arrest within the first 4 to 6 hours rather than the first 4 to 6 minutes as they do today.

In the limiting case of a technology capable of completely general molecular repairs, restoration of a healthy state would always be possible. Whatever repairs were necessary to repair/reconstruct a functional, biologically healthy brain and body could always be performed. What would happen is that long periods of clinical death followed by repair would result in varying degrees of memory loss about prior events. If decomposition were severe enough, “repair” would result in a new person. How much memory loss is required before the original patient is considered deceased? It is a tradition in medicine

that if brain function can be restored, the original patient is considered recovered despite amnesia. This custom seems likely to continue in the future whenever clinically deceased patients can be restored to consciousness, even when the repaired injuries were severe.

Ethics of Non-ideal Cases

The ethical justification for non-ideal cryonics cases begins with the ethical justification for cryonics generally, which is that medicine should not be limited to treating conditions that can only be treated in real-time with a certain outcome. Any remedial strategy that is scientifically defensible, even if requiring very long time scales, is a legitimate strategy for protection of human life. Cryonics under ideal conditions is scientifically defensible.⁷⁻¹⁰

If it is stipulated that performing cryonics under ideal conditions can be ethical, what of the non-ideal cryonics case? Clearly there are degrees of biological decay that will obliterate so much of the original person that future repair

will not recover the original person. This state has been called *information theoretic death*.⁷ But short of complete destruction of a person, how can information theoretic death be determined?

Present medical practice is to suddenly stop care of patients that reach certain stages of illness, and destroy them. This is done by a legal and social ritual that strips them of personhood. That ritual is legal death. The sudden transition from living patient to “remains” is so inculcated in popular culture that the very idea that a person without blood circulation or brain function could still be a person is unthinkable. In reality, there is no sudden loss of personhood when the heart stops, only a relatively sudden loss of ability to be resuscitated by current technology. That loss used to occur at the very moment the heart stopped. Now it occurs after 4 to 6 minutes. If post-resuscitation cooling is used, it can be over 10 minutes. Drug interventions show promise for extending it to 20 minutes. Eventually nanomedicine will extend it to hours. There is no sudden moment at which a brain, or person, ceases to be viable.

“The sudden transition from living patient to “remains” is so inculcated in popular culture that the very idea that a person without blood circulation or brain function could still be a person is unthinkable.”

The idea that human life is something that disappears slowly hours after clinical death, even as disposal rituals are already underway, is an aspect of biology that is rarely examined because the implications are so disturbing. Yet the availability of technologies for stabilizing patients for indefinite periods of time (cryonics) forces hard examination of this issue.

Ralph Merkle has called cryonics “conservative” medicine that is in keeping with the medical ethical imperative, “First, do no harm.” A triage process that commits viable patients to destruction certainly does harm, at least to the patient concerned. Thus “do no harm” would seem to require the cryopreservation of any patient with remaining brain structure until such time as tools become available to adequately examine and reconstitute the patient.

According to this paradigm, almost all conditions now considered “death” are actually disease states in which future treatment would result in resuscitation, albeit with varying degrees of loss of memory of prior events. No patient would be left behind. No patient should be left behind based on short-sighted judgments.

The Best and Worst of Cryonics Ethics

It is ironic that what some might call the noblest ethical statement in cryonics—the “no patient left behind” doctrine—can lead to the worst ethical criticism of cryonics. Cryopreserving “bodies” in states of severe deterioration appears scientifically indefensible. Doing so in exchange for money appears ethically indefensible. Which view is correct?

It may be that they are both correct, depending on circumstances. Most people who arrange for cryonics do so while young and healthy. They plan for, save for, and consent to cryonics many years in advance of need. Many specify in their sign-up paperwork that “any biological remains whatsoever” are to be cryopreserved, consistent with the “no patient left behind” doctrine. They do so in full knowledge that there is a line of deterioration beyond which cryonics cannot work.

But they elect not to guess at where that line might be. Since funds have been set aside long ago, proceeding with cryonics under poor conditions is not a financial hardship or decision burden on family or society. It is a matter of personal planning and choice, and even medical ethical idealism. Were the “no patient left behind” doctrine ever to be accepted by society generally,

with common funding mechanisms established, it would arguably be ethically superior to the current system of discarding patients whenever contemporary medical capability is unable to meet their needs. The expense would be small compared to total lifetime medical expenses in the industrialized world.

The most serious ethical problems of non-ideal cases arise in the context of “last minute” cases. A “last minute” case is a case in which a cryonics organization is contacted when legal death is imminent, or has already occurred, for a non-member of the organization.

These cases typically involve distraught families, high emotion, lack of informed consent, and even lack of patient consent when the patient is unconscious or already legally deceased. Families are faced with the decision of paying a large amount of money for something they do not understand, is not likely to work, and that cryonics organizations can barely defend. Such cases conform to the worst negative stereotypes of cryonics preying on grieving families for financial gain. “Last minute” cases are rarely accepted by Alcor for many of these reasons.

Two Ideas, One Word

The word “cryonics” is actually a name for two different ideas. The first idea is that human cryopreservation under ideal conditions today could be reversible in the future. The second idea is that medicine should never leave patients behind; every patient beyond the capabilities of



FIRST, DO NO HARM

“When someone discovers a person laying on the ground with an apparent cardiac arrest, he does not enter into a debate with himself or other bystanders about whether or not his application of cardiopulmonary resuscitation will work for this particular individual, whether the victim will suffer brain damage, has another terminal illness, would have wanted CPR to be applied, or whether or not doctors will be able to treat the cause of his heart arrest successfully. Rather, the rescuer immediately applies CPR in order to stabilize the victim’s condition and prevent any further deterioration from occurring until the victim can reach trained medical personnel who can make those decisions. It is not the rescuer’s place to second guess medical capability.”

—Why We Are Cryonicists, by Mike Darwin, *Cryonics*, January, 1983.

contemporary care should be cryopreserved instead of destroyed, even if found in poor condition. The distinction is necessary because it is possible to agree with the first idea even while not accepting the second. The first idea is a scientific proposition, while the second is a philosophical imperative.

For those who advocate the broader second view of cryonics, it is important to remember that non-ideal cases can be an expression of both the best and worst of cryonics ethics. It is the responsibility of cryonicists to ensure that non-ideal cases are handled

with the highest ethical standards. This is best done by upholding “no patient left behind” as an ideal of medicine and personal planning, while discouraging sale of cryonics under poor conditions where no prior cryopreservation plans exist. ■

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Recent Developments in the Ethics of Life-Extension

By Nick Bostrom, Ph.D.

Blackballing the Reaper

Blackballing the reaper is an old ambition, and considerable progress has been made. For the past 150 years, best-performance life-expectancy (i.e. life-expectancy in the country where it is highest) has increased at a very steady rate of 3 months per year.¹ Life-expectancy for the ancient Romans was circa 23 years; today the average life-expectancy in the world is 64 years.² Will this trend continue? What are the consequences if it does? And what ethical and political challenges does the prospect of life-extension create for us today? This article comments on some views on the ethics, science, and politics of life-extension from an edited volume, *The Fountain of Youth: Cultural Scientific and Ethical Perspectives on a Biomedical Goal*.

