CRYONICS

2nd Quarter 2024 | Vol 45, Issue 2 www.alcor.org

CRYONICS

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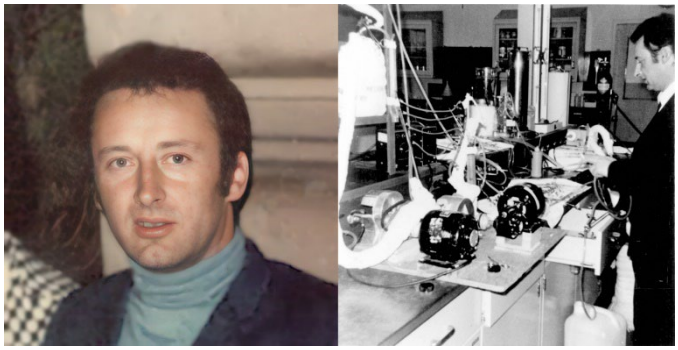
Cryonics Then and Now: How Much Progress?

Cryonics is the practice of storing the newly deceased or important part at cryogenic temperatures in hopes of eventual restoration of the whole person to healthy consciousness. Legally, it is simply another way of "disposal of the dead," but, from the time the practice started in the 1960s, it was recognized that something very different from conventional mortuary practice was called for. It was also something beyond conventional cryobiology, in which it is found that isolated cells or small tissue masses can sometimes return to function after deep freezing. Such cells were found to survive much better with cryoprotective agents such as glycerol, making it imperative, in human cases, to induce such agents prior to or concurrent with lowering the temperature.[1]

Methods were accordingly developed in which the blood and other body fluids of a newly-deceased donor were replaced in a process called perfusion. The substance or perfusate which replaced the body fluids, a kind of antifreeze, might contain glycerol or another liquid such as dimethyl sulfoxide (DMSO) which also had been found useful as a cryoprotectant. The perfusion process though was complicated and required a delicate apparatus to pump in perfusate, and at the same time, draw the body fluids out. The process had been pioneered by mortuary practice, in which embalming fluid served as the perfusate, but cells were not observed to revive after the fixative process of embalming, and certainly not if they were afterward cooled to low, cryogenic temperatures and later warmed. Other issues such as the pressure at which fluid was introduced, and the possibility of including oxygen in the perfusate to provide metabolic support and reduce cellular deterioration, were also important in a way not essential in mortuary practice, in which no thought is given to eventual revival.

In developing a perfusion process for cryonics cases, one scientist stands out. Dante Brunol (full name: Mario Dante Bruno-Lena), a biophysicist and M.D., was the first to develop a protocol for this cryoprotective perfusion, and the first to attempt its use. (This was at the insistence of Robert Ettinger, the principal founder of cryonics.)[4]



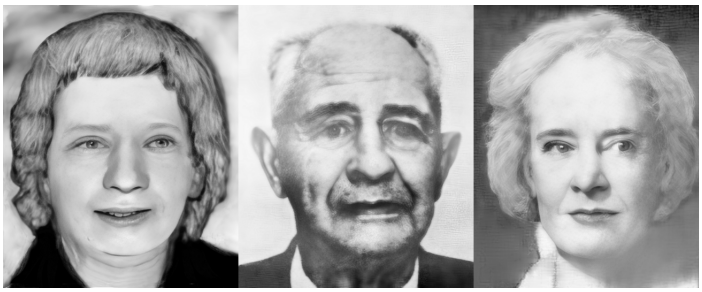
Dante Brunol, the father of cryoprotective perfusion in cryonics, in 1969; Dr. Brunol in laboratory setting. Dark objects mounted on board, foreground, are roller pumps as would be used in perfusion.

Brunol's protocol, published in 1968 under the pseudonym of Mario Satini, is a landmark of early cryonics literature, worth studying both for its philosophical and its technical features.[9] Both have served as guidelines or at least food for thought ever since. There were critics meanwhile who thought that "freeze now" advocates were going too far and their proposed freezing should be postponed "until the process is perfected." Brunol's rebuttal is touching. "How can I tell a dying man, begging for life, 'I cannot do anything for you … it would be unscientific to attempt to send your body to future generations ... I am sorry, but I do not want to ruin my reputation'?" Instead he advocates proceeding with the preservation, with the hope "that future generations will be able to repair the damages produced by my method."[3]

In fact, though, Brunol was very concerned about his scientific reputation, particularly after the freezing of James Bedford when he had to explain his involvement to his employer, the University of Southern California. He had hoped that this involvement would generate research funds which he could use to further validate and refine his method, but this didn't happen, and he soon dropped out of active participation in cryopreservations though remaining sympathetic. In January 1978, however, at age 51, he died in his native Italy and was not himself cryopreserved.

But the early rapid progress in techniques, spearheaded by Brunol's work, is shown in the first three cases of actual human cryopreservation. Sarah Gilbert[5] was simply straight frozen (April 1966) after being embalmed and stored several weeks in a mortuary refrigerator. Next on the list, James Bedford's cryopreservation (January 1967) started very soon after he arrested, with an attempt to follow Brunol's new protocol. Heparin was injected to inhibit blood clotting, and a chest compression and oxygenation device, the Westinghouse Iron Heart, was used to keep the blood circulating and oxygenated, to try to inhibit postmortem tissue deterioration. The plan was to replace the blood with a perfusate consisting of 15% DMSO in Ringer's solution, to reduce ice crystal formation and resultant damage as the temperature was then lowered to the cryogenic range. A complication developed, however, when it became clear that the perfusion apparatus, never before used, could not be made ready in time. (Bedford's arrest had been unexpectedly early.) As a last resort, perfusate was injected into the vasculature while the blood was circulating, so that perhaps some amount of protective effect occurred. Overall, though, the operation was probably little better than a straight freeze.[2][6][9]

The third case, that of Marie Phelps-Sweet (who liked to be known as "Miss Sweet" though she was married), started in August 1967.[7][8] This time the perfusion apparatus was ready, and the case proceeded much like more recent cases, though still not as Brunol would have liked. (He would later complain that air bubbles were introduced into the perfusate by people inadequately trained.)[4] But here there was another complication, still all too common, in that Ms. Sweet was not found for a few hours after she arrested, alone in a hotel room, then was transferred to a mortuary freezer (30° F, about -1° C) where she was stored for about three days so the preservation was compromised by a somewhat long ischemic interval beforehand.[7] (As a bittersweet footnote, the cryopreservations of both Ms. Gilbert and Ms. Sweet were given up within a few years,[10] only Bedford's continuing to this day; he is now a patient at Alcor.)



The first three human cryopreservation cases: Sarah Gilbert, Apr. 1966; James Bedford, Jan. 1967; Marie Phelps-Sweet, Aug. 1967.

In the half-century and more since then, protocols have improved, and we now speak, in the better cases, of *vitrification* having occurred – turning the tissue into a glassy state in which damaging ice crystals are avoided. Unfortunately, we are still dogged by delays in applying our protocols, a problem addressed at length in an interview in this issue. Max Marty and Daniel Walters generously consented to a transcription of their podcast of June 13, 2023, in which Alcor member Michael Benjamin details results of a meta-analysis of Alcor's cases. He considers the S-MIX, a measure of ischemic exposure that shows, over the years, approximately level results rather than the progress we might have hoped for, but we do have a starting point for gauging, henceforth, whether and how much progress has occurred. Other matters are covered also, including Benjamin's background, with 20 years' experience in physics, engineering, and mathematics, at such places as NASA, Goddard Space Flight Center, the Brookhaven National Labs, and Lockheed Martin. Due to its length, the interview is divided into four parts. Included also is an article by Sarah Kelley regarding a "new normal" of practices at Alcor, based on an address given last summer at Alcor's conference in Estes Park.

As a final comment, I start with the observation that it's difficult to second-guess the limits of future technology. Today we have not achieved the revival of cryonics patients or even large, cryopreserved tissue masses. But the information and structure stored our preserved specimens that have been continuously maintained at low temperature, is intact and essentially unchanging. Some arguments suggest that memory information in the brain may be robustly encoded, so that one could expect decipherment to be possible even under adverse conditions of preservation, something that should offer hope as we try, as always, to improve our protocols. The protocols themselves must be constantly evaluated and recognized for their speculative nature, and that there are still, as always, many unknowns. For example, are we really doing more good than harm by oxygenating tissue during perfusion, under various conditions, and how do we ensure that our protocols are in fact beneficial?

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Image Credits

1. Dante Brunol, 1969, [4].
2. Brunol with lab instruments, photo from Robert F. Nelson.
3. Sarah Gilbert (probable birth name), approximate face reconstruction based on Alcor archival photographs.
4. James Bedford, [6], also cover, *Cryonics* 12(7) (Jul. 1991).
5. Marie Phelps-Sweet, [8].

An Alcor Celebration in Estes Park, Colorado

For many years the little mountain town of Nederland, Colorado hosted an annual event centering around a certain, very unusual cryonics case, that of Norwegian Bredo Morstøl (pronounced *bred-oh morstul*). His grandson Trygve Bauge (*trig-vuh bahw-guh*) had had him straight-frozen, first stored at Trans Time's facility in Oakland, California,[1] and then maintained for many years on dry ice in a shed near Nederland. There the well-preserved grandpa became the focus of an annual celebration, the Frozen Dead Guy Days (FDGD), generally held in March (when it's cold and snowy, but not quite like January). Finally, in 2023, the March festival was moved to another Colorado mountain location, the grounds of the famous Stanley Hotel in Estes Park. Grandpa stayed in his shed for the time being but that summer he too was moved to the hotel grounds, put into a dewar with liquid nitrogen, and, most importantly, became a patient of Alcor. On examination during this move his frozen body appeared to be in quite good condition.[1][2]

Alcor meanwhile found itself involved in the FDGD, though of course we challenge the dictum that frozen people are necessarily "dead" – we are hoping for their revival after all, not excepting Bredo himself. But now there was a unique opportunity to reemphasize cryonics and thereby promote our theme of *life over death*. Accordingly, Alcor had a booth, alongside others, in Fairgrounds, "Barn W" at the 2024 festival, with plans to continue in subsequent years. People could spin a wheel and win a prize, a T-shirt, a small rubber brain, magnets, a temporary tattoo, or stickers. Questions relating to Alcor and/or cryonics were invited and many were addressed by the dedicated staff, especially our Membership Administrator, Diane Cremeens. (Personally, I had some chores to do in helping with better, more automated transfet of data from Bredo's capsule to Alcor HQ – RMP.) Meanwhile, our DART team staged a reenactment of the recovery of Bredo from his shed in Nederland. The "patient" in this case was played by the silvered-faced winner of the frozen man "look-alike" contest at the Royal Blue Ball, held the night before. He stood up briskly after the operation concluded, very "alive and well," to underscore how revival is the hope and eventual goal.

Following are some photos relating to the event. Are you going there next year?

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2. https://cryonics.miraheze.org/wiki/File:Bredo_Morstol.jpg; https://www.youtube.com/watch?v=K8X6sRsRCaQ. (mainly photo credits).

Estes Park, Colorado, FDGD celebration, Mar. 16, 2024

Royal Blue Ball, evening of Mar. 15.

Diane Cremeens helps customer at Alcor's booth, Mar. 16.

Another scene at Alcor booth, Diane with customer, Sarah Kelly nearby, rack of T-shirts lower right.

Cryonics nitty-gritty. From *left*: (1) Bredo Morstøl; (2) Morstøl's capsule at the Ice House,Stanley Hotel, now housing the International Cryonics Museum. Arrow (inset) points to digital gauge showing liquid nitrogen level above set-point and liquid usage in inches per day. (3) detail of gauge. This data is electronically relayed to Alcor HQ in Arizona and the liquid level is logged each day. A large tank outside in back (not visible) supplies liquid nitrogen to the capsule through an automated fill system and is itself refilled periodically from a delivery truck.

Again Mar. 16, Alcor's "moment in the sun" to inform people of cryonics services and also demo a "deployment and recovery" operation with a live performance. From *left*: Ice Queen; Bredo "look-alike" with cape showing Norwegian flag (both chosen night before at Royal Blue Ball); Marji Klima addressing audience about Alcor, James Arrowood looking on.

Alcor Deployment and Recovery Team (DART) having just placed "patient" in "ice bath," said patient being generously modeled by Bredo look-alike, above.

Remembering Joe Hovey

1st Life Cycle

1939-2024

Joe Hovey was a longtime Alcor member and contributor who very recently was cryopreserved. This short article does not do justice to the man or his contributions over the years, but will have to do for now.

Joseph Augustine Hovey was born January 10, 1939, in Los Angeles, where he was brought up in a Catholic household and graduated from Cathedral High School in 1956. (In the end he became a religious skeptic.) In 1962, he earned a BA in International Business Relations from the University of Southern California, Los Angeles.

After this, Joe was a government employee for 7 years, working for the CIA. Half of this time was spent in Vietnam where he and a colleague, James V. Ogle, predicted the Tet Offensive that took the American forces by surprise in 1968 when their warning was ignored. After his government work, in 1970 Joe attended the American Institute of Foreign Trade (later Thunderbird Graduate School of International Management) in Phoenix, Arizona. He then worked for RCA, Charles Dunn and Company, and Time Sharor Corporation.

Joe came to work for Alcor in 1989 to help build a database for the company. Following completion of this project, he became Alcor's accounting manager, in charge of all monetary transactions within the foundation. Over many years he handled a variety of duties including bookkeeping, membership billing, and payroll. He managed Alcor's Patient Care Trust, and he was Deputy Administrator of the State of the Art (SOTA) Fund.

On a personal level, Joe was one of my closest friends and always interested in discussing matters great and small pertaining to life extension, cryonics, right and wrong, good and evil, and the proper role of people in society today as well as in the future we hope to see. He and I were also active in the Society for Venturism which sought to aid cryonicists through such means as issuing no-autopsy cards and fundraising efforts for people who could not otherwise afford to be cryopreserved.

He will be missed. His Alcor cryopreservation (neuro) started March 9 and went well, starting from the standby at his home near Alcor's facility. One hopes his revival will be straightforward, given the timely response and future advanced technology.

My thanks to Hugh Hixon for consultation during writing this article.–RMP.

Sources:https://web.archive.org/web/20050114044953/http://www.alcor.org/, under "Alcor Staff"; Alcor archives; author's personal knowledge

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Intriguing Outcomes of Alcor's Meta-Analysis Interview with Michael Benjamin Cryonics Underground Podcast 13 Jun. 2023

Part 1: Background, Alcor Protocols, and Research

Max Marty and Daniel Walters host an online interview program, Cryosphere, formerly Cryonics Underground. Here they interview longtime Alcor member and scientific researcher Michael Benjamin. With their kind permission, all of the interview is included in this issue of Cryonics*, divided into three parts due to length.*

Greetings to you listeners. I'm your host, **Max Marty**.

And I'm your host, **Daniel Walters**.

MM: And you're listening to the one and only **Cryonics Underground** podcast. **Michael Benjamin** is a founding member of Biostasis Technologies and is currently the operations manager, secretary, and treasurer. He was previously a research associate at Advanced Neural Biosciences, joining the company in April of 2019. He worked on a comprehensive meta-analysis of all Alcor patient cases, an endeavor whose goal is to develop, experimentally validate and refine a quantitative cryopreservation evaluation methodology. Michael brings with him 20 years of experience in physics, engineering, and mathematics, having worked at places such as NASA, Goddard Space Flight Center, the Brookhaven National Labs, and Lockheed Martin. Michael Benjamin, welcome to the Cryonics Underground.

MB: Thank you for having me.

DW: [Can you] tell us, just for the listeners and the viewers out there, a little bit about your background and your career to get us started?

MB: Yeah, sure. So, I've tried a bunch of different things. When I got out of high school, I had no idea what I wanted to do. I spent a few years driving a truck for a medical supply company, did various jobs. About 10 years later, after high school, I decided to go back to school for computer science. I took a physics course and fell in love with

the physics and ended up with a degree in physics. I did some internships and some graduate work while at NASA, working on solar physics. I ended up having to come back to New York, started a master's degree in physics teaching; did a couple of years of that. While I was doing my graduate work and some of my undergraduate work, I worked out of Brookhaven on material science, studied batteries for JPL for space missions. While in grad school, Lockheed Martin comes along and says, do you want a job? I said, yeah, sure, why not? So I ended up going to Lockheed Martin. I worked on radar systems at Lockheed Martin, on their Aegis system, a naval radar system. But I was always interested in space, so I started looking around at Lockheed for jobs in the space sector. And long story short, I ended up in space operations for a couple of years, moved out west, spent a couple of years doing that, and then moved back east to DC and got more into the project management side of things. That was around 2006 to 2008. Then, around 2012, I had some health issues, and I decided to come back to New York to be closer to family, closer to my support system. I was sick for a number of years, and fortunately, the autoimmune condition I had, I'm not gonna say went into remission, but calmed down. And I ended up going back to work. Interestingly enough, being this is New York, there's no space jobs in New York, and I wanted to stay in New York. Actually, there are people working on trying to get space jobs in New York. I do some work with them now, actually. But the most immediate job was [in] artificial intelligence but in the legal profession. So, I ended up working in that industry [about a year], and I met Ascwhin De Wolf. Aschwin spent about 6 months convincing me to come to work for Advanced Neural Biosciences, to work on his Alcor meta-analysis project. And we finally agreed after about 6 months of discussing it, and I came on board with Advanced Neural Biosciences. And sort of the rest is history. I worked for ANB for, I guess it was 2019, April 2019, so, three and a half or four years before I transitioned over to Biostasis Technologies. The meta-analysis project was slated to come to an end at the end of 2022. Most of the data has been collected for that project, and now we're just writing up the reports and doing the analysis, should have that by the end of the year.

DW: I want to go back for a second to the NASA and Brookhaven and Lockheed-Martin. Cryonics has its fair share of space buffs, so I have to ask, are there any particularly interesting or notable stories that stand out from your career with one of those organizations?

MB: Um, nothing I can really talk about, at least in most of the space-related stuff. I still do some space consulting. I just worked on a project doing some orbit analysis for a company out in California. So I still do keep my fingers in that pond. But [regarding] the NASA work, I was working as an intern at Goddard Space Flight Center down in Maryland, working on solar physics. Actually that mission, that satellite just came down about 2 months ago. I think it reached its end of life a few years ago, but it finally came down. It was a whole big thing, that they thought it was gonna crash into something, but it didn't. So what happened when I was at NASA, they offered to pay my mentor, they offered to pay for the first year of my PhD, and I was gonna do my graduate work at the Catholic University. That's who had the contract with the program I was on. So, long story short, I moved down there and a few weeks later, NASA had huge budget cuts. That's why I ended up moving back to New York at that time, to pursue some graduate work up here at Hunter College.

DW: OK, and how did you originally get interested in cryonics?

MB: You know, at some point in your life, you start to think about death, right? When you're younger, you generally don't think about it. I know Emil Kendziorra is working on changing that, to get the younger generation to sign up for Tomorrow Biostasis [Kenziorra's cryonics organization, based in Switzerland]. But you know, it was basically when I had part of the process of confronting my mortality. I had a cancer diagnosis first before I got this autoimmune diagnosis. Fortunately, the cancer was an easy one to take care of. But it just started the the wheels turning, on thinking about mortality. I don't remember exactly how I first came across cryonics, but I did join as an associate member of Alcor. I think it was about three or four years before I actually signed up as a member. And here we are.

DW: And what years were that?

MB: So 2017, I signed up as a member and probably 2 or 3 years before that I was an associate member. It was 2017, I became a full member.

DW: And if you don't mind me asking the name of your autoimmune disorder, I believe it was scleroderma.

MB: Scleroderma. I do some advocacy work for some of the scleroderma organizations as well.

DW: OK, and what are the kinds of effects of that on your life physically?

MB: It's an autoimmune connective tissue disease. So, long story short, the body creates excess collagen, which creates excess scar tissue, and it can happen anywhere in the body. In general, there's places where it affects more than others, and most people who have it, hands, for example. You know, it can affect any internal organ in the body. Scleroderma means hard skin. So it affects the skin, causing scar tissue and tightening of the skin. But it can

also affect internal organs like the heart and the lungs, and I have some effects on those things. But you know, you sort of play whack a mole with all these things to try to make sure things stay as stable as possible and functioning as possible.

DW: Yeah, and I guess previously you had mentioned something about your concerns with stabilization for cryonics, in regards to scleroderma. What exactly are the concerns there?

MB: Scleroderma also affects the vascular system. It attacks the endothelial cells in the walls of all your veins and arteries, and all that. And that affects blood flow and can affect other things with regard to the cardiovascular system, which may or may not – and I've been looking at it peripherally – affect perfusion. It causes lack of blood flow in the hand. There's something called Raynaud's phenomenon where your hands, when they're exposed to what at least your body thinks it's cold, for me, it's 65 degrees or colder, circulation stops in my hands. So, the capillaries spasm in the extremities, in the hands, in the feet, and it can also happen in the brain. So, as you're cooling and you're perfusing somebody, I don't know if you're still gonna have that Raynaud defect, where the capillaries and some of the veins are gonna spasm in the hands, in the brain, wherever, while you're being perfused and cooled down at the same time. So, I think that's something that needs to be looked at.

DW: And I'm curious since we're on that topic, are there other types of conditions that people may not be aware of that can affect stabilization in the same way – whether it's a disease or, I would assume you know if you have just generally bad vascularization due to age or being highly overweight or something along those lines. I'm wondering if there's any particularly notable things people should actually know about that.

MB: I think that any cardiovascular condition in general can cause problems, and depending on what the condition is, they can cause different problems. It's common for autoimmune conditions, certain autoimmune conditions, to cause similar problems to what scleroderma causes in the vascular system. I think lupus has some similar effects, but I think any cardiovascular condition can potentially cause problems with perfusion.

MM: So Mike, I want to drop us into this meta-analysis and your work on [it] for Alcor and how it came about. So where did the idea for this meta-analysis come from? Was it Aschwin who brought it to you, and how did you decide to get involved in this? Why did you feel like you were the right person?

MB: I'm not sure about the genesis of it, but my understanding is that Aschwin was a big supporter of this. I don't know if it started at Alcor, if it's something Aschwin came up with originally. But I'm sure, you know, Aschwin and many other people realized that there was really a lack of understanding on a large scale of what was going on, [relating to] how successful have these cryopreservations been. I don't think there was a deep enough understanding. There's always this push to improve procedures, but I don't think there was a deep understanding, if things were actually improving, even with the new technologies and the new procedures, on a macro scale.

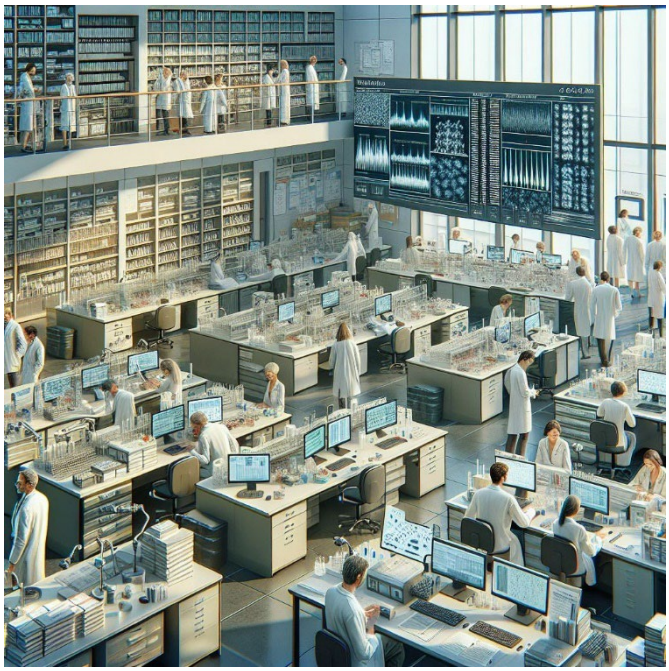
MM: So, before Alcor engaged you guys to help make this a reality, was there any kind of digital database of all the different metrics and factors here, or was everything like in pieces of paper in a filing cabinet somewhere?

MB: Basically, pieces of paper in a filing cabinet. They had digitized some stuff but not any sort of database or anything like that, as far as I know.

MM: When you were getting started with this, what was the date that you wanted to first start looking at for this? What was the earliest date?

MB: I basically looked at all the case reports and all the data that came along with the case reports, temperature data, anything that's done during the entire process, any data that was available, you know, the earlier you go back [to], the more lacking the data was in many cases. So, it was a lot of collecting whatever data I could, and then in terms of the analysis, piecing things together and trying to fill in gaps without making things up, obviously.

MM: And what were the earliest dates that you feel like you could get reasonable data you felt comfortable putting into a database?



MB: It was kind of up and down, but I would say, by the late 80s, early 90s, they had been collecting some really decent data. [In] the early 90s, things really started to become more thorough, but, as different people come and go, the quality of the reports and the data collecting, data saved, goes up and down as well. There's a lot of variation in that.

MM: And so you wouldn't say that was because of the technology, you would just say it was because of the kind of internal Alcor policies or whoever was –

MB: Yeah, I would say it's whoever was doing things at the time.

MM: So, what were the factors that you felt were most important when you were looking at this database? There's probably a list of a lot of different metrics that you thought were gonna be relevant. Were there some that you thought, okay, I could start collecting. Here are the 4 or 5 that were actually available in say the early 80s or such, but then maybe by the 2000s you had, like, access to 10 or 12 of these various factors.

MB: You know, I think probably one of the most important things is stabilization. When you have standby, you're in much better shape, you're there as soon as the patient deanimates to get the procedures going right away. But I think one of the more important periods is the stabilization, how quickly the patient is cooled down, what procedures are done at that time. What there is lacking in a lot of cases, particularly in the earlier cases, is temperature data for that period, and that creates some other challenges, for example, [with] the S-MIX, which we'll probably talk about a little bit later.

MM: Yeah, that'll be a whole [area to cover].

MB: Just to explain briefly right now, it's a measure of ischemic damage occurring in a patient during a cryopreservation.

MM: Were there numerous factors that you wanted to keep track of in this database that weren't directly relevant to the overall quality of the cryopreservation, for example, whether or not the medical personnel were helpful and cooperative in the patient's case or things like that? [Were there] other things that might be useful to track to have some sense of how well Alcor is doing in in one way or another or where they should be putting resources, but which aren't directly relevant to the overall outcome?

MB: Well, you know, one of the most important things is time. The quicker you get the cryopreservation done, the better. And any human interaction, whether it be medical personnel or what have you, affects how long this process takes. I can talk about that in a little bit. I'm working on writing up a number of reports on different areas of different periods of the cryopreservation, and one of them is how did hospitals cooperate with the standby team or hospices, and how that affected the timeline. So, we're looking at details like that as well. There are so many different pieces of this that affect the timeline, that affect the quality of care. I think every piece of data, no matter how insignificant it seems, can be important in some way. And I don't think that will be completely understood until we get through this analysis. And frankly, you know, I'm doing the work that I'm doing, but I think this data collection is gonna create years of analysis to understand this whole process.

DW: Yeah, and to get an understanding of when you're saying like interruptions and things like that, how granular was some of this kind of data? Were they were recording? Or was it someone taking notes after the fact [because, say, a] nurse stopped [them] and said this and it took 10 seconds? Or how is this actually being recorded?