The Ethics of Life-Extension

In *The Fountain of Youth*, Richard Miller, a biogerontologist at the University of Michigan, divulges a present-day obstacle preventing the development of effective anti-aging interventions: “gerontologiphobia”. There is, he writes,

an irrational public predisposition to regard research on specific late-life diseases as marvelous but to regard research on aging, and thus on all late-life diseases together, as a public menace bound to produce a world filled with nonproductive, chronically disabled, unhappy senior citizens consuming more resources than they produce. ... Pointing out that such an argument would inveigh, with equally fallacious force, against research on heart attacks, diabetes, and cancer (whose goals, like those of gerontology, are to allow people to live longer and healthier lives) does little good in practice to dispel this fixed belief.³

This common attitude towards aging has been compared to the Stockholm syndrome, in which hostages develop an emotional attachment to their captors. The victim comes to see the captor as a “good guy,” a savior. Freed hostages are even known to have participated in the legal defense of their former captors and to have raised money for a legal defense fund. Perhaps in an analogous way, apologism for human senescence might be viewed as a psychological defense mechanism that many people deploy as



a way of coping with their own inescapable “capture” by the aging process. But just as the emotional bonding observed in the Stockholm syndrome can become counterproductive when it leads hostages to actively assist their captors in thwarting rescue efforts by the police, so too our adaptive acceptance of aging may become a problem when it prevents us from implementing the most promising research programs for improving healthy life expectancy.

The ethics of life-extension is covered in several chapters of *The Fountain of Youth*. Leon Kass, a prominent bioconservative ethicist, is an outspoken opponent of the goals of anti-aging medicine. Longer lives, Kass believes, would reduce our incentives to make the most of the time we have. He also maintains that

simply to covet a prolonged life span for ourselves is both a sign and a cause of our failure to open ourselves to procreation and to any higher purpose. ... [The] desire to prolong youthfulness is not only a childish desire to eat one’s life and keep it; it is also an expression of a childish and narcissistic wish incompatible with devotion to posterity.⁴

Kass is not the only commentator who has criticized longevity on ethical grounds. Another is Audrey Chapman, also presenting

his views in the present volume. Chapman worries about the justice implications of investing in the quest for longer lifespan: isn’t it wrong to spend money on studying aging in a world where many people lack access to clean drinking water and basic health care?

Opponents of longevity, however, fail to offer a convincing explanation of why it would be ethically acceptable for society to be spending vast amounts on researching and curing particular diseases in an effort to extend healthy life for people in rich countries and yet unacceptable to conduct research into the biology of aging in order to develop more effective interventions to achieve the same aim. Another problem for the justice objection to life-extension research is that one could argue in reply that if we want to do more to help the poor, we should surely sacrifice some less essential form of consumption rather than forego potentially lifesaving medical or biogerontological advances. It is unclear why aging research should be singled out for blame or special concern in this regard. Many factors contribute to global inequality, and spending on gerontological research is such a minute fraction of the financial outlays of wealthy nations that it seems a bizarre place to look for savings to transfer to the poor.

For the most part, however, the critics’ concern is not so much the money we spend on aging research but rather the consequences

if this research should succeed in extending healthspan. Some commentators have worried that longer healthy lifespans for people in the rich world would lead to increased pressure on the environment or, alternatively, that it would be intrinsically unfair for some people to live much longer than others. It is worth noting that this objection presupposes that biogerontology is a more effective means to extending healthy life span than are other kinds of medical research. If it weren't more effective, then the objectors ought to favor focusing health care funding on biogerontology on grounds that this would be less likely to produce what they maintain is a negative outcome, i.e. longer healthspan for people in developed countries. In other words, those who believe that longer healthspan would be on balance bad should, in order to be consistent, prefer that money earmarked for medical research go to those research projects that are least likely to succeed in lengthening healthspan. This would be an exceedingly odd position to hold. Might one suspect a "Stockholm syndrome" of playing a role here?

It is not only in terms of its therapeutic goal—in seeking the prolongation of healthy lifespan—that biogerontology is continuous with other forms of medical research. Biogerontology is also increasingly overlapping with other parts of medicine in its subject matter. As several of the book chapters on the science of aging make clear, the more we understand about the biochemical processes involved in senescence the more we find that they look like disease processes. The accumulation of lysosomal aggregates and amyloid plaques, extracellular protein-protein cross-linking, nuclear and mitochondrial mutations, cell atrophy, cell senescence, and cell loss without replacement: these processes may all be implicated in both pathology and senescence.⁵ At the level of genetics and biochemistry, there simply does not seem to be any meaningful distinction between "processes predisposing to or constituting disease" and "normal aging".

It is now also generally accepted that aging is not an evolutionary adaptation. Aging, rather, is what happens when various bodily systems evolved to maintain health gradually accumulate defects and begin to malfunction. In the Pleistocene, when life-expectancy is estimated to have been a mere 20 years, too few of our ancestors survived to ripe old age for evolution to favor investment in stronger anti-aging defenses than those we now possess and are forced to rely upon, notwithstanding their evident inadequacy in the modern era where many causes of premature death have been removed.⁶ (The tortoise, by contrast, whose ancestors were less accident-prone thanks to their protective shells, enjoys anti-aging defenses robust enough to give it a lifespan of upwards of 150 years. It is humbling to reflect that somewhere on the Galapagos Islands a giant tortoise might still be around who watched the landing of Charles Darwin.)

Bioethicist Arthur Caplan, in another chapter, presents a more positive ethical assessment of the prospect of life-extension, concluding that aging is "in no way an intrinsic part of human nature" and that "there is no reason why it is intrinsically wrong to try to reverse or cure aging."⁷ Eric Juengst, too, while pointing to some further ethical questions that he thinks have not yet been answered, holds the door open for prolongevity: "As long as anti-aging interventions serve to forestall the morbidities associated with the aging process, they have a legitimate place in the armamentarium of preventive medicine."⁸

Christine Overall, a Canadian philosopher who has examined the ethics of life-extension in detail in a recent monograph, has an even clearer view of the value of prolongevity:

[O]ther things being equal, a longer life is a better one, provided that one is in a minimally good state of health. The case for longer life ...



Dr. Nick Bostrom, Director of the Future of Humanity Institute at the University of Oxford and former Yale lecturer for the Department of Philosophy, uses his PhD in philosophy to specialize in the philosophy of science, among other areas. He is a prolific writer and has produced three books, myriad journal papers and articles, and nearly 100 keynote speeches in the last decade. Frequently consulted as an expert commentator on bioethical issues, he has appeared on CNN, Fox News, and the Discovery Channel, among other prime time outlets around the world.

At times, when being interviewed, the topic has turned to cryonics. He recalls that some reporters "worry about whether it is selfish to spend money on cryonics when there are so many other pressing problems in the world." Bostrom takes a practical stance proclaiming, "It is no more and no less selfish than spending money on other expensive medical procedures, and it seems decidedly more defensible than spending money on a fancy car."

Dr. Bostrom's expertise spans many areas, including artificial intelligence, life-extension, human enhancement, and the transhumanist movement. As the co-founder and chair of the World Transhumanist Association, an international nonprofit membership organization which advocates the ethical use of technology to expand human capacities, he is accustomed to fielding questions regarding the big picture of future technologies. When asked whether he sees any ethical obstacles relevant to cryonics, he candidly replied that there is "no obstacle in the sense of an ethical reason not to do it."

He does, however, ponder the existence of "many interesting ethical problems that would arise if the practice becomes more widespread or if and when reanimation becomes possible. For instance, should cryonics be covered in countries that have public health care? If reanimation were expensive, who has responsibility to pay if the cryopatient has not set aside sufficient funds? At what point should a patient be reanimated if the procedure is initially risky and the patient has not given any clear advance directives?" For the time being, these are just a few of the burning questions in the ethics of cryonics.

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is founded on a genuine appreciation of human potential, of what people want in their lives and are capable of doing and experiencing when given more opportunities. An increased lifespan gives human beings the chance for activities and experiences that they would not otherwise have enjoyed. Collectively, extending average life expectancy provides for the society in which it occurs the value of increased experience, know-how, labor, loving relationships, and so on—that is, whatever healthy old(er) people can contribute.⁹

Overall's chapter examines from a feminist perspective what changes in social norms and moral attitudes are called for in response to increasing human longevity. She draws a parallel with other systematic forms of oppression, such as sexism, racism, classism, ableism, and heterosexualism, and highlights how ageism needs to be opposed along with these other noxious “-isms”:

Contrary to ageist stereotypes about aging people, the potential to adapt and change is a fundamental characteristic of all human beings at all ages. Hence, as human lives get longer, it will be essential to be critical of categories such as the *elderly*, *the aging*, and *senior citizens*. We would have to give up, once and for all, the unthinking assumption that adulthood is the apex of life, for which childhood is the preparation and from which old age is merely the decline and downward deterioration.¹⁰

The Humanitarian Imperative

As the practical possibility of doing something about aging draws closer, one may hope that the ambivalence and negativity that has sometimes characterized ethical assessments of prolongevity will give way to a steadier focus on what must surely be the central fact in this discussion: that people's

lives and health are at stake, and that any delay in the development of rejuvenation therapies means that thousands of people, who could have been saved, will get cancer, Alzheimer's disease, heart disease, arteriosclerosis, and other age-related ailments, and will die as a result.

The humanitarian imperative to avoid this outcome needs to be kept firmly in mind at all times when we consider the various problems and challenges that may arise as we succeed in further extending healthy lifespan.¹¹ For any possible problem that might arise, one question that we must not fail to ask ourselves is: “Is this problem so bad that it is worth sacrificing up to 100,000 lives per day to avoid having to solve it?”¹² If the answer is no—and it is hard to imagine how it could be otherwise—then the problem is not a sufficient reason to oppose the development of effective anti-aging therapies. ■

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1. (Oeppen and Vaupel 2002).
 2. (Central_Intelligence_Agency 2005).
 3. p. 243.
 4. p. 317.
 5. See e.g. pp. 249-267.
 6. See e.g. chapter 6, written by Jay Olshansky and Bruce Carnes.
 7. p. 283
 8. p. 336.
 9. p. 287. See (Overall 2003) for an elaboration of her arguments for this position.
 10. p. 297. Overall is here also drawing from and referring to earlier work by Phillida Salmon (Salmon 1985).
 11. For an argument along these lines, see (Bostrom 2005).
 12. One hundred thousand is the approximate number of deaths per day due to aging in the world.

Previously published in the Sept/Oct 2005 issue of *Aging Horizons*.

Bioethics Battleground

By Deborah Johnson



As far back as 2500 years ago, ancient Greeks were discussing medical ethics: should patient information be privileged, what was a physician's role, what principles should guide the physician, and what was the role of the physician in relationship to society and religion? Hippocrates, possibly the first medical ethicist, struggled with these questions. His sensibilities still inform Western medicine today in the form of the Hippocratic Oath.

Even then, in a time uncomplicated by electron microscopy, genetic sequencing and stem cell research, science and society did not always agree. It's no wonder that with today's dramatic discoveries, we find ourselves regularly confronted with confounding questions about what to do with this knowledge. These questions push us to the very boundaries of our beliefs and understandings of the nature of humanity and life, the relationship between secularity and faith, and defining what kind of world we want for ourselves and the generations to follow.

So, what is the state of ethics in this exponentially more complicated era of science and medicine? Whose voices should be heard? What role can cryonicists play?

What is Bioethics?

Sometime in the 1970s, the term "bioethics" emerged as part of the vernacular. Basically, it is the study of the ethical and moral implications of new biological discoveries and biomedical advances. In its best practice it is the bridge between scientific progress and societal concerns.

Ronald M. Green, Ph.D., director of the Ethics Institute at Dartmouth University states the role of science succinctly, "The asking of questions, the exploring of questions, the scientist's curiosity, for me that has to be treated almost as a sacred reality."

But with science poised on the edge of unlocking the very code for life in our DNA, are we also at the edge of a slippery slope? Can science go too far, too fast?

"I think any restrictions come with great caution," says Gerald R. Fink, Ph.D., Member of Whitehead Institute and Professor at MIT. "Because, if you inhibit the good research for fear of the bad, people may end up dying."

In his presentation at the 10th annual congress of the International Association of Biomedical Gerontology in 2004, Aubrey de Grey, Ph.D., argued that same point. de Grey says that biogerontologists have a moral duty to publicly discuss the timescale for slowing, halting or reversing human aging. He asserts that failure to do so would only slow down the scientific conquest of aging—and waste lives. Certainly the same can be said about many lines of scientific exploration these days, including stem cells research, gene sequencing, cloning, limb regeneration and medical nanotechnology.

James Hughes, Ph.D., who teaches Health Policy at Trinity College in Hartford Connecticut and serves as Trinity's Associate Director of Institutional Research and Planning reinforces Dr. de Grey's insights, "I think we have an obligation to see that opposition to (scientific ad-

vances) does not keep them from funding and seeking their potential. We could kill millions of people if they have to wait.”

While these opinions may resonate with most forward-thinking people, they are by no means either the most vocal or most endorsed opinions in contemporary America today.

Historical Perspective

There have always been questions about what was moral, what was right, what was in society's best interest. In medieval times dissection of corpses was resisted by the Church. During the Renaissance there was a renewed interest in science which spurred an equal resurgence in the debate over the moral issues involved.

More recently, medical advances like penicillin, the polio vaccine and advanced surgical techniques helped create public trust. The public saw the benefits of these advances and more important, that they benefited everyone, not a select few.

By the middle of the 20th Century, however, significant scientific developments began to erode the public's blanket support of scientific research. Following WWII, the world saw disturbing evidence of the Nazi's abusive medical experimentation on humans. The 1953 discovery of DNA opened up unheard of scientific frontiers. And the Tuskegee syphilis experiments on human subjects outraged Americans and the world when it was made public in 1972. A stunned public began to ask whether every kind of scientific curiosity should be sacred.

Further into the 20th Century, the computer revolution gave science and medicine a whole new way of accelerating the learning curve. A tidal wave of discoveries with great promise intrigued the public and the media. But the cost of highly advanced research needed to be funded. Enter corporations, with bottom-line orientations and high expectations.

Now, the promise of great outcomes was accompanied by equally poignant questions about their impact and legitimacy. Who would benefit—a few or many? Who should, would or could pay for the enormous cost of research? Who would make decisions about what research was conducted—scientists or CPAs? Who would own and benefit from the findings? And, more debate continued about the role God and religion should play in the answers to all of these questions.