MB: Yes, to all of the above, and sometimes there were video recordings, sometimes there were not. Sometimes there's granularity to the level of the nurse, while the hospital wouldn't let the standby team do anything to the patient after deanimation. One of the nurses cooperated and did 5 or 10 minutes of CPR – chest compressions – and gave heparin. So different cases have different details and different ways of recording those details. But I think the most common is the report being written and reviewed by the people who were there.

MM: So is a lot of this data that was sitting in filing cabinets or such, is it a lot of just handwritten notes of people saying, here are things that I think were relevant to this case and then, you know, a few pages of random stuff and you have to figure out how to give that structure?

MB: Yeah, that's exactly right. It was a tedious task.

MM: I can imagine. So is one of the things, maybe more recently being done, is creating some kind of paperwork to be able to record these things better than they have been recorded in the past? So, instead of just freely writing notes where you're gonna forget important details or you're gonna write things that aren't really relevant or you're gonna just waste time, having a sheet that says, did this occur? Yes, no, or to some extent or whatever?

MB: They've always had those. And it's just a question of, sometimes it's handwriting. You just can't read the handwriting. Sometimes the copies are bad. Sometimes not everything was checked off, and it really comes down to these reports. I do have to say, I've looked at the data up through 2020, and I have been looking at the more recent reports, '21 to the present. And I do think there has been a great improvement over the last few years in the quality of the written reports and the incorporation of the data that's available. So, you have a team of people writing up these reports and looking at all the data and putting the data as much as they can into the reports and clarifying it. So, I think we're in much better shape now than we have been in the past in terms of the quality of the reports and the data being reported.

DW: This is just speculation, but how possible do you think the technology will be in a year or two for just having a video recording being analyzed by an AI, and just taking very dutiful notes about everything going on, and printing perfect transcripts? Because I mean right now, for text they can do that pretty well, they're working on pictures, and for videos, soon that will be pretty capable as well. Any idea if that would even be an option or would there be some barrier?

MB: Most of the video taking is done in the Alcor operating room. Hospitals and hospices, they're not gonna allow video in their facilities for the most part. So, I don't think we're gonna have that video aspect anytime soon, in the beginnings, in the stages where you're in another, external facility. Can you set up video things in the rescue vehicles? I think that depends on a number of factors. Are teams traveling to get to a patient, and are they renting vehicles? In that case, setting up a camera might take some extra time. If you have enough people, great, [but] there's all kinds of difficulties here. These cases are really complex, and the more complexity you add, like setting up a video camera, takes more time away. So, you know, there really has to be a balance between doing what's important at the moment for the patient and what's going to help us in the future in terms of analysis. Now, going back to old reports, many of the reports, not all, but many of the reports, and again, it depends on who wrote them, are written somewhat anecdotally. This one was thinking this at the time about what this one said to them, and all this sort of gossipy things going on at the same time in these reports. I'm not sure. I don't know how well the current AIs are at pulling important information out of things like these at this point. I would imagine we're not there yet. Looking at some of the older reports still might be difficult for an AI system. The closer we get to a generalized AI, the more likely that's gonna be, but that has other implications.

MM: Yeah, maybe GPT six or seven or eight or whatever would be just fine on this front, [though] on other fronts have some interesting times.

MB: Yeah, I wouldn't throw any non-public things into Chat GPT, since we don't seem to quite own the data that goes into them anymore.

MM: It's a random question, but is all this information that is kept in these files, file drawers and all this, I mean, Alcor has its own privacy policies and procedures, but is it protected by HIPAA or or anything like that?

MB: By default, we apply HIPAA to it. But what I would say is, when you sign up for Alcor, you have a choice if you want your case public or private. But you're generally not gonna have a conversation about every medical detail, [so] how do you decide what to put out there and what not to put out there? And Alcor has put a lot of detailed information out there. I think more recently they've erred more on the side of caution. So I think, even if a patient has said you can make my case public, they're leaning towards sharing less information publicly than they used to.

MM: I want to give folks a flavor of the types of information that Alcor and you were trying to put into a database, trying to collect, trying to look at. Some of [these]

are [appears to be reading from a list], whether or not there was an autopsy, was there an unattended death incident, SST deployment and cardiopulmonary support, I suppose how much of that was administered, what were the issues around the hospice or hospital logistics, was hypothermia induced, I suppose when and how, etc., which medications were administered, and at what points, etc., remote blood substitution, not sure what you mean by that, but cryoprotection field, cryoprotection, right, so was that done, monitoring of SST and cryoprotection, and then a whole bunch of stuff around the S-MIX. Were there any major factors that you wish had been kept track of over the years and that you could put into a database, but hadn't been, and now those are some big factors that you hope are gonna be reported going forward?

MB: I think the most important thing is temperature data. There's a lot of cases where temperature data was either not taken during the entire process or data loggers stopped working, any problem you can imagine going wrong with taking the temperature, [such as]: Where was the temperature taken? How far was the device inserted? Was the head cooling faster than the rest of the body? There's, you know, all these data points to take into account all of these factors, and the main thing we're concerned with is the brain, and it's preserving the brain as well as possible. It takes a certain amount of time for the brain to cool before, say, your nasopharyngeal area cools. So, you know, there's all these [issues]. There's a lot of, I think, extrapolation in terms of how well cryopreservation is being done based on temperature data.

MM: And on the subject of temperature data, you mentioned a couple of different ways to read temperature data. What would you say is the gold standard for sensors and collection of temperature data? So, under perfect circumstances, under complete lab-controlled conditions, which probes, which sensors are where in the person's body, and how are they tracking that?

MB: By default, if I had every temperature probe available I was gonna use in calculating the S-MIX, I would use the nasopharyngeal, again, because of the importance of the brain and preserving the brain properly.

MM: And so you think with that one, you don't need very many others.

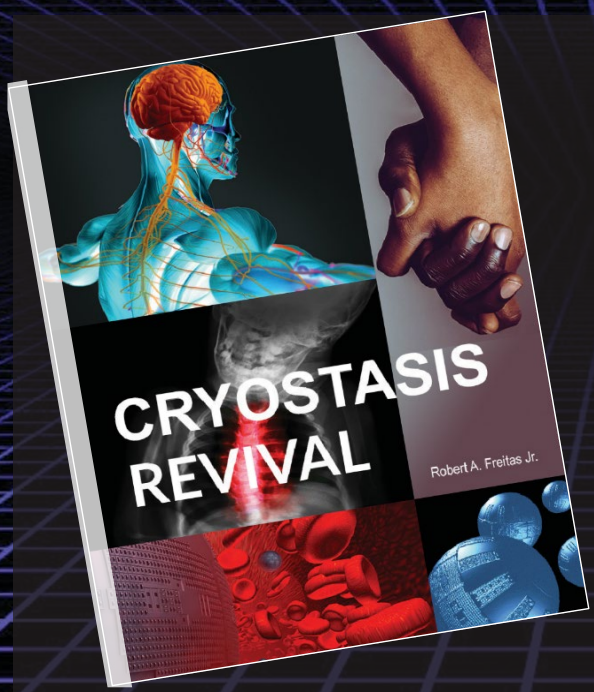
MB: I wouldn't say I don't need them, but I would say that, if I had to make a choice of which one to have, it would be the nasopharyngeal.

MM: Got it, got it. So there's a lot of factors in this, and of course now we should probably talk about the one that is related to this temperature issue and to cooldown, etc., as you've been describing and we've been avoiding it, but we're now gonna jump into it.

End of Part 1. Part 2 continues p. 17.

Free Book by Robert A. Freitas Jr.

Cryostasis Revival: The Recovery of Cryonics Patients through Nanomedicine



Cryostasis is an emergency medical procedure in which a human patient is placed in biological stasis at cryogenic temperatures.
A cryopreserved patient can be maintained in this condition indefinitely without suffering additional degradation, but cannot yet be revived using currently available technology.
This book presents the first comprehensive conceptual protocol for revival from human cryopreservation, using medical nanorobots.
The revival methods presented in this book involve three stages: (1) collecting information from preserved structure, (2) computing how to fix damaged structure, and (3) implementing the repair procedure using nanorobots manufactured in a nanofactory – a system for atomically precise manufacturing that is now visible on the technological horizon.

"Robert Freitas is an extraordinary thinker and author whose previous works have been transformational for our ability to visualize the extraordinary capabilities of future medical technology. In Cryostasis Revival, he now puts his prodigious previous knowledge of nanomedicine to the task of envisioning methods for healing those whose injuries challenge even the ultimate limits of future medicine. His illuminating results and new insights will greatly inform debate over, and may even help to resolve, controversies that have persisted for decades." – ***Gregory M. Fahy, Ph.D., Fellow, Society for Cryobiology & Executive Director, 21st Century Medicine, Inc.***

"Future repair and revival of damaged cryopreserved tissue has been the subject of speculation for decades. This book by a nanomedicine expert examines the problem in detail far beyond anything ever written before. With more than 3000 references, it's both wide-ranging and intensely specific about diverse technical aspects of the problem. It will surely stimulate much discussion, and be an invaluable resource for thinkers about nanomedical cell repair for years to come." – ***Brian Wowk, Ph.D., complex systems cryobiologist, Chief Technology Officer, 21st Century Medicine, Inc.***

"We now have considerable evidence that cryopreserved patients retain the physical structures encoding memory and personality. For most people, the difficulty lies in understanding how it could ever be possible to repair and revive patients. Leading nanomedicine expert Robert Freitas fills in that gap with admirable and remarkable depth. Cryostasis Revival provides an unparalleled clarification of pathways for researchers to explore in the quest to make human cryopreservation reversible." – ***Max More, Ph.D., former president, Alcor Life Extension Foundation***

"Cryostasis Revival is the most magnificent tour de force on cryonics ever done with the signature flair, comprehensive coverage and authoritative style of Robert A. Freitas Jr. It describes all the issues involved in reviving cryopreserved patients: from the philosophical (what is "information theoretic death") to the practical (what damage actually takes place during a cryopreservation) to the technological (how to apply nanotechnology to restore a cryopreserved patient) and more. Nothing else even approaches such a complete and incisive treatment of this life-saving subject. Cryostasis Revival is the book to give anyone who's thinking about cryonics but "isn't sure about the science." – ***Ralph C. Merkle, Ph.D., Senior Research Fellow, Institute for Molecular Manufacturing.***

Free electronic book and hardback copies for sale at:
https://www.alcor.org/cryostasis-revival or Amazon.com

Intriguing Outcomes of Alcor's Meta-Analysis

Part 2: The S-MIX

MM: Tell us, what is an S-MIX score, and why does this score matter?

MB: OK, let me just bring something up real quick. S-MIX stands for the standardized measure of ischemic exposure. And what this measures, is how much ischemic exposure in units of time was experienced by the patient during the cryopreservation process. So, it's measuring how much damage was done to the patient ischemically during the process. And the most important part of that calculation is temperature data. So, what we're doing is taking time periods or procedure periods during the cryopreservation. So, for example, how quickly did the body cool between when the patient deanimated and when CPR was completed? Was there oxygenation with the CPR? Was the patient cooled in an ice bath? So, the question is, between the beginning of the deanimation of the patient and the end of CPR, what was done, temperature and time being the most important factors to calculate this S-MIX score.

MM: When you say, was CPR being done, or was somebody attempting to provide oxygen to this patient even though they weren't doing that by themselves, do you measure the quality of that, of somebody doing that? So, somebody sitting there doing chest compressions and breathing into a person is one thing, but if they're on the equivalent of a ventilator, that would be a higher quality version of that. Do you distinguish between those two in the S-MIX?

MB: The S-MIX right now does not distinguish, as long as somebody's doing some sort of chest compressions, whether it's a human or a machine doing it, we count that as the same. Generally, when there's a human doing it, if there's enough people to keep switching off – because, you know, we get tired, right? – you have a longer period of chest compressions than you would normally with only one or two people there. With the machine, obviously you have longer periods. But whether it's 5 minutes or 20 minutes, that's counted the same no matter how it's being done.

MM: Got it. I heard a presentation on the S-MIX before, I've heard it described and discussed, and I've talked about it to some people. Now you can tell me, Mike, that I was completely wrong, but I was making the argument that the S-MIX score is not an overall score of ischemic damage. It is simply a measure of ischemic exposure, but not necessarily damage. Because there may be other mitigating factors in how much actual damage was being done to the cells in this way, rather than simply the amount of time they were exposed to this damage. There may be certain medications, for example, that were administered that could lessen the amount of damage that cells were receiving due to this lack of oxygen. Am I wrong in making this argument? Would you say that this should be considered a measure of the actual damage or, what's the nuance here?

MB: The answer is somewhere in between. Again, we're focused on the brain. So the way to check that, and they do this, is to do CT scans of the brain, after the cryopreservation has been completed. That's one of the things we're looking at. We're comparing the S-MIX results to the CT scan results to see how much preservation was done. You can't really measure in every part of the body what exactly type of damage has been done. So in that sense, you're right. In terms of just going by ischemic exposure, that is generally what this is looking at. But we can bring the two together – compare the S-MIX to the CT scan results – to see how well an S-MIX can predict actual ischemic damage.

DW: Two things. First, just so listeners and viewers understand, the lower the S-MIX score the better, right? OK, so just to get that clear, and then I was interested when you [brought up] correlating the CT scans and the S-MIX. So for starters, what exactly are CT scans measuring?

MB: They're measuring how much water versus cryopreservation material is in the brain.

DW: OK. So if you're trying to correlate these two, how many Alcor patients have actually had CT scans?

MB: They've been doing the head CT scan since 2011. Most neuro [head only] cases since 2011 have had CT scans.

DW: And that happens immediately after the preservation?

MB: Yeah, generally before they're put in the dewar.

DW: OK, and so it's been neuro specifically. Are there plans to do that with previous patients who are already in the dewars?

MB: My understanding is that they're not planning on doing that specifically because of the effort that that would take. I'm thinking that there has been maybe one or two other cases where they were taking the patient out for some other reason and they did a CAT scan. I don't know what cases those were. I don't think they're specifically

planning on doing that right now.