Current Landscape

It's not surprising that we arrive in the first decade of the 21st Century with bioethics as a battleground. Lives are literally at stake. Our quality of life is at stake. Fundamental beliefs about the nature of life and God are at stake. Self-determination to live, die or live longer is at stake. Billions of dollars are at stake. This scenario was beyond our collective imagination half a century ago.

It's no wonder there are strong efforts to seize control of the debate. And it's no wonder that these efforts are causing a growing polarization. Whether you characterize it as fear vs. progress, good vs. bad, science vs. religion or conservative vs. liberal—scientists, politicians, theologians and the general public are aligning and entrenching themselves in their camps of choice.

It would appear that after 25 centuries of being on neutral ground, ethical questions and the direction of scientific inquiry are in danger of being hijacked by special interests, pharmaceuticals, corporations, and our own government.

Gilbert Meilander, professor of Christian Ethics at Valparaiso University, says in a 2002 paper prepared for the President's Council on Bioethics, “If we simply oppose the forward thrust of scientific medicine, we fail to honor human freedom.... There is probably no cookbook that gives the recipe for knowing how best to honor—simultaneously—both our freedom and our finitude.”

Hughes, who serves as the Executive Director of the World Transhumanist Association and its affiliated Institute for Ethics and Emerging Technologies, believes strongly that cryonicists must ardently make their voices heard by defending individual freedom and the right to make personal choices.

Questions at Hand

What does this conundrum of ethics mean to cryonicists specifically? The list of topics that relate to cryonics is substantial. Those with religious and moral overtones will probably be debated forever: when does a person begin and cease to be a “person”, should we be “playing God”, should there be limits to the quest to conquer death, what is the value of suffering versus curing disease, should we conduct research if only a few benefit, is cryonics indistinguishable from

saving lives? But, let's focus on a couple that profoundly impact cryonics and have a potential for resolution.

The first is what is death? The question is a juggernaut, because it involves a shifting understanding of what death is and what it is not. Once, it seemed simple enough—when your heart stopped, you were dead. At one time, conventional wisdom was that the soul exited the body immediately and that restarting the heart would leave the body soulless. Fears like this left the public skeptical of life-extending technologies. In time, modern medicine and technology succeeded in reviving hearts through CPR, open-heart surgery and transplants, thus changing the definition of death. With these medical breakthroughs, heart attack victims, children who drowned in cold water and drug-induced coma patients have all been “brought back to life.” More important, those who were so revived, have awakened as “themselves,” quieting the fears of soulless humans in our midst.

So, if cessation of a heartbeat does not constitute death, then what does?

According to George Dvorsky, deputy editor of *Betterhumans* and co-founder of the Toronto Transhumanist Association “the ‘information’ that's encoded in the brain and in constant flux is the person.”

To most cryonicists, it seems straightforward that “you” are the information encoded in your brain. While this information exists, you are still “alive.” When it's gone, so are you. But this concept of information theoretic death is not widely known, let alone accepted. Many still cling to a primacy of body over mind.

In the 1960s with the rise in organ transplants, states began to adopt brain death as legal criteria. But Hughes reminds us that the brain death criterion is beginning to “fall apart with advancing knowledge about neurological activity.”

Dvorsky says, “Traditional bioethicists argue that a person remains a person until all biological activity has stopped.” Witness the struggle over the Terry Schiavo case. While medical sensibilities are migrating toward a neurological definition of being alive, it has not reached the consciousness of the American public.

This brings up the next question about end-of-life issues. Who should have control over the end of your life—you, your doctor or the state? Is there a point in time when you should have the right to say “enough is enough” and end your

own life? Should you have the right to say that enough is not enough and extend your life?

Tom Beauchamp, who authored the seminal textbook *Principles of Biomedical Ethics* in 1979, says he is concerned that conservative religious groups today are “unwilling to concede what the courts have made clear, that bioethics is fundamentally a secular enterprise.... It’s as clear as anything in ethics can be that you have the right, especially when you are threatened by a disastrous fate, to determine what happens to you.”

But conservative ethics organizations are well-funded, well-organized and vocal. Some of the central ethical issues surrounding cryonics energize those on the right, because, as Dvorsky says, “They are in large part the legacy of religious injunctions against playing God.” And in the current political environment, they are exhibiting considerable influence over public policy.

The Role of Cryonicists

Bioethics forces us to ask what a human being really is and to reflect upon the unity and integrity of a person. These questions create an environment rich in debate and intellectual exploration—if the debate is allowed freedom.

“It’s important that transhumanists and cryonicists link hands with the social justice movement and social reform in any way they can,” says Hughes. He notes that the conservative right is training cadres of bioethicists to vo-

calize the far right’s positions on a wide range of topics including who should be allowed to make end-of-life choices, what types of scientific research should be allowed to expand, and where federal dollars should be spent.

Dvorsky points out, “A number of my peers like to say that your body is a battlefield (in the bioethics debate).” He goes on to say, “It’s crucial that we develop an awareness of ethics at the dawn of what is going to be a radical century in terms of how we apply science and technology to ourselves.”

One of the hallmarks of cryonicists is their ability to envision the future—to extrapolate astounding possibilities from only a glimmer of evidence. It may be time to apply those abilities to the ethical debate that is raging. Imagine what would happen to personal autonomy, to end-of-life choices, to length-of-life choices, and to as-yet unimagined discoveries if the ethics debate is co-opted by special interest groups.

The voices of scientists, physicians, educators and other incisive thinkers need to be heard. Now. ■

Deborah Johnson is an EMMY Award-winning writer. She has a Masters degree from the University of Washington, where she studied cognitive psychology and television production. She is part of the WalshCOMM team, Alcor’s public relations firm. Deborah can be reached at djohnson@walshcomm.com

Following is a partial list of resources for your edification. A particularly well-framed and thoughtful paper by Kathryn Hinsch, co-founder of the Seattle-based Women’s Bioethics Project will provide abundant food for thought. It reviews conservative and progressive organizations, illuminates their funding sources, sites their key opportunities, and offers an exhaustive list of conservative and progressive organizations, along with their web sites.

The Women’s bioethics Project paper can be found at: www.womensbioethics.org/downloads/bioethicsandpublicpolicy.pdf

You can also sign up for the organization’s newsletter at: www.womensbioethicsproject.org

To help familiarize yourself with the ethics debate, *USA Today* sites four high-profile voices

from bioethics centers across the country you might want to pay attention to:

1. Director Daniel Callahan of the Hastings Center;
2. Tom Beauchamp of the Kennedy Institute of Ethics at Georgetown University; Arthur Caplan of the University of Pennsylvania Center for Bioethics;
3. C. Ben Mitchell of the conservative Christian-based Center for Bioethics and Human Dignity;
4. Orthodox Jew Laurie Zoloth of Northwestern University’s Feinberg School of Medicine.

James Hughes, the Executive Director of the World Transhumanist Association and its affiliated Institute for Ethics and Emerging Technologies, says, “Transhuman-



ists welcome the new biotechnologies, and the choices and challenges they offer, believing the benefits can outweigh the costs. In particular, they believe that human beings can and should take control of their own biological destiny, individually and collectively enhancing our abilities and expanding the diversity of intelligent life.”

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George Dvorsky is deputy editor of *Betterhumans* and co-founder of the Toronto Transhumanist Association. Dvorsky suggests four



courses of action important for those wishing to assert their freedoms as this debate progresses:

- 1) Stay up-to-date on the latest advances in biotechnology,
- 2) Inform yourself about and promote personhood-based ethics, including those issues pertaining to changing ideas about brain death and what is meant by unrecoverable death,
- 3) Talk openly about cryonics, and
- 4) Meet with local groups and like-minded individuals.

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REMEMBERING JOE AND TERRY CANNON

By R. Michael Perry, Ph.D.



Joe and Terry Cannon's wedding picture circa 1945

Born in Wisconsin in 1915, Joseph George Cannon studied engineering in college and became a licensed consulting engineer in the early 1940s. During World War II he worked in shipbuilding under U. S. Navy supervision. In mid-1945 he married Theresa (Terry) Mackey who would be his dotting companion for many years. Terry Cannon, born in Michigan in 1916, was an elementary-school speech correctionist by profession. She was also a prolific diarist, an animal lover, and a devoted companion of her

husband. Joe boasted that in 39 years of marriage they never had an argument, though they did have disagreements. The Cannons purchased property in Florida and started spending their winters there, returning to their home in Wisconsin for the warmer months.

Joe was a maverick with unusual talents and always preferred independence to regular employment at higher remuneration. As an entrepreneur he established an engineering office where at various times he operated a commercial printing service, an electroplating plant, and an engraving shop, as well as single-handedly constructing houses, apartments, and commercial buildings. In 1958 he opened one of the earliest discount businesses in the Midwest. Though other engineers chided him about "perpetual motion" he patented a unique automatic flush valve. He also published two musical compositions (waltzes) for which he wrote both music and lyrics. He speculated about one day starting a tourism business using steamboats on some of the small, interconnected lakes near his home in Appleton, Wisconsin. Naturally, he would serenade his guests on their watery excursions. The project never materialized, but the music remains.

Other details of his life, recounted in his bashfully mistitled, 1989 memoir, *Recollections of an Average Man*, reveal a fun-loving personality with many friends and much good will along with good sense. (Quotations are from this source.) One episode from *Recollections* shows Terry, the ever-caring housewife, and gives an interesting glimpse of their home life. "From the day we were married,"

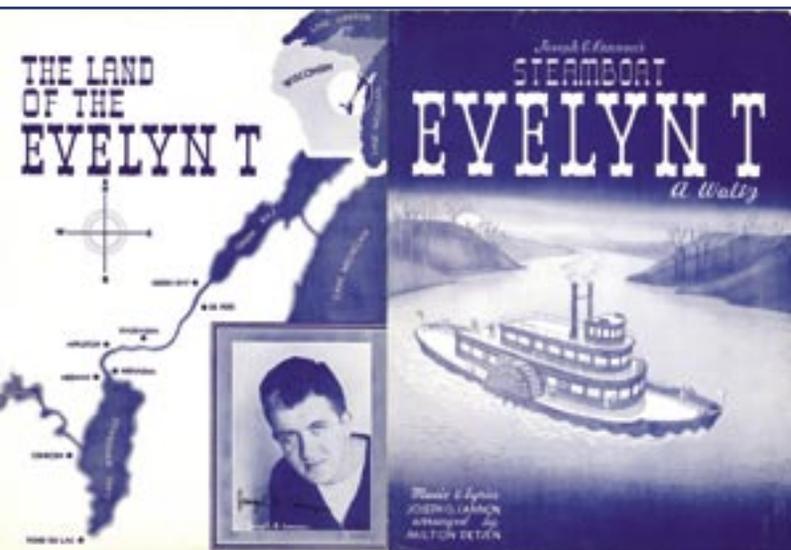
Joe relates, "she tried to please me in every way. She baked brownies with raisins in them to make them a little nicer. But when she asked me how I liked them, I replied they were very good, but I didn't really care for raisins in brownies." She put raisins in chocolate cake and Joe didn't like that either. This was repeated with several other treats. Then she started omitting the raisins from his portion of her recipes. Finally she made rice pudding for him, omitting the raisins as had become customary. When she asked Joe how he liked it, he said it was very good, except, as a matter of fact, he liked raisins in rice pudding.

Terry was cryopreserved at Alcor in February 1985. After her cryopreservation, when her birthday drew near, Joe was thinking about what might be an appropriate gift if she could be revived. "She loved to travel and see new sights, and did as much of it as was possible on our limited finances." Joe's solution: "to arrange passage for my wife on the first civilian flight to the planet Mars." It took some effort to convince his travel agent that he was serious, but a gift certificate was drawn up and a down payment made. Joe was not hopeful, however, that she would be revived in time for this first trip. "She'll have to take a later flight. But I know my wife and she won't be very happy about missing the first flight."

Joe, in later years, became a lonely old man in a care facility. While there, in February 1997, he committed suicide. Alcor managed his case as best it could, and he and Terry became a rare married couple who are both cryopreserved (as neuropreservation patients). If all goes well for Joe and Terry they will have many more times together and we can get to know them ourselves as the fine people they were and will be again. ■



Terry and Joe Cannon in later years; both joined Alcor in 1985



Joe Cannon published two waltzes for his dream of starting a steamboat-based tourism business near his home in Appleton, Wisconsin

Sources:

Joseph G. Cannon, *Recollections of an Average Man*, Avon Park, Fla.: Joseph G. Cannon, 1989.

Mae Junod (ed), *The Outlook* 2(7) (July 1971): 4.

Case Summary

Cryopreservation of A-1237

By Tanya Jones

Background

Member A-1237 joined Alcor in August 1990 and was one of the more rapid membership sign-ups of the time, having completed his membership arrangements only two months after applying for membership. His medical history included a diagnosis of stomach cancer in 1987. Surgical treatment was successful, even without chemotherapy or radiation. Though it took him a full two years to recover from the operation, there were no reoccurrences of his cancer. According to his wife, the only reminders of that medical crisis were a scar and monthly injections of B12.

Nothing in his recent history gives any indication why this gentleman would suddenly die in his sleep at the age of 52, but the emergency call came in from his wife at 07:53 on 28 February 2006. She indicated that her husband had not been feeling well, but they had not been worried. As the owner of a brokerage firm in Ohio, he kept early hours; and so she did not notice him lying in a chair in his office for quite some time.

When she discovered her husband's body, rigor mortis was already in evidence. She called the police and then called Alcor. The local police department communicated well with Alcor personnel, keeping Alcor informed when the Coroner's representative arrived on the scene to investigate. The County policy dictated that a complete autopsy would be performed, if one was performed at all, and a minimally-invasive autopsy was not possible.