DW: Yeah, I imagine the logistics of that might cause issues around, well, for starters, damaging the patient. And then I think there would probably be some issues – I'm curious on your thoughts on this – with informed consent. Actually, I would have to relook at the contracts, but is it in the patient's best interests, to be scanned at this current moment, maybe at some point in the future, when they're ready to be revived or they need some information so that they can better do the revival process? But how would that help them?

MB: I think that sort of thing is left up to Alcor to decide. I don't think there's anything in the contract that sort of micromanages any of that. It basically says if Alcor thinks that XYZ is going to improve your chances of reanimation, Alcor is free to do that.

MM: I want to push a little more on this question of whether the S-MIX is really able to determine or how well is it correlated with the actual amount of damage done to the patient's brain from ischemic damage. When you've had the chance to look over all these CAT scans, what would you say is the correlation? Have you already been able to determine what the correlation is between the S-MIX and the quality of the CT scans?

MB: No, we're we're in the process of doing that now, but the short version is the more ice you see in the CAT scan, the worse it is.

MM: And then in any given case, how closely is that related to the S-MIX?

MB: You know, I think in the extreme cases, there's not a perfect correlation. I don't think [there is] in any of the cases, some are more obvious than others, like the more extreme cases, but we're in the process of reviewing all that now. So I don't have a definitive answer for you.

DW: Would theoretically something like a straight freeze that was done very fast have a [better] S-MIX?

MB: That would be 100% ice.

DW: Yeah

MB: But there's also gonna be impact. Generally, in a straight freeze case, almost all the time there's a long period before any procedures in terms of stabilization were done, so that automatically is going to create a high S-MIX.

MM: Have you also used the S-MIX score on nonhuman animals, have you tried to look at [that]?

MB: No.

MM: OK. That could just show you that there might be a whole bunch more data that you can then use to make that correlation. I mean, it might be easier to do [with] CT scans.

MB: I'm not sure how much there is on that, in order to do a good enough study on that.

MM: Because historically, if you have little data on human temperatures, you're gonna have even less data on [animals].

MB: Yeah. And we're already talking a large amount of data, but not a huge number of patients.

MM: Yeah. What other factors, besides a CT scan, do you think would be useful in being able to say [that] if we know the S-MIX plus this plus this plus this, then we will know a 99% correlation with the actual amount of ischemic damage.

MB: I don't think we're there yet. I think that's an area that has to be studied. One of the purposes of the meta-analysis in coming up with this S-MIX was to further determine what research needs to be done to answer questions like you're asking. So, the purpose of the meta-analysis is not to answer all these questions. We can answer some of them and we can do the steps towards answering those questions. But one of the main purposes of this analysis and collecting all this data is to open up new questions and the ability for other researchers to look at all this data in one place and ask these questions and do more research.

MM: Can you tell us a little bit about what you've found so far, when it comes to these S-MIX scores and how they have been changing?

MB: I think the most surprising thing [for] most people is – mind you, these cases are from the beginning, some of them include James Bedford, some of them don't, so, from 1967 to 2020 – and the trend as to whether or not cryopreservation has improved largely seems to be flat. I mean, there's actually a slight downward curve, but for the most part, it seems to be flat in terms of any improvement in cryopreservation. So, that was one of the most shocking findings here.

DW: Can I interrupt real quick here? [Do you mean] any improvement in cryopreservation or any improvement in specifically the S-MIX score?

MB: Any improvement in cryopreservation itself and the results in the patients based on the S-MIX score. So the S-MIX scores over time actually show a slight increase; an increase is bad in time, it's taking longer to do the preservations. Again, it's only a slight curve upwards and I think for all intents and purposes it's flat. So it's taking about the same time as it did 40, 50 years ago, overall, to do a case.

DW: I remember at the Tomorrow Biostasis conference

you had mentioned this and I feel like myself and others were a little bit shocked by hearing this, because the assumption for everybody would be that over time things get better, especially in a field that revolves around technology. To hear you say that it was flat and even going down to some small degree felt like a gut punch a little bit. But, thinking back on it, is it fair that you're using S-MIX in a vacuum to make that determination? If you add in all the other variables, is it actually getting worse or is it S-MIX that's causing that perception?

MB: So, that that's the question, right? I don't think we have the answer to that. I think that, once more analysis is done on all these other factors to determine how we think a case went, there's going to be some improvement in cases. But, if I use one other factor, let's say I make it as important as the S-MIX, and that's the quality of data, the quality of reports over time, I do see the same up and down. If you look at a graph of the S-MIX scores over that time period, if I were to make a graph of the quality of reports and data available, in a similar fashion, I think you would see the same ups and downs that you see in the S-MIX score as you do in the quality of data. Now, you could argue that that's because the data is bad. That's why the S-MIX looks the way it is, but we don't know that. We don't have an answer to that question. Now, if you ask that question from a mathematical perspective, I'm not sure I'm the right person to ask that. This might be a Mike Perry or an Aschwin de Wolf question, [the ones] who developed this. Given my experience in mathematics, it's not a perfect thing. It's not gonna be a perfect correlation to everything, but I do think in terms of a general trend, we're gonna see some variations up or down, but I think we're in the ballpark. And when I say that I'm using the quality of case reports, I also correlate in my mind at least, if the case report is bad, the quality of care might have been bad. So, without sitting down and doing a detailed analysis of each of these pieces yet, I am seeing a correlation on a macro level with all these things.

DW: I refuse to believe it [chuckling]. I'm having willful ignorance right here.

MB: Technology is tools, right? And if you have somebody who is not using the tools properly, it doesn't matter what the technology is unless you're going into the general AI discussion, which you could also argue against because it was developed by people to begin with. So the quality of the tools may help, but it's not gonna solve the problem.

MM: I'm in Daniel's camp. I'm still trying to push against this, right? But, for example, the mix of medications that are administered to a patient, as they're initiating cooldown and all that, that has changed over time and presumably it's gotten better over time. That's potentially one mitigating factor that would suggest that things aren't as bad as they seem. Maybe if there's a handful of other mitigating factors like that, obviously the cryoprotectant has gotten better since the development, I think it was in the early 2000s or such, of M22 or whatever it was. So, [if] there's a list of a few of these mitigating factors, then presumably [the] actual end result cryopreservation could be getting better even if the S-MIX scores are flat.

MB: Let me just step back a minute. One of the areas that I specialized in when I was an engineer at Lockheed was process improvement. When I worked in space systems, we had top-of-the-line technologies, anything you can imagine technology-wise. But, if the humans didn't get it right, if the humans didn't understand it right, if they didn't do the procedures right, if they didn't catch something, the entire satellite could come down. My job in this period was to do a sort of 6 sigma process improvement type of event. And I see the same thing, the same problem, here. The procedures which Aschwin wrote, many of them, might look great on paper, but how they are implemented, again, that has gone up and down over time. And I think that is really, really important, more important than most people realize, to get these processes in place, and done in a proper way, the way it's written, as close to theoretical as humanly possible. Now there's a lot of mitigating factors. For example, if you can get into a hospital and do a standby, there's still things like that, but I think there are ways to mitigate most of these things. It's a really, really, really complex problem, how to get these procedures done properly. This is not something we easily talk about. You can't just say, well, somebody screwed up, so they screwed up the whole case. It's not that simple. And until you've looked at all of the data and all the procedures and how they're implemented, sure, there's lots of places where you could say, this got screwed up or that got

screwed up, or we just don't know because the information is not there, why is the information not there? But there's so many mitigating factors that it's really hard to say what the cause is. That's why we're collecting so much data, and, again, it's gonna take a long time to really dig into to understand what factors are causing what. On the surface, it may seem shocking that there hasn't been a great deal of improvement, but looking at it from the perspective of, I'll call it operator error, I'm not surprised.

DW: You said, if the tools are not being used right and you mentioned operator error–

MB: Or, [the tools] just failed –

DW: Yeah, so, can you give one or two examples of what exactly is failing, like the temperature gauge, and any kind of random malfunctions of a tool. Are there specific ones that that are particularly egregious in terms of failure rates or not not being useful over time?

MB: Temperature is important, knowing what the temperature changes are, is important. Now, why are we missing data? The data logger's failed. I see that all the time. The data is just missing, it's not in the file, not in the folder. In the reports that I've been looking at, you have a lot of extremes of good quality and bad quality, and again, the only way I can look at this is to extrapolate and say, on some level, the bad quality reports, more often than not, mean it might have been a bad case. Or I mean, it also could just mean stuff wasn't recorded properly, they were too engrossed in what they were doing to record anything. But there's really no way to tell. And going back to the thing that both of you guys were talking about, you in particular, Max, how well do we correlate actual ischemic damage to the S-MIX? I think while studying that, that those results are gonna take into account these human factors. And that human factor data is going to help us understand that same thing as well.

I'll give you an example, in the space business, where I came across one particular situation where the satellite just kept failing. And nobody could understand why the satellite kept failing and they had trouble getting it back and operating properly. You had multiple teams working on these systems. And it was a lack of understanding of who was responsible for what. Who was responsible for this part of the system, who was responsible for this procedure, and once this process improvement was done and the mitigations were applied, we went from 3 to 4 midnight call-ins a week to 0. I mean 0. That's how important I think improving the implementation of procedures and processes is, and I see the same thing here in cryonics.

MM: So, just for my own clarification, the S-MIX score takes into account the amount of time during which someone was at a given temperature above freezing, right? Once you're below freezing, that's not really relevant.

MB: Yes.

MM: Of course, somebody could be at 2 degrees below freezing for a week and that's not good.

MB: Right, that's a different problem.

MM: But it does affect the overall quality of the cryopreservation at the end of the day.

MB: Yep.

MM: So that just might be one way in which the correlation is not gonna be perfect between the S-MIX and actual damage.

MB: It's like someone being at dry ice temperature versus liquid nitrogen temperature. There's going to be more damage at dry ice temperature than liquid nitrogen temperature.

MM: So I guess there's two, in my head, still remaining, non-trivial objections to the S-MIX as a useful metric, one of which I think you'll mostly agree with and one of which I think you'll mostly disagree with. The one that I think you'll mostly agree with is that what we would really want is some kind of overall, absolute, here's the cryopreservation quality index. One of the factors it [would take] into account might be the S-MIX score. Another one might be, for example, some kind of S-MIX-like score that factors in time between 0 °C down to liquid nitrogen temperature and then it might also take into account other things, whether somebody was poking around during the procedure and did something else that might have caused damage to the brain or didn't administer the right medications at the right time or whatever the case was. So I feel like there could be multiple other scores that could be factored into some overall thing.

MB: Or even factor these other things into the S-MIX score somehow.

MM: But then it wouldn't be an S-MIX, right? It would be something other, you know, rename it or something, right?

MB: Yeah, I mean, it depends on what you're throwing in there.

MM: Yeah. So I feel like that one, you're mostly on board with, right? The more we can throw in there that's relevant [the better,] and then overall come out to some really good index. But I think one other objection that you might not agree with would be that the S-MIX score is kind of the street light problem. Because we don't have access to all these other potential sources of information as to the overall quality of the cryopreservation, the only one that we've managed to design in a quantifiable way is the S-MIX. I mean, correct me if I'm wrong, I don't think anybody else has tried to come up with a score that's at all

correlated with actual end result damage. But because this is the only one we have, we are so focused on this that we're losing focus on all the other things that could potentially be relevant to the overall cryopreservation, right? And so – street light problem, right? – we're looking for the answer where the light is, we're looking for the answer here at the S-MIX just because this is all we've got and it's a bad idea to be so focused on the S-MIX, but it's an objection. What do you think about that?

MB: Certainly, I agree with you. I don't disagree. I think there are some people that have that spotlight problem. It depends on who's there to talk about it. And that's why I keep reinforcing that there's still other work that needs to be done, whether it's correlating with the CT scans or correlating with the other data. You know, we're not there with some perfect overall thing yet. What I am saying is that I do think that the S-MIX is still representing some general trend. I think you're gonna see variations in whether that trend goes up or down. I don't think you're gonna see any exponential differences in the trend we're seeing in the S-MIX and any trends we're gonna see with other data. Could there be one point of something that's shockingly different? Sure, you're gonna have that with anything. But I think, for an initial shot at this, we're in a general ballpark of what the trending looks like. And again, it doesn't surprise me based on what I've seen, and quality of reports and human error, et cetera. Without that, I might have backed off and said, OK, maybe you're completely right, and maybe this is useless. But based on what I've seen in terms of quality of execution of procedures, quality of reports, and my background in process improvement, I'm not surprised, and I think that this S-MIX score does have some accuracy in terms of the trending.

DW: And so, in terms of some of the takeaways of why the S-MIX score is the way it is, in one of your talks you discussed a few large factors, one of the biggest ones being unattended death. How much does that factor in? I think I remember you said, like 70% of the top 10 S-MIX scores were unattended deaths. So how much overall are these unattended deaths specifically contributing to these kinds of downward S-MIX's?

MB: So, if you remember from the talk, one of the trend lines I did was without them. And it did improve slightly, but not significantly enough to say oh that was the cause of the whole problem. Not even close.

DW: OK. That's good to know. I do actually want to get into those more because separately they were also one of the most interesting takeaways, I thought. So first, just to define things, I understand what unattended death implies, but attended death, does that mean specifically an SST team there, or could it be a family member just doing CPR or a nurse at a hospital? What defines attended?

MB: The person is not alone. So the person could be in the hospital and deanimate, and they just don't even throw them in a cooler, right? I mean, not that that happens very often, but it can happen for two or three hours. But for the most part, unattended is those rare cases, where there's nobody there to call somebody and say start some kind of stabilization process.

MM: Yeah, it could be that a person dies next to their spouse, early in the night, and the spouse doesn't even realize it.

MB: Exactly. That's for our purposes unattended.

DW: OK. And then for those unattended, what percentage of those ended up being straight freezes versus being vitrified?

MB: I have to look up those stats. Give me a second. I would say most of them are straight freezes, but let me, I don't know if I have that handy.

DW: That's OK. I guess a more pertinent question would be first, under what conditions were the straight freezes happening generally?

MB: Unattended death and postmortem third party.

DW: OK. And you had said about 50% of the people were home alone for these unattended deaths. I'm not particularly surprised by that, but it does bring up some interesting issues of a lot of cryonicists being single and without spouses and without children, at least children that they live with. Do you have any specific thoughts on that? I guess, generally speaking, everybody would probably agree it's a bad idea, but I'm curious if there was any data that was interesting on that front.

MB: Yeah, so let me go back to the straight freeze question real quick. I've got a slide here that shows that of unattended deaths, 54% of those were straight freezes.

DW: Okay.

MB: So, in terms of your last question [asks to repeat it].

DW: About 50% were unattended, were straight freeze, so members should know that if you end up unattended, there's [something] mitigating that.

MB: Oh, so, mitigating [that for] the people who live alone. Alcor has people like Ben Best and Nikki [Olson who] have looked at technologies to help mitigate that. Things like the Apple Watch may be one way, but Alcor has implemented a service, I think, that costs extra, to check on people at least once a day, to make sure they're OK. So that's one of the things that we're looking at, how do you mitigate an unattended death, we're looking at that a little bit, but I think that's something that needs to be studied and is being studied by some people.

DW: Alcor's program I think is a good start, but –

MB: I mitigate by using Alcor's service and I also have an app on my phone that [sends an alert] if I don't press a button by a certain time, so I spread [my coverage between them] throughout the day. But I also have the Apple Watch which doesn't alert if your heart stops, but alerts if you fall over and sends out an emergency message. So there's all these things like this that you can do.

DW: Yes. We had Nikki on the podcast not too long ago, and she has a lot to say about these sensors. Quickly, I'm gonna plug in her website, cryonicsmonitoring.org. She's compared all the different cryonics monitoring devices that are currently out there and I think, if people are interested in [this topic], that'd be a good place to get an overview of the pros and cons of each of them, and what needs to happen to actually make that a thing. But, given that so many people are dying alone at home, I think this is something that needs to actually get addressed, sooner [rather] than later.

End of Part 2. Part 3 continues p. 24.

Membership Statistics

2023-24	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Cryo Members	1417	1424	1419	1422	1423	1418	1424	1425	1430	1435	1439	1440
Basic Members	35	35	35	36	38	39	40	43	46	45	45	46
Patients	212	212	217	218	222	224	225	226	227	230	233	233
Assoc./Apps	218	219	228	238	245	249	247	248	241	245	246	323
Total	**1882**	**1890**	**1899**	**1914**	**1928**	**1930**	**1936**	**1942**	**1944**	**1955**	**1963**	**2042**

Intriguing Outcomes of Alcor's Meta-Analysis Part 3: Other Topics and Conclusion

DW: Moving on, another [topic] which I would say might have been even more shocking than some of the S-MIX scores, was suicide. Something like 40% of the unattended deaths were suicides. That's just so strange to me. I would not have expected that at all, given that someone signed up for cryonics has to be aware that they have a specific goal in mind, to get their body to these cryo orgs. You know something has to have gone really wrong in their lives to be in such a bad [state] where they want to commit suicide in the first place. But also [baffling is] not to have either the faculties or the willpower or any number of contributing factors to actually figure out if that would get them a good or bad cryopreservation. So, quickly, what are some of the overall general findings on the members that did commit suicide and how that affected their cryopreservations?

MB: What do you mean, findings in terms of what?

DW: I guess my assumption is they got very bad cryopreservations, because of the suicide. I have a small picture of one of your charts. Some of the highest S-MIX scores, so the worst outcomes, were suicides. Could you tell us anything about the general demographics of people who are committing suicide, the younger, older, male, female, I guess anything you can let me know.

MB: It varies. We have one case of a gentleman in his 80s and one case, somebody in his 20s, so, I think you just see the similar demographics as you would [for] the general population. You know, it was interesting, I was listening to your podcast with Emil [Kendziorra, head of Tomorrow Bio], and I think Max you brought this up about there seems to be this algorithm that as you get older, you just don't care about living longer anymore. Perhaps the suicide thing is a malfunction of that same algorithm.

MM: Yeah, whatever system keeps us going seems to degrade just like everything else is degrading.

MB: Or some shock to the system kicks in that algorithm.

DW: And is it true that the suicides also increase the risk of autopsy?

MB: Yes, it's a requirement in most places.

DW: Oh wow. OK.

MB: Even unattended deaths, it's a requirement to do an autopsy.

DW: Oh. OK. So just [for] a general undecided death, they're required to do an autopsy, even if they're reading the bracelet and calling Alcor. What about being unattended specifically triggers these autopsies?

MB: Because nobody was there to see the death, and they don't know if somebody was in the house or whatever, and killed the person somehow in some difficult to detect way or what have you. Alcor does do a lot of work in terms of trying to mitigate autopsies in these types of cases, whether it's minimizing the autopsy, not slicing up the brain, just doing a CAT scan, it depends on the case. It depends on the medical examiner, it depends on a lot of different factors as to whether or not they're able to mitigate an autopsy. One of the rules is preserve the brain, preserve the brain, preserve the brain. So the thing that they're generally most interested in is not having the brain sliced up. But even when that does happen, I think it depends on when the contract was written, some of the contracts say, even if that happens, preserve whatever brain material you have. But Alcor does [what they can]. They bring in the lawyers, they get involved in the courts right away as quick as they can. They do a lot to try to mitigate autopsies.

MM: I want to ask you a question here on the issue of suicide. [For] these suicide cases, did they count people who were home alone or in the hospital, were in pain, and just kept pressing the morphine button too many times, or are these real, you know, the person just couldn't stand it anymore and took a shotgun and [used that]? Are they different?

MB: Yeah.

MM: [The] real suicides, [are] not accidental [as in] I pressed the morphine button,

MB: sneakily, I guess you want to call it.

DW: OK, and not to be morbid, but Max, that actually is what prompts me to [ask] does the data show how they committed suicide?

MB: Yeah.

DW: OK, and I actually don't know the general statistics on suicide and how most people do it, but I'm only asking to try to put myself in the mind of a cryonicist who's doing this. Are they doing this with some thought as to how it will affect their cryopreservation?

MB: I don't think so. I don't think there's any concern about that.

DW: OK. So at this point, when they're committing suicide, cryonics is not even in their mind probably. Are any of them calling Alcor beforehand?

MB: Yeah. There's not that many cases here, so I'm careful to discuss details, because you might be able to pick out who this might have been. But there's cases where one individual spent months talking to people at Alcor and they tried to talk this individual out of it and give all the reasons why this person shouldn't do it and it ended up happening anyway. And then there's cases like you said where somebody just picks up the gun and that's the end. So, you know, it's all over the place.

DW: Yeah. It seems to some extent loneliness is a huge factor in a good cryopreservation for a good portion of these, both the unattended part and the suicide.

MB: Yeah, it's hard to know why somebody commits suicide. Is it an organic problem in the brain? It's hard to tell.

DW: Sorry, I've depressed myself with this conversation [chuckles]. [Going on, with 40% of the unattended home alone being suicide, it leaves] 10% [who passed] during sleep. I don't know if there's anything interesting to discuss with people dying in their sleep. It's kind of the same issue with needing proper monitoring.

[But, going on,] what would you recommend knowing what you know now to not just Alcor but any [cryonics services organizations], what should they be doing differently and why?

MB: It's a difficult question to answer because each organization has in some cases very different procedures and very different services they offer, or level of service that they offer. For a place like Alcor, and I suspect Tomorrow Biostasis, [they should] really mitigate that human factor issue, whether it's procedures being done properly and thoroughly, or interaction with hospitals, or having connections with doctors who are friendly to cryonics, in any particular area. Just to bring up Biostasis Technologies real quick 'cause I think it's pertinent here: The idea behind BT is to create a standards organization to create standards for SST – standby, stabilization, and transport. But the other idea is to have local organizations do cases only in their areas. And by doing that, they're creating relationships with local hospitals, local doctors, local medical examiners. So this is one of the attempts to mitigate the things that we're talking about by having local organizations with all these connections to smooth that entire process by having all the connections in place, on top of doing the procedures right and thoroughly.

DW: Now, you had mentioned Biostasis Technologies and I want to get into that, but before we do, Max, did you have any further thoughts?

MM: Yeah, I was wondering, I know that the database, and the S-MIX scores that you've put together for all these cases, were obviously just Alcor's data. But is there any chance that, CI [the Cryonics Institute, in Clinton Township, Michigan] would be willing to share any of their data or their historical findings or such? It might just be useful to have more to look at, more data points to understand better what actually is going right or wrong.

MB: Yeah, with CI I don't know. I haven't been involved in any discussions even if there have been any. Aschwin would be the person to ask that question. I know that there have been discussions with Tomorrow Biostasis along those lines, but I'm not familiar with the outcomes yet.

MM: Yeah, hopefully there can be at least one database encompassing as much of the data as possible and Tomorrow Biostasis has the benefit of it.

MB: I imagine they would.

MM: And hopefully, CI also decides to partake in that. That would be very helpful for the for the whole industry. So it could either be some kind of [setting] where all the different cryo organizations are cooperating or it could be some third party, maybe something like a Biostasis Technologies that helps coordinate this mechanism to put these things together.

MB: Right, yeah.

MM: So, are you still fully involved and engaged in putting this together, or are there other individuals within Biostasis Technologies or outside of it – is there anybody else involved in this, putting the database together, doing the meta-analysis – ?

MB: That's pretty much been my purview, more than anybody else, and obviously Aschwin has had quite a bit of input to that.

MM: OK, and you're still the one doing this going forward as well.

MB: Yeah.

MM: Got it. So Daniel, you want to jump into BT?

DW: OK. So I want to talk a decent amount about this new organization, Biostasis Technologies,.the new kid on the block. So first, what exactly is it? Who's working on it, who started it? And then I have a few more follow-ups from there.

MB: So, there's a bunch of people involved. I'm trying to decide where to start. I don't know much of the history of all the other organizations. In terms of that history, Aschwin or somebody else would be better equipped than I am to go through that. Obviously Aschwin was a big proponent of this, and people like Ben Best and Houston Westfall, and a handful of other people. Carrie Radomsky is on the board of BT.

[As for the] lack of improvement: I think the people that have been directly involved for a long time were not entirely surprised by this result. I mean, it's still a shocking result no matter who's looking at it in terms of whether there's been improvement. But I think as people thought about it, particularly the people that have been involved for quite some time, [opinions emerged like] here's where I think the holes were that caused this problem, based on my experience doing this. And I think that's the group of people who have come together to put

together Biostasis Technologies. And the idea is not to just try to reinvent the wheel and just create another SST organization, there's another organization that's doing that. But [instead it was] to create an organization that creates standards across the industry, that whatever organization comes up can can look at, and say, OK, this was researched, this was studied. And these are the results they came up with in terms of whether it's equipment to use, quality of equipment, procedures to do. That's sort of the idea behind biostasis technologies – to create these standards for people to follow. And again, like I said earlier, that's part of the problem. Then you've got to have the people implementing it properly and that's where training comes in. BT intends to do this training as well, for SST organizations as they come up. That's the other big piece of it.

DW: So you're gonna be both doing this work in SST alongside being kind of an open source hub to some extent. I don't know if that's a fair analogy.

MB: Yeah, that's an interesting way to look at it. It's like an IEEE of cryonics, right? Where you're setting standards for certain things, but at the same time, an organization like IEEE does the trainings as well, right? So it's sort of modeled after these other organizations that create standards for different industries.

MM: And are you gonna do certifications too?

MB: Yeah, training and potential certifications. That's all being formed now, that's what the plans are.

DW: Who's funding the project or the company?

MB: BRLS [Biomedical Research and Longevity Society].

DW: I believe that's Bill Falloon, with Ben Best part of that as well. What would you say are some of the major projects you're working on at the moment in biostasis technologies?

MB: There's about 7 or 8 things that we're looking at right now.

Liquid ventilation: Charles Platt has been looking at that.

We're looking at different dry shippers for brain only cases, what dry shippers are the best. We actually bought a dry shipper and we're gonna be shipping some equivalent of brain material, whether it's a piece of meat or what have you, ship it across country, keep temperature recording while it's being shipped, do all the studying of how good these particular dry shippers are.

Comparing mechanical CPR devices: We have two right now that we've compared, the LUCAS and the Corpuls, evaluating [them] for how long [they] can operate, battery times, how difficult to operate. So we've been working on that.

Air transportable perfusion circuits: That's one of the things we plan on looking at.

Training protocols which I mentioned.

Ice bath design: we now have 3 different versions of ice baths, the last two that Charles Platt has put together. We actually have those in our facility in Long Island City right now, the two that Charles built and a rescue vehicle that we have.

Overall rescue vehicle equipment, fabrication and integration: we have a vehicle that Alcor had given us, that we're using as sort of a sandbox, to put together the best equipment in a vehicle that we can, maybe create a standard out of that. We're also looking at not just that vehicle, we're looking at all other different vehicles like a Ford Transit or a Mercedes Sprinter. How do we look at different vehicles like that and build rescue vehicles from those?

[We] also plan on looking at whole body field cryoprotection protocols. Aschwin would be probably the main person to talk to about that. But these are the types of things that BT is going to study and put some standards [for] out there.

DW: OK, and how far are you along the road to being fully up and running, or are you fully up and running?

MB: No, we really got started in October [2022] as an organization. I mean, things were being done before that, but we had to get the facility which we got in November, and we've been sort of gearing up the facility, [a] combination of things, getting the facility ready to operate, getting the equipment to do some of this testing and doing some. So, I think we're at the beginning in terms of starting the test equipment, and, by the end of this, probably in the next two months, the facility will be up and running with everything set up to do all the things that we want to get done. And then I say by the end of the year, we'll probably have some results on some of the testing and then start to write protocols and standards. We also have somebody working on training materials as we speak, so there's a bunch of things going on right now, but still, mid end of wrap-up stage.