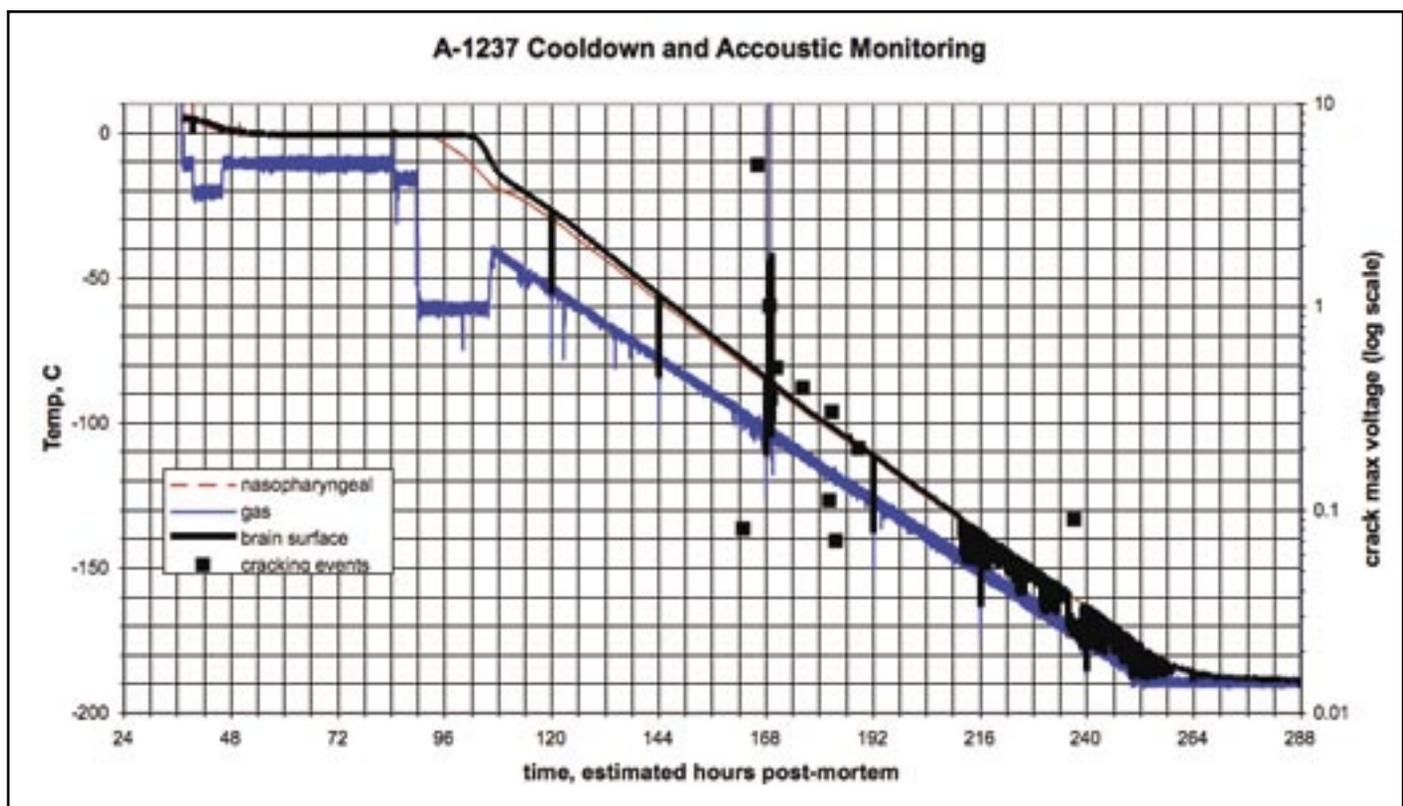
The patient was transported to the local Coroner's Office about two hours after being discovered by his wife. The Coroner was amenable to placing the patient into a refrigerator at 70°F until such time as the autopsy procedure was performed. His wife maintained contact with Alcor throughout the day as the arrangements were made for transport to Alcor. She was aware and supportive of her husband's desire for cryopreservation, and later that day she made the difficult decision to waive the requirement for an autopsy. Though she wanted to know why he had experienced cardiac arrest in the middle of the night, she chose to let go of

that out of respect for his wishes for an optimal cryopreservation. The Coroner did insist on performing a toxicology screening, to rule out the possibility of a poisoning death, but that involved taking blood samples for later analysis.

Transport and Cooling

With the toxicology sampling done, the patient was released to a local funeral director the following day for packaging in ice and transport to Alcor. Transport was done using a conventional carrier, and no delays were experienced during transit.

The patient arrived at the Alcor facility at 11:36 on 1 March. There was significant ischemic insult due to the circumstances of his death, and cryoprotection was not done. Instead, this case was handled as a "straight freeze" and the cooling protocol was to be implemented. Two burr holes were prepared, one for each hemisphere of the brain, and the patient was instrumented for acoustic and temperature monitoring. Preparing the burr holes was unexpectedly difficult, and it took



The nasopharyngeal probe led the brain surface probe, indicating poor placement or mislabeling of the nasopharyngeal probe. The fracturing seen from -100°C to -130°C cannot be reasonably related to prior experience with 21CM cryoprotectants, and must be considered in isolation at this time.

several attempts to make two. Skull thickness and bone compliance (hardness of the bones) may have been factors. Once instrumented and placed in a whole-body pod, the patient was transferred to a dewar for cooling.

Because this was the first time vapor cooling methods were used on a straight freeze, whole-body patient who was contained within a pod, there were several concerns about the patient's temperature as it dropped below 0°C. Those concerns included: cell death versus temperature and time, ice expansion, shell freezing (where the tissue freezes at the outside edges first and damages the inner sections, in a progressive fashion, with the expanding ice fronts), brain and skull cracking, extrusion of the unfrozen portion of the brain, heat loss through the insulation, and heat transfer up the neck.

The cooling temperature was initially set at -10°C in order to cross the barrier between unfrozen and frozen tissue more gently (in an attempt to reduce the freezing injury) but this proved too high, because the patient's temperature was not dropping from 5°C. Lowering the set temperature another ten degrees to -20°C did not achieve the desired cooling either, as it took 6.4 hours to drop the patient's temperature from 4.9°C to 0.4°C. When the nitrogen gas temperature was dropped to -60°C, with the brain partially frozen, it took another 13 hours for the pharyngeal temperature to begin dropping.

The cool-down ramp was started when the brain surface was at -17°C and the pharyngeal temp was at -8°C. The initial ramp temperature was set at -40°C and fairly rapidly the brain surface and brain interior only differed by 3°C. The circulating outside gas was about 20°C colder than the temperature of the patient, which is a substantial, but not unusual, temperature difference. Similar results were seen in the data collected during the cryopreservation of A-1356.

Ultimately, the cool-down to liquid nitrogen temperature of -196°C took 240 hours (10 days). The patient was transferred to a long-term care dewar on 22 March.

Observations

Even though this was a straight freeze case, which may seem less technically challenging, it was a learning experience. Placing the patient into a sleeping bag and pod before starting the cool-down was a good idea, because it



prevented later re-warming between cooling stages; but doing so made controlling the cool-down more difficult, especially without placing additional thermocouples detectors to ascertain, with greater certainty, exactly what was happening.

Had the nitrogen vapor temperature been run at -100°C, which was one of the original suggestions for how to begin this cool-down, it would have taken less than 12 hours to freeze the brain. However, it would also have resulted in a large interior-exterior temperature differential, which would have resulted in straining the tissue. An interior-exterior temperature difference of about -10°C is desirable and can be achieved by shifting to the cooling ramp within an hour

or so of when the interior finally freezes. When handling another case that is similar, we intend to run better calculations on this based on our experience.