DW: OK, and how long do you foresee until you're offering full-fledged SST services? It's a hard question.

MB: BT is not gonna offer SST services. That's not the idea behind BT. Resurgence Biomedical Sciences, which Houston Westfall is working on down in Florida – they're gonna be an SST organization, so they're gonna be local to the Florida market. And we're looking at getting one started up in New York as well. We don't know the incarnation of that yet, whether it's connected to Resurgence Biomedical or gonna be a separate entity, and who's gonna do that. So we're putting all those pieces together now for an SST organization in New York as well.

DW: And, could I ask, Tomorrow Biostasis has discussed a little about having some services eventually in New York and Florida. Are these at all connected?

MB: It's all connected.

DW: OK. And I don't know if there's anything you can say at the moment about that relationship.

MB: I haven't been directly involved in all the discussions. That would be an Aschwin question.

MM: We've had both Aaron Drake and Eric Vogt [both of International Cryomedicine Experts, ICE] on the show and both of them are fantastic. They know their stuff really well. In the past, historically, right, SST has been [implemented remotely] as long as you're not actually only miles away or whatever from the facility. It's [otherwise] been [necessary to send] out ICE or SA [Suspended Animation, Inc.] to the patient's bedside. So, do you foresee that in the future there will be maybe a handful of these very localized SST organizations in very specific markets and then everybody else is still gonna be served by something like ICE or SA?

MB: Well, that depends on where these organizations are, right? I don't know the answer to that question yet. I imagine, for the more rural areas, there's still gonna be the need to go out and travel to get to a case. Is there gonna be an ICE or an SA that does that, based in California or wherever, and they're gonna run out to, you know, the middle of Missouri to do a case, or is there gonna be an organization in Saint Louis that can drive 2 or 3 hours to rural Missouri, and do the case themselves? I think all that sort of thing is gonna depend on where these local organizations are, and how many resources do they have. Does the local organization have enough vehicles in case there's a second case in the more local area versus the more distant area. I think it's gonna be on a case-by-case basis. I think, for the near future, and maybe even in the mid future, there's still gonna be some need for travel, by ICE or whoever.

MM: I feel like there's two major factors here. One is, of course, the proximity and how quickly these teams can potentially get to a patient and all this. But the other is that there are just so few cases in a given year. If we had a team here in say Austin, Texas, we might – I don't know the numbers of course, but even when you add up CI and Alcor – we're gonna get maybe one case per year and I guess if they're serving all of Texas, maybe a couple of cases in a year. Maybe it's higher in New York, or obviously, in the Bay Area, or in South Florida or such, but it seems like there's just not enough. You've done a lot of [study] of what it really takes to get a team to be well honed and know their procedures and have their logistics ready and [so on] and a lot of it is just practice, right? So, if one of these groups are doing a case once a year or a couple of times a year or once every other year, that to me might be more dangerous than a team that would get there even 1 hour or 2 hours later than that [other] group but they've at least done numerous cases in a given year and they know what they're doing a lot better. How do you think of these competing problems?

MB: This has been discussed more in the guise of Resurgence Biomedical, and Houston would be the person to talk to more about this, but all these topics have been discussed and some mitigations have been discussed. The model of the businesses of an SST organization itself, how do you sustain it? How do you sustain it when you have so few cases, and what you're mentioning makes that question even more challenging, right? Because it's just local cases. You know, just briefly, one of the ideas that Resurgence is working on is to not just have an SST organization, but to actually have a medical practice attached to the SST organization. And that serves a number of purposes. I can't talk much about it because I've not been directly involved in the details of it, but there's that piece of it to keep the medical personnel trained. Then there have also been discussions and, nothing set in stone yet, of sending people from one area to another where there's a case to have them be involved. Now they may not get there in the very beginning [unless] there's a standby, [but they'll] cross-train across locations. So that's been in discussion as well, to try and mitigate that.

MM: To have them get there and shadow the people who are [already on site].

MB: Yep. So they've been thinking about all these things.

MM: Yeah, it seems like a lot of things might change in the next few years as these things roll out, hopefully for the best. So, does Biostasis Technologies – and everything you've described has to do with procedures, logistics, the science and technology of this, the medicine – do they have any kind of outreach arm, or is that part of their mission?

MB: Yeah, so, as you know, we hired Max More to be our communications director, and we have a substack out there, that they've been writing articles about, and there's a monthly newsletter there. I think the first [issue] just came out in May. They're working on how to grow that and how to bring cryonics or I'll call it biostasis to the masses, so to speak. So that is one of the goals of that wing of things.

MM: So when you say the goals, is it to function as a kind of a marketing arm of the cryonics industry as a whole, or is it just to better communicate with scientists and technologists in the field, or, how would you describe that?

MB: I would say that part of it is the – I know I use the word marketing – but I guess that's what it is, marketing to the masses, the idea of biostasis and cryonics and bring[ing] more people into it, and the next generation.

DW: I don't mean to be skeptical here, but isn't that two separate missions completely, in terms of marketing to the masses, and what you're trying to do?

MB: Well, that's why I was hesitant to use the word *marketing*. We're trying to be advocates for cryonics and biostasis, and *advocates* is probably a better word.

MM: And are there any metrics that you guys are gonna try and use to determine how well that's going? Because, when you're in an organization like Tomorrow Biostasis, they can come up with a new plan, "hey, let's put out more YouTube content, and then we're gonna track people that are in this particular demographic." Then they can track over time. [Then suppose] they're getting people calling them up or sending them emails, and [the others] say, "hey, where did you first hear about us?" And they say, "oh, these YouTube videos that you guys are producing, and they're great." And that gives them some feedback as to whether or not what they're doing is useful. Do you guys have

any sense of what mechanisms you might have for that kind of feedback?

MB: Yeah, they're working it out now. Max has been on board since March, so they're working on all these things now.

MM: Cool. Yeah, I saw the substack you guys have. Is it a paid substack?

MB: There's unpaid and paid. You have a choice.

MM: Are you gating any of the articles behind that paywall or –

MB: I'm not sure what they've done yet. I think they've played a little bit with that, but they're in the process of putting a plan together for that.

DW: And would that be the place where people should be able to keep up to date with biostasis technologies as a company as well?

MB: Yeah, the monthly newsletter comes out on that substack.

DW: OK, we'll put a link in the show notes.

MM: So now we'd like to wrap up these conversations with an "overrated or underrated" segment. Do you believe that the things we're gonna mention, are they overrated or underrated or maybe appropriately rated? You were talking about this earlier, so the first one is NASA's organizational culture. People say that it's very bureaucratic, it's very slow, it doesn't learn well, it has a lot of these problems. So NASA's organizational culture, is it overrated, underrated, or are things a lot better than people think they are or what's your experience?

MB: I would say, in general, in the space industry, whether it's NASA or commercial or other government space areas, I think there's been a great deal of improvement in the last 15 or so years. So I would think, from what I hear in the industry now for at least the more government-related programs, things are rated as they should be. [As for] commercial, I think a lot of it, not all of it, but a lot of it is still being run with a startup mentality. So, yes, they're gonna do all these great things, and commercial is the way to go, and commercial is gonna be the future, and I agree with that. But I think, aside from maybe, SpaceX and Blue Origin [which] are obviously way ahead of most of the other smaller companies, the majority of the industry, aside from those two, are probably a little bit overrated as to where they are. I think they all have the potential to get to where SpaceX or Blue Origin is. But, from what I've seen, I think that embracing some of the stuff I talked about before in terms of procedure and process improvement and that sort of thing, as well as improvement of the technology, is gonna be the key to their success. So I think commercially, the majority of the industry is a little bit overrated, SpaceX and and Blue Origin I think are where they should be, and government is rated as they should be.

MM: So there's a lot of money chasing that SpaceX and Blue Origin kind of unicorn – and hoping that a lot of these other, smaller players will morph into that.

MB: Become these unicorns.

DW: And, just a follow up on that question, personally speaking, what do you consider the most exciting projects going on in the space industry generally?

MB: The Artemis Program – the moon program. Landing people on the moon and creating colonies on the moon.

DW: Ah, gotcha.

MB: We're gonna do that one long before we do that on Mars, I think.

MM: It seems to me like a great idea. I mean, it's right there, you know.

MB: I was just gonna say just because of proximity.

MM: Yeah, seems like a great jumping off point to then be able to use for other space projects in the future.

MB: NASA just awarded Blue Origin some of the landing contracts for some of the astronauts for the moon colony.

DW: While we're on the topic, what do you think of cryonics on the moon?

MB: Well, you know, cryonics for space travel in general, right? How do you travel to the Andromeda Galaxy? I think we've got a long way before we get there just like we do here.

MM: Yeah, I think we'll hopefully perfect the technology in the best of circumstances here on Earth and then consider its applications elsewhere.

DW: So another "overrated, underrated": you had mentioned your grandson has epilepsy, you told me that, and you support a couple of epilepsy related charities or organizations. So I'd like to know a little bit more about that but first, overrated or underrated, standard epileptic treatments versus I guess any that are less mainstream.

MB: You know, there's always the standard stuff in medicine. When it comes to the less mainstream, it's diet, it's exercise, it's this, that and the other thing. I haven't seen anything with

epilepsy as of yet in my travels and research, in terms of anything outside the normal medical industry box to treat it. I have seen lots of that with scleroderma and other autoimmune [disorders], but not as much with epilepsy. So I think natural medicine or whatever you want to call it, for epilepsy, anything that's out there is probably overrated.

DW: Yeah, I had kept on hearing one thing specific[ally], and at this point I couldn't actually tell if it was mainstream or not.

MB: Keto diet?

DW: Yeah, keto specifically for epilepsy, which from what I understand was a thing well before it became a kind of a fad diet for the general public. It was specifically useful in epilepsy, although a very extreme version [of this diet] that a normal person would not fare well on.

MB: Right, which has its own problems. That's why I still say "overrated." I include the keto in that.

MM: So, a final "overrated and underrated," and this can call upon a lot of the stuff we were talking about earlier in this discussion with the research that you've done into a lot of these cases. But, overrated or underrated, relocating to be near to the CSO at the end of life.

MB: Underrated, I think everybody should be doing that. It's underrated in the sense that people don't take that seriously enough.

MM: Yeah, they're undervaluing it. At what stage should people be taking that [step], just bite the bullet, pack your bags, and get out there? Should they wait for a diagnosis of late stage cancer? Or early stage, at what point should a person be taking the option very seriously?

MB: If it was me, I think the key factor would be how difficult is travel. Can I hop on a plane and get to say, Scottsdale with little to no difficulty, whether I have 2 weeks to live or 2 months to live or what have you? If it was me, I would like to be out there within a month or two of when I'm expected to deanimate. But, you know, it's hard. I mean, there's a lot of factors in that as to whether people can afford that, and what have you, how are the local organizations, I mean, that's changing over time and hopefully improving, local SST organizations. We'll see where that goes, but I think as of now, get as close as you can as soon as you can.

MM: So if a person is still ambulatory and is feeling OK, but they have a 6 month diagnosis, and they're officially in hospice care, and they have some pain but they're still able to move around, you would say that at that point, pack, that's the optimal time, do it now.

MB: At least start thinking about it at that point. Don't let it get to the point where you're incapacitated. Probably, again, if it was me, if I started to become incapacitated, if I was at the beginning of a downward slope that I noticed physically, I would get up and go. If there was no SST organizations, and I said to myself, yeah, they can get here, no problem, get me there, no problem. If I knew that there would be a jet waiting to take me, I wouldn't have to sit on the tarmac for two hours in a Ziegler case, you know.

DW: Yeah, and just a quick [public service announcement] on that, I believe, unless something's changed, for Alcor members they provide like a $10,000 relocation fee, at the end of life. I hope I'm not mistaken, but I believe that was the case.

MB: I don't think that's changed. I think that's accurate.

MM: Cool. Well, that will wrap it up there Michael, is there anything else you want to let listeners know about or refer them to here, at the end of our conversation?

MB: Just keep an eye on BT. If you can share the Biostasis Technology website as well, that'd be great, and check out the substack, sign up [for it].

MM: Cool, yeah, all links to that will be over in the description, so be sure to check those out. Sign up for the substack, follow what everybody's doing, and this has been wonderful. Michael Benjamin, thank you very much for joining us here on the Cryonics Underground.

MB: And thank you for having me.

DW: Thanks Michael.

MM: All right, and Michael Benjamin has left our virtual studio. And as folks can probably tell, at least those who are watching on video, we have magically transported to a different place, in fact, to a different time. It's a few days after what happened. Daniel, you look like you've lost 10 pounds, and I look like I'm on a boat somewhere in the Arctic Ocean, because in fact, I am. At any rate, we just went back through everything we recorded some days ago and had some closing thoughts on the conversation. Daniel, do you want to kick us off?

DW: Yeah, absolutely. So, first off, I want to thank Alcor for actually commissioning this project in the first place. I think it's to their credit that they're going out of their way to actually analyze the effectiveness of these procedures, despite what I imagine were probably some concerns about the "optics" of doing this, because, you know, [there's] always the risk of it not turning out to be particularly flattering. While I can't say I wasn't disappointed with the findings, I still think I have to acknowledge that cryonics is an experiment and that these kinds of road bumps need to be expected. My hope is though that people will view this as a catalyst for positive change. I know some are just gonna like complain about the findings and say it's evidence of things not going well. But I would really like to stress that this perspective isn't really useful or productive towards the general discourse in cryonics, nor the improvement of cryonics. It's pretty unwise to punish an organization for prioritizing introspection and self-improvement, and, personally, I'm looking forward to even more analysis of the data and whatever future changes will be implemented because of the data. So I hope others will follow my lead. In any case, what are your thoughts, Max?

MM: Yeah, I would echo a lot of that, and I would say that the only way that any cryonics related organization can learn is by studying what has already been done and figuring out where they could improve. If not, how does one get better at these sorts of things? So, I'm glad that this is finally being done, and it's being done in a systematic way and in a careful way. And by somebody as good at this as Michael Benjamin, whom Daniel and I have both met in person, now more than once, and, at least for me, I can say he's not just an incredibly brilliant mind and a dedicated individual, but he's just also a really good person, just somebody you want to spend time with. That's important to me as well, and I think to many people in the industry. So, I know that Michael felt that the S-MIX captured everything or almost everything that's relevant to actual ischemic damage rather than just ischemic exposure. But I still believe that in the future we're gonna come up with some better way to actually analyze how much ischemic damage was done directly rather than using these indirect correlates of ischemic damage. I think that'll be good when we get there. But we're not there yet, and for now, this seems to be a pretty good measure. Along with everything else we discussed, of course. And yeah, with all this work, hopefully we'll get to a better place, better cryopreservations, higher quality cryopreservations in the years to come, and the kinds of trends that we saw being discussed will be a thing of the past and we'll switch that to a to a positive curve there. As always, we will include links down below, including to the original paper on the S-MIX scores and a few other things of note. Until next time, this has been the Cryonics Underground podcast, and we will see you all on the next one. Farewell for now.

THE END

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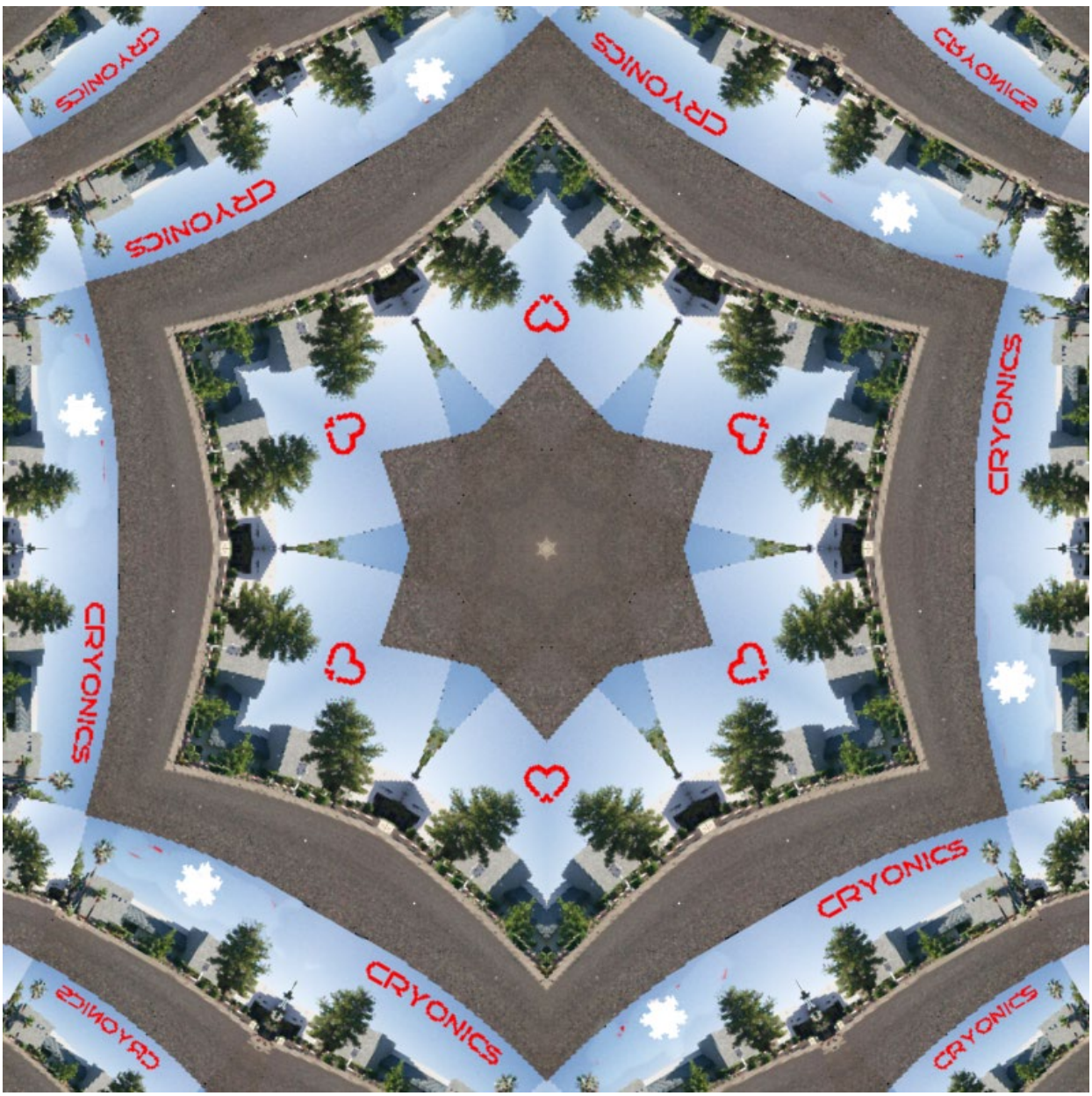


Start preparing your

MEMORY BOX ...now!

Start your own time-capsule!

Create a Memory Box with items to augment your memories when you are resuscitated.

No one knows better than you what you will want to have with you.

Alcor makes available to every member and patient, without charge, one acid free Memory Box about the size of a standard banker's box (H10" x W12" x L15") for memorabilia to be stored underground at a commercial storage site called Underground Vaults and Storage (UV&S) in Kansas. Additional Boxes are a one-time charge of $250 each for perpetual storage.

Some of the most popular items that have been placed into storage are such things as letters, cards, photographs, diaries, journals, notebooks, books, clippings, army records, directories, recipes, video tapes, cassettes, medical records, flash drives, and external drives.

If you would like to begin working on your own Memory Box, or perhaps contribute items to a Box for an Alcor Member already in stasis, or if you have any questions, please contact **Ashley Bettini at ashley.bettini@alcr.org**.

Asset Preservation Trusts for Alcor Members

Would you like to have access to your assets when you are revived?

Would you like to talk to someone who understands cryonics as well as trusts and estate planning?

There are two unique revival trusts that have been developed to help accomplish those goals. The Asset Preservation Trust is an individual trust for Members who can place a minimum of $500,000 into it, and the pooled Multi-Investor Future Income Trust (MIFIT), which requires a minimum investment of $25,000.

Want to learn more? Contact Linda Chamberlain at linda.chamberlain@alcor.org

Management and Preparation for the New Normal, Scaling for Simultaneous Cases

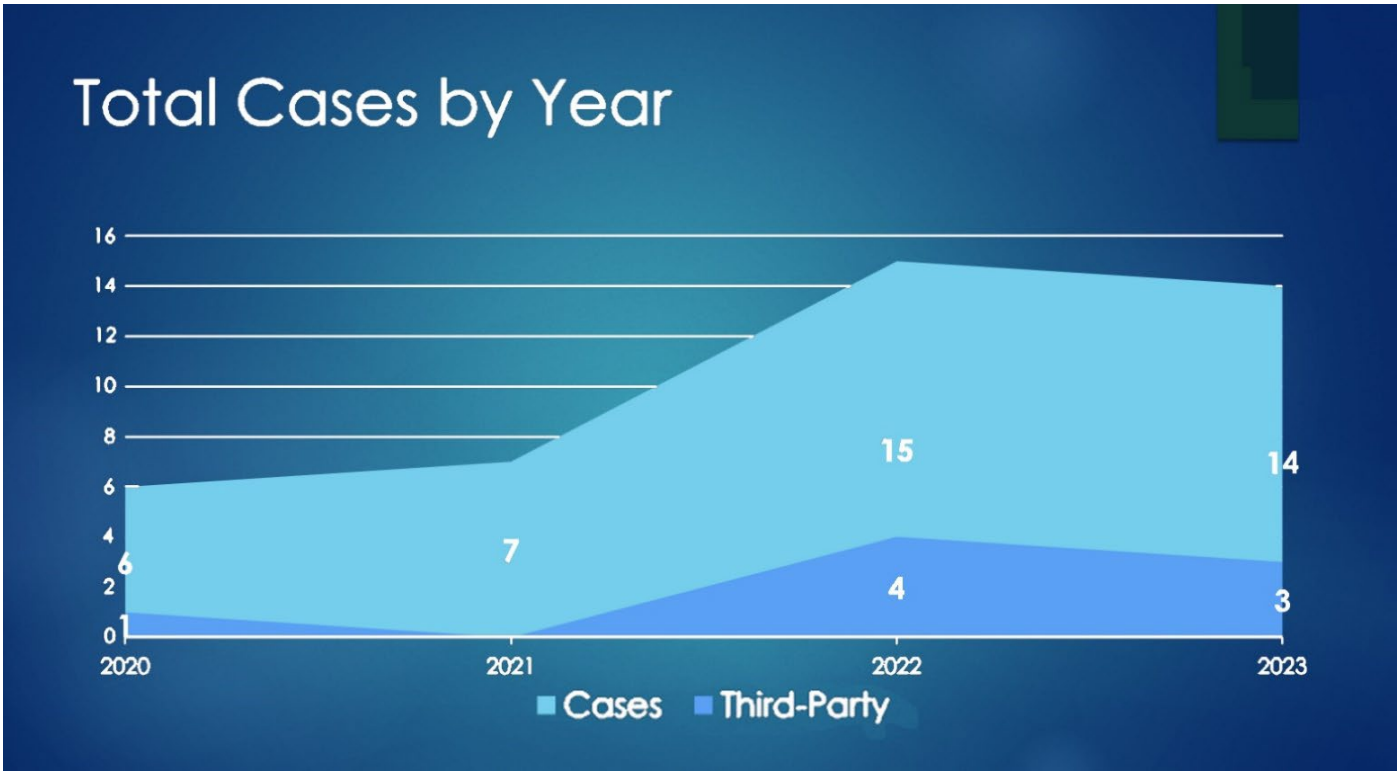
SARAH KELLY, CNP, NREMT, MSC
DIRECTOR OF DEVELOPMENT

This presentation was given at Alcor's conference in Estes Park, Colorado, Aug. 26, 2023.

Introduction

- Case volume
- Response
- Partnerships
- Optimization
- Scaling

I will be giving a summary of case volume and our response to the changes in volume through partnership, optimization, and scaling.



We had 6 cases in 2020 and 7 cases in 2021. The beginning of 2022 seemed like it would be the same – until June. I don't know how many people have been checking for case announcement updates, but if you have, we have been updating it a lot more frequently. We had 12 cases from June to December. There was a total of 15 Last year, breaking the previous record of 14 in 2014. Now, we are on track for another record-breaking year. So far, we have already completed 14 cases. A two-year trend is a small sample, but the current projections support a continued increase in the number of cases.

We have also seen an increase in the number of last-minute or third-party enrollment cases. These have not historically been in the case projection models and are harder to predict because demographic data is not available ahead of time and will be in addition to membership projections. Scaling our capabilities has been an ongoing project, the volume of cases in the last year was motivation to expedite an expansion of response capability.

We have created and maintained relationships with funeral homes in high membership density locations. This has been a focus for the past several years and it is still a high priority. We are continuing to keep track of locations that we have partnered with in the past and can rely on in the future. Select funeral homes in high density areas have proven invaluable this year as they have helped us successfully navigate new and complicated hurdles without jeopardizing the quality of cryopreservation or the outcome of the case. Additionally, we are expanding our direct supplier partnerships. Earlier this year, I was able to attend an international medical expo where we solidified relationships with medical manufacturers that we will be working with directly. This has opened doors to products that need less alteration to be ready for deployment in the field and reduces costs.

With these partnerships, we will be able to eliminate some sourcing bottlenecks for critical equipment as we move through optimization and scaling. We will be able to expand our inventory of equipment as needed going forward.

A lot of time goes into building kit components, mixing perfusate, and ensuring that all equipment is available and ready to be deployed. There are many items in our response kits that we custom build or alter for our specific purposes. This year we have been working to optimize items in the kits to minimize the amount of preparation that is needed in the field. Our goal is to reduce the number of steps needed for field teams during deployment and maximize the value from our current resources.

Some improvements to the packaging of the medication kit has been implemented this year. These changes have reduced prep time in the field by more than 50% so administration can happen as quickly as possible when needed most. It will also increase the shelf life of certain medications and reduce overall waste. Additionally, fewer administration supplies are needed which frees up critically limited space for other vital equipment. With these improvements, stabilization can be completed faster when there is an emergency and every second counts. The preparation steps can be shifted to bulk processes at Alcor, which streamlines each individual process and saves time overall. To respond to the doubling of the caseload, changes that we have made overtime to increase production have been put to the test. For some background information, in 2020, we built up our response capabilities with our contractors so we can perform field neuro cryopreservation where we can start perfusion in the field. This reduces delays in preservation due to transport requirements and enables us to do the entire perfusion protocol and begin the cooldown on location. This improves times significantly, but it can use more perfusate than cases in the operating room may use.

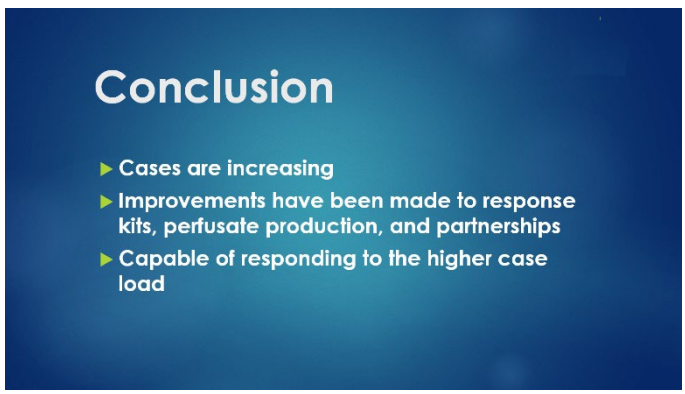
Each case uses a 'set' of perfusate, which includes different concentrations of cryoprotectant to build up to full concentration perfusion. It took a lot of time to make deployment ready perfusate sets. It could take 10 hours, which is an entire day, to make two thirds of a set for deployment. That amount of time investment is not sustainable with higher case volumes.