This was one member who spent a lot of time talking to his family and friends about cryonics. He was proud of his affiliation with Alcor and was a man with an appreciation for life that extended to his cancer survival and beyond. It is unfortunate that his sudden death led to a less-than-ideal cryopreservation. He was, however, fortunate to have had such a supportive wife. Her cooperation and communication was sincerely appreciated by the Alcor staff, and there is no question that this difficult situation would have been further compromised without her supportive involvement. ■



Science Examines Animal Suffering

About 2.85 million animals were used in experiments in 2004. Scientists are carrying out a study to see if it is possible to report levels of suffering experienced by animals during scientific procedures. The Home Office (UK) only issues statistics based on how severe a procedure is expected to be when it is licensed. The study aims to see if suffering can be assessed and reported after the experimental procedure has taken place. A report setting out the preliminary findings of the investigation is due to be published. The work is a collaboration between the Laboratory Animal Science Association and the Animal Procedures Committee.

BBC News
4/4/06

<http://news.bbc.co.uk/1/hi/sci/tech/4877410.stm>

Bush "Out of Touch" on Stem Cells

Scientists have reacted with anger to US President George W. Bush's decision to veto a bill allowing federal funding for new embryonic stem cell research. They argue it will damage a promising field of medical research. Leading researchers labeled Mr. Bush "hypocritical," "out of touch" and "selfish" over his decision not to sign into law a bill approved by Congress. Mr. Bush argued that the law "crossed a moral boundary that our decent society needs to respect." Polls suggest most Americans back the research, which scientists hope will lead to cures for serious illnesses such as Alzheimer's, Parkinson's and diabetes. The vetoed bill, the Stem Cell Research Enhancement Act, would have scrapped limits on federal funding imposed by Mr. Bush in 2001. It was the first time in his presidency that Mr. Bush refused to sign into law a bill approved by Congress. The bill failed to reach the two-thirds majority in its Senate vote which would have overturned the presidential veto.

BBC News
7/20/06

<http://news.bbc.co.uk/1/hi/sci/tech/5197926.stm>

Life Cycle of A Protein Observed With Single-Molecule Resolution

Using a sensitive, single-molecule measurement technique, researchers at the University of Illinois at Urbana-Champaign have observed the life cycle of RecA, a protein that plays a major role in

repairing damaged DNA. The protein forms a filament, which grows and shrinks primarily by one monomer at a time, the researchers report in the August issue of the journal *Cell*. A better understanding of how these proteins function could help our understanding of cancer.

ScienceDaily
8/12/06

www.sciencedaily.com/releases/2006/08/060811091647.htm

Discovery in Understanding Diseases of Aging

By disrupting the aging process in an organism, scientists at The Scripps Research Institute and the Salk Institute for Biological Studies have discovered two mechanisms in an animal model of Alzheimer's disease that protect cells against protein aggregation that leads to damage called "proteotoxicity." Since proteotoxicity appears to cause the neurodegeneration in disorders such as Alzheimer's and Parkinson's diseases, these findings have important therapeutic implications. The research, led by Professor Jeffery Kelly of Scripps Research and Professor Andrew Dillin of the Salk Institute's Molecular and Cell Biology Laboratory, is being published August 10, 2006, in an online edition of the journal *Science*. The new study—conducted in a *C. elegans* model, a roundworm that expresses a protein whose aggregation appears to cause Alzheimer's disease—showed that toxicity from protein aggregation is "drastically reduced" when aging is slowed by modulating the insulin growth factor (IGF) signaling pathway.

ScienceDaily
8/13/06

www.sciencedaily.com/releases/2006/08/060812154828.htm

No Cell Walls, No New Cancer Cells

Cancer cells, like houses, need building materials for their walls. And as with a house, the cell wall needs to be built at just the right moment to protect and allow the construction of internal components. A team from the Uppsala (Sweden) Branch of the global Ludwig Institute for Cancer Research has not only shown how the cell gets this timing right, but has also conducted proof-of-principle studies that indicate taking away the cell's "bricks and

mortar" is a potential strategy for cancer control. "New cells are created by the duplication of existing cells through a highly-organized process known as the cell cycle," explains lead author, Dr. Maite Bengoechea Alonso. The SREBP1 protein has been shown to control the cell cycle, and disrupting the function of SREBP1 might prevent the lipid synthesis required for new cell walls. "In fact, we literally stopped the cell cycle in its tracks by removing SREBP1 from cells. It seems that if you don't have SREBP1 activity, you can't make lipids, and if you don't have lipids, you can't make new cells."

ScienceDaily
8/28/06

www.sciencedaily.com/releases/2006/08/060826224403.htm

Scientists Uncover Critical Step in DNA Mutation

Scientists at the Georgia Institute of Technology have made an important step toward solving a critical puzzle relating to a chemical reaction that leads to DNA mutation, which underlies many forms of cancer. The research, which uncovers knowledge that could be critical to the development of strategies for cancer prevention and treatment, appears in the August 2006 edition (Volume 128, issue 33) of the *Journal of the American Chemical Society*.

ScienceDaily
8/28/06

www.sciencedaily.com/releases/2006/08/060823184811.htm

Gene Therapy Transforms Cells into Tumor Killers

Mark Origer entered the last-ditch experiment hoping to beat back his melanoma for a few months, long enough to walk his daughter down the aisle. He got far luckier: Almost two years later, his body shows no signs of the aggressive skin cancer. U.S. Government scientists rescued Origer and one other man with advanced melanoma by genetically altering their own white blood cells to turn them into tumor fighters. The treatment did not help 15 other melanoma victims. So scientists are trying to strengthen it to work better.

Associated Press/MSNBC
8/31/06

<http://msnbc.msn.com/id/14600863/>

Treatment “to Neutralize All Flu”

Scientists say they are developing an entirely new way of providing instant protection against flu. In preliminary tests, it was found to protect animals against various strains of the virus—and may also protect against future pandemic strains. University of Warwick researchers used a flu virus naturally stripped of some genetic material to compete with other invading flu viruses. This slowed the rate of infection so much that the body could fight it off. In effect, the invading virus became its own vaccine by triggering an immune response sufficiently powerful to neutralize it before it could gain a strong enough foothold. The Warwick team plan to develop the treatment as a nasal spray. Experts warned much more testing was required. However, they said the development of the vaccine was timely, amid concerns that the H5N1 bird flu strain circulating in Southeast Asia could mutate into a pandemic strain which would put millions of lives at risk.

BBC News
10/3/06

<http://news.bbc.co.uk/1/hi/health/5404184.stm>

Scientists Teleport Two Different Objects

Beaming people in “Star Trek” fashion is still in the realm of science fiction, but physicists in Denmark have teleported information from light to matter bringing quantum communication and computing closer to reality. Until now, scientists have teleported similar objects such as light or single atoms over short distances from one spot to another in a split second. But Professor Eugene Polzik and his team at the Niels Bohr Institute at Copenhagen University in Denmark have made a breakthrough by using both light and matter. “It is one step further because for the first time it involves teleportation between light and matter, two different objects. One is the carrier of information and the other one is the storage medium,” Polzik explained in an interview on Wednesday. The experiment involved for the first time a macroscopic atomic object containing thousands of billions of atoms. They also teleported the information a distance of half a meter, but believe it can be extended further.

CNN.com
10/5/06

<http://edition.cnn.com/2006/TECH/science/10/04/teleportation.reut/index.html>

Fantastic Voyage: a Nanoscale View of the Biological World

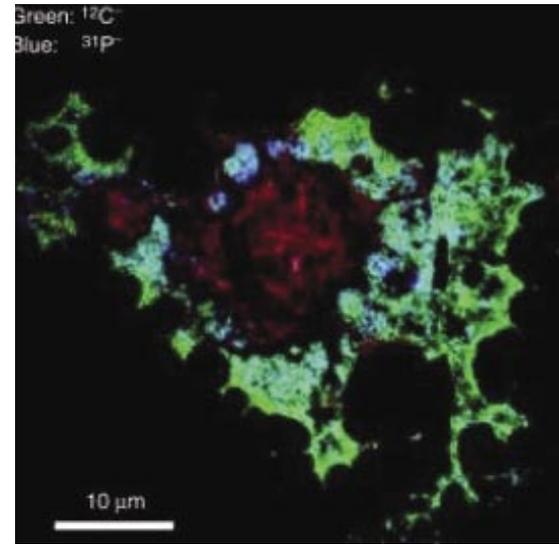
Echoing the science-fictional journey through the human body in *Fantastic Voyage*, doctors might soon be able to track individual donor cells after a transplant, or to find where and how much of a cancer treatment drug there is within a cell. New technology described in a study published today in the open access journal *Journal of Biology* makes it possible to image and quantify molecules within individual mammalian or bacterial cells. Claude Lechene and colleagues describe the development of multi-isotope imaging mass spectrometry (MIMS), which has applications in all fields of biology and biomedical research. “This method allows us to see what has never been seen before, and to measure what has never before been measured,” Lechene says. “Imagine looking into a building, slice by slice. You can see not only that it contains apartments, but also that each apartment contains a refrigerator. You can see that there are tomatoes in the refrigerator of one apartment, and potatoes in the refrigerator of another...It is this level of resolution and quantification that MIMS makes possible within cells.”

ScienceDaily
10/6/06

www.sciencedaily.com/releases/2006/10/061006081659.htm

Silk “Could Help Repair Nerves”

Silk may be able to help repair damaged nerves, according to scientists. The UK researchers have shown how nerve cells can grow along bundles of a special fiber, which has properties similar to spider silk. They hope the silk will encourage cell re-growth across severed nerves, possibly even in damaged spinal cords. The silk, dubbed Spidrex, comes from silk worms that have been modified to give the fibres special properties that help cells to bind. Professor John Priestley, a neuroscientist from Queen Mary’s School of Medicine and Dentistry, London, and lead researcher, said the silk acted as a scaffold on which nerve cells could grow. The team hopes the silk can be used to treat patients whose peripheral nerves - the nerves that control muscle and provide sensation - have been severed: someone who has received a bad cut to the hand, for example. A more ambitious goal, explained Professor Priestley,



Analysis of cell using MIMS

would be to use the silk to help repair damaged spinal cords, but this would be much more complex, he stressed.

BBC News
7/12/06

<http://news.bbc.co.uk/1/hi/sci/tech/5172422.stm>

3-in-1 Heart Pill Could Save Millions Worldwide

A new three-in-one pill to treat heart disease could save millions of lives worldwide, said experts Monday at the World Congress of Cardiology. The so-called “polypill” would target developing countries, where rates of heart disease are climbing dramatically. The pill would be packed with aspirin, statins and ACE inhibitors—the three drugs known to prevent recurrent heart disease.

MSNBC/Associated Press
9/4/06

<http://msnbc.msn.com/id/14669038/>



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AN UPDATE ON RECENT PROGRESS: RESEARCH AND DEVELOPMENT

Aside from our standard administrative tasks and special projects like the conference, the organization has primarily focused on engineering improvements for the cryopreservation processes. We have acquired equipment to automate collection of data during the cryopreservation process and control the perfusion process. We have also worked towards improvement of patient stabilization capabilities, as discussed below.

We have built a prototype of a partial liquid ventilation system for rapid cooling while performing cardiopulmonary support during a patient stabilization. Partial liquid ventilation is a process involving the introduction of a cooled, oxygenated liquid into the lungs, where the massive surface area can facilitate extremely rapid cooling. It is partial ventilation, because the oxygen-carrying capacity of the fluid is insufficient to support metabolism, and so a patient requires additional oxygen support.

Our mechanical system for partial liquid ventilation will allow cooling of patients during the critical first-minutes of the stabilization procedure, a vital capability with the potential to drastically improve a patient's overall cryopreservation. This system is expected to provide nearly the cooling rate of the blood washout, at an estimated half degree Celsius per minute, with none of the invasive surgery or time delays. The prototype has now been submitted as Alcor's first patent and is based on earlier work done at Critical Care Research. It is simpler to deploy, less expensive, considerably more portable and requires significantly less training to operate than any other device patented for this purpose.

This redesigned Portable Ice Bath (PIB) is more efficient in mobility, portability, user-friendliness, and weight-carrying capacity than previous versions.

We have also nearly completed a re-design of the portable ice bath (PIB), a lightweight bathtub on wheels which enables a patient to be cooled with ice and treated while being moved. The new design was based on an idea by Michelle Fry and built by Randal Fry, with assistance from Diane Cremeens. Our previous PIB was one of the least efficient pieces of our stabilization kit, and our new design should meet the requirements of being portable, easy to assemble, more weight-carrying capacity and capable of whole-body cooling. It has significantly improved mobility, enabling movement over curbs, small steps and other surfaces, like grass. Once design and testing are complete, we intend to replace all previous versions in the field.

Our research team is working hard on the development of a cardiopulmonary bypass laboratory. This development is an important step in our plan to begin comprehensive testing of every aspect of the cryopreservation procedure, from the impact of different cooling methods or medications to the advantages and disadvantages of various cryoprotectants. Using our cardiopulmonary bypass laboratory, we intend to replicate the total body washout experiments performed by Cryovita and Alcor in the late 1980s and early 1990s in the rat model. We have acquired most of the equipment necessary to establish the model, and the protocols are being drafted for experimentation. Setting up the perfusion system has been the most complicated factor, and Chana Williford, Alcor's Research Associate, has developed a design that seems likely to avoid one of the major problems of rat perfusion: priming volumes, which should be as low as possible. Williford's circuit has an extremely small priming volume, and the design should be publishable in scientific journals if it holds up under scrutiny.

Intermediate temperature storage is something else we are



Once complete, Alcor's cardiopulmonary bypass laboratory will be used for comprehensive testing of Alcor's cryopreservation procedure via experiments in the rat model.

working toward and has been discussed for some time. It is important to mention that providing long-term care of patients at higher temperatures, like -140 degrees Celsius, does not actually eliminate fracturing in patients. We believe annealing, a process whereby strain can be relieved in glassy materials through raising and lowering temperature in a controlled fashion, may be the solution to eliminating fracturing in patients.

To test our hypothesis, we have constructed a prototype annealing test cell for investigation of the physics of fractures in our patients. If this prototype is effective, we will replicate it to allow multiple samples to be processed during fracture experiments. Our hope is that we can develop a reliable protocol for minimizing—or even eliminating—fractures in our patients. This work is expected to take some time, as learning how to cool a pure cryoprotectant is very different from learning how to cool a complex organ system. We intend to begin testing our cryoprotectant very soon.

In many ways, our research and development program is being built up from nothing. Lack of focus, changes in personnel and lack of serious commitment all contributed to poor development in technical areas in the past. Rather than leading the drive for improved cryopreservations, we were relying on external organizations for research and largely languished in areas of development. We have begun to repair this serious deficit and intend for our current and upcoming research and development efforts to aid in our goal of becoming recognized as a serious, scientific research organization. ■





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