New processes have been developed for perfusate packaging to make a finished product that is deployed in the field. This can now be done in less than 10% of the time it took previously. With these improvements, multiple sets can be made in a single day or a series of two days if making up to 8 at once. This saves valuable time for staff to work on other critical projects and reduces turnaround time needed between cases.

We maintained three kits which can be used back-to-back on cases while the others are getting reset. This year alone, we have doubled our response capability through doubling the number of kits that we have prepared and are ready to deploy. This will enable response to more cases and ensure that back-to-back or simultaneous cases are possible with no delays.

We can order in bulk through our newly formed manufacturing partnerships. This saves time by reducing the total number of orders and can help reduce some costs. We have increased the minimum quantity thresholds to ensure that we can responsibly maintain supply levels for restocking and future increases in case volume. Production of in-house batched medications has also been increased to meet demand and plans for future scaling have been developed.

We have developed processes that expedite perfusate manufacturing, increasing our production by 5 times. This new process cuts down significantly on prep time, production time, and reduces the disposables used in the process. Coupled with the improved time for deployment ready perfusate for field neuro preservation, we can now make these in bulk and be prepared for significantly higher case volume. Restocking after cases is now significantly faster and we can plan for case use much farther into the future. If there is a large increase in cases, this process can be easily scaled up even more with minimal new equipment. There are more upgrades that are in the works for improving the perfusate batching processes which will significantly improve the scale of production and minimize human error. Scaling will continue to be a focus next year and many projects are in the works for future improvements.



In conclusion, we are experiencing cases more frequently. We have made improvements in the optimization of response kits,

scaling of perfusate production, and have made more beneficial partnerships.

Our improvements have already been put to the test and have shown positive results. During this year, there were three separate occasions where Alcor was deployed on two cases at one time. We have the resources to respond to the increase in demand for cryonics services and we look forward to continued expansion of our capabilities as we rise to the challenge. There are many more exciting things in the works so keep an eye out for future updates.

Dual-radionuclide in vivo imaging of micro-metastasis and lymph tract with submillimetre resolution

Atsushi Yagishita, Shin'ichiro Takeda, Kazunobu Ohnuki, Miho Katsuragawa, Oltea Sampetrean, Hirofumi Fujii, Tadayuki Takahashi

Scientific Reports **13**, 19464 (09 Nov. 2023), https://doi.org/10.1038/s41598-023-46907-1

Abstract

Multi-radionuclide in vivo imaging with submillimetre resolution can be a potent tool for biomedical research. While high-resolution radionuclide imaging faces challenges in sensitivity, multi-radionuclide imaging encounters difficulty due to radiation contamination, stemming from crosstalk between radionuclides and Compton scattering. Addressing these challenges simultaneously is imperative for multi-radionuclide high-resolution imaging. To tackle this, we developed a high-spatial-resolution and high-energy-resolution small animal single-photon emission computed tomography (SPECT) scanner, named CdTe-DSD SPECT-I. We first assessed the feasibility of multi-tracer SPECT imaging of submillimetre targets. Using the CdTe-DSD SPECT-I, we performed SPECT imaging of submillimetre zeolite spheres absorbed with $^{125}I^-$ and subsequently imaged ^{125}I-accumulated spheroids of 200–400 μm in size within an hour, achieving clear and quantitative images. Furthermore, dual-radionuclide phantom imaging revealed a distinct image of the submillimetre sphere absorbed with $^{125}I^-$ immersed in a ^{99m}Tc-pertechnetate solution, and provided a fair quantification of each radionuclide. Lastly, in vivo imaging was conducted on a cancer-bearing mouse with lymph node micro-metastasis using dual-tracers. The results displayed dual-tracer images of lymph tract by ^{99m}Tc-phytic acid and the submillimetre metastatic lesion by $^{125}I^-$, shown to align with the immunofluorescence image.

From: Development of tissue molecular imaging technique using multiple probes at hundreds of microns

Kavli IPMU, 27 Dec. 2023, https://phys.org/news/2023-12-tissue-molecular-imaging-technique-multiple.html, accessed 03 Jan. 2024.

Researchers have shown it is possible to image small animal tissue clearly to several hundred micrometers using multi-probe imaging, reports a recent study in *Scientific Reports*.

This technique could be useful in various fields of medical research because it enables researchers to observe the microstructure of small animal tissues and clarify the localization and interaction of multiple molecules such as microscopic metastatic lesions of cancer cells.

Single-photon emission tomography (SPECT) is currently used for molecular imaging in both animals and humans. However, the technology faces several limitations, including relatively low spatial resolution and challenges associated with the simultaneous use of multiple probes. A team of researchers, led by Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU) Project, resolved these problems using a SPECT system equipped with a cadmium telluride (CdTe) semiconductor detector that was previously used for space observations.

Then, the team performed in vivo imaging on a cancer-bearing mouse with lymph node micro-metastasis using dual-tracers. The results displayed dual-tracer images of lymph tract by 99mTc-phytic acid and the submillimeter metastatic lesion by 125I-, shown to align with the immunofluorescence image.

The longevity bottleneck hypothesis: Could dinosaurs have shaped ageing in present-day mammals?

João Pedro de Magalhães, *BioEssays*, 28 Nov. 2923, https://onlinelibrary.wiley.com/doi/10.1002/bies.202300098.

Abstract

The evolution and biodiversity of ageing have long fascinated scientists and the public alike. While mammals, including long-lived species such as humans, show a marked ageing process, some species of reptiles and amphibians exhibit very slow and even the absence of ageing phenotypes. How can reptiles and other vertebrates age slower than mammals? Herein, I propose that evolving during the rule of the dinosaurs left a lasting legacy in mammals. For over 100 million years when dinosaurs were the dominant predators, mammals were generally small, nocturnal, and short-lived. My hypothesis is that such a long evolutionary pressure on early mammals for rapid reproduction led to the loss or inactivation of genes and pathways associated with long life. I call this the 'longevity bottleneck hypothesis', which is further supported by the absence in mammals of regenerative traits. Although mammals, such as humans, can evolve long lifespans, they do so under constraints dating to the dinosaur era.

From: Dinosaurs may be reason why humans age fast, study finds

Vishwam Sankaran, *Independent*, 06 Jan. 2024, https://www.independent.co.uk/news/science/dinosaurs-human-ageing-fast-b2474281.html, accessed 10 Jan. 2024.

Human ageing and lifespan are likely influenced by millions of years of domination by dinosaurs, a new theory suggests. While some reptiles and amphibians do not show any significant signs

of ageing before they die, all mammals – including humans – show marked developments in their appearance as they get older. A new theory, dubbed the "longevity bottleneck hypothesis," suggests mammals faced persistent pressure for rapid reproduction during the era of dinosaurs.

Over 100 million years, this likely led to the inactivation or loss of genes linked to long life playing roles in tissue regeneration and DNA repair, according to the study published in the journal BioEssays. "While humans are among the longest-living animals, there are many reptiles and other animals that have a much slower aging process and show minimal signs of senescence over their lives," study author João Pedro de Magalhães from the University of Birmingham said.

"The 'longevity bottleneck hypothesis' may shed light on evolutionary forces that have shaped mammalian aging over millions of years," Dr Magalhaes said. Studies have shown that some of the earliest mammals lived at the bottom of the food chain and may have spent over 100 million years during the age of the dinosaurs evolving to survive via rapid reproduction.

"That long period of evolutionary pressure has, I propose, an impact on the way that we humans age," Dr Magalhaes said. While some animals have "truly remarkable" methods of cell and tissue repair as well as regeneration, such genetic traits would have been "unnecessary" for early mammals which were lucky enough not to end up as food for predatory dinosaurs like *T. rex*.

T. rex by OpenArt

"While we now have a plethora of mammals – including humans, whales, and elephants – that grow big and live long, we and these mammals live with the genetic constraints from the Mesozoic era, and we age surprisingly faster than many reptiles," Dr Magalhaes added.

Although the idea currently exists only as a hypothesis, further inquiries on this path may shed more light on why cancer is more frequent in mammals than in other species, the biologist added.

Complexity of life sciences in quantum and AI era

Alexey Pyrkov, Alex Aliper, Dmitry Bezrukov, Dmitriy Podolskiy, Feng Ren, Alex Zhavoronkov, *WIREs Computational Molecular Science*,17 Jan. 2024, https://doi.org/10.1002/wcms.1701.

Edited by: Peter R. Schreiner, Editor-in-Chief

Abstract

Having made significant advancements in understanding living organisms at various levels such as genes, cells, molecules, tissues, and pathways, the field of life sciences is now shifting towards integrating these components into the bigger picture to understand their collective behavior. Such a shift of perspective requires a general conceptual framework for understanding complexity in life sciences which is currently elusive, a transition being facilitated by large-scale data collection, unprecedented computational power, and new analytical tools. In recent years, life sciences have been revolutionized with AI methods, and quantum computing is touted to be the next most significant leap in technology. Here, we provide a theoretical framework to orient researchers around key concepts of how quantum computing can be integrated into the study of the hierarchical complexity of living organisms and discuss recent advances in quantum computing for life sciences.

From: Quantum computing can help decode the mysteries of aging and disease

Eric Ralls, Earth,com, 28 Jan. 2024, https://www.earth.com/news/quantum-computing-can-help-decode-the-mysteries-of-aging-and-disease/, accessed 27 Jan. 2024.

In the realm of quantum computing and molecular science, a new paper by Insilico Medicine, a leader in AI-driven drug discovery, is turning heads. The researchers, in collaboration with the University of Toronto's Acceleration Consortium and Foxconn Research Institute, have unveiled a novel approach that integrates quantum computing with the study of living organisms. This fascinating work holds the promise of deepening our understanding of complex biological processes like aging and disease.

The foundation for this innovative approach was laid in May 2023 when the collaborative team published their research on quantum generative adversarial networks in generative chemistry in the American Chemical Society's Journal of Chemical Information and Modeling.This marked a significant stride in demonstrating the potential benefits of quantum computing in this field.

The latest paper from Insilico builds upon this foundation. It offers a comprehensive view of how a fusion of AI, quantum computing, and the physics of complex systems can lead to new

insights into human health. The researchers highlight the latest advancements in physics-guided AI, emphasizing its potential in revolutionizing our understanding of biological phenomena.

The paper delves into the intricate biological processes that span from cellular to organ to systemic levels, highlighting the need for simultaneous multi-scale analysis. With the advent of projects like the 1000 Genomes Project and the UK Biobank, which have generated an unprecedented volume of biological data, the necessity for immense computing power to process and analyze this data has never been greater.

Quantum computing emerges as a game-changer in this context. Its ability to augment AI methods, thanks to the unique properties of qubits that hold values of both 0 and 1 simultaneously (unlike classical bits), provides vastly superior computing speed and capability.

The authors advocate for a physics-guided AI approach to gain a deeper understanding of human biology.

3D bioprinting of human neural tissues with functional connectivity

Yuanwei Yan, Xueyan Li, Yu Gao1, Sakthikumar Mathivanan, Linghai Kong, Yunlong Tao, Yi Dong, Xiang Li, Anita Bhattacharyya1, Xinyu Zhao, Su-Chun Zhang, Technology 31(2) 260-274, 01 Feb. 2024, https://www.cell.com/cell-stem-cell/fulltext/S1934-5909(23)00439-3.

Summary

Probing how human neural networks operate is hindered by the lack of reliable human neural tissues amenable to the dynamic functional assessment of neural circuits. We developed a 3D bioprinting platform to assemble tissues with defined human neural cell types in a desired dimension using a commercial bioprinter. The printed neuronal progenitors differentiate into neurons and form functional neural circuits within and between tissue layers with specificity within weeks, evidenced by the cortical-to-striatal projection, spontaneous synaptic currents, and synaptic response to neuronal excitation. Printed astrocyte progenitors develop into mature astrocytes with elaborated processes and form functional neuron-astrocyte networks, indicated by calcium flux and glutamate uptake in response to neuronal excitation under physiological and pathological conditions. These designed human neural tissues will likely be useful for understanding the wiring of human neural networks, modeling pathological processes, and serving as platforms for drug testing

Graphical abstract next page.

From: Revolutionary 3D-Printed Brain Tissue Mimics Human Function

Emily Leclerc, U. of Wisconsin, in Neuroscience News.com, 01 Feb. 2024, https://neurosciencenews.com/3d-printed-brain-tissue-25554/, accessed 02 Feb. 2024.

A team of University of Wisconsin–Madison scientists has developed the first 3D-printed brain tissue that can grow and function like typical brain tissue. It's an achievement with important implications for scientists studying the brain and working on treatments for a broad range of neurological and neurodevelopmental disorders, such as Alzheimer's and Parkinson's disease.

"This could be a hugely powerful model to help us understand how brain cells and parts of the brain communicate in humans," says Su-Chun Zhang, professor of neuroscience and neurology at UW-Madison's Waisman Center. "It could change the way we look at stem cell biology, neuroscience, and the pathogenesis of many neurological and psychiatric disorders."

Printing methods have limited the success of previous attempts to print brain tissue, according to Zhang and Yuanwei Yan, a scientist in Zhang's lab. The group behind the new 3D-printing process described their method today in the journal *Cell Stem Cell.* Instead of using the traditional 3D-printing approach, stacking layers vertically, the researchers went horizontally. They situated brain cells, neurons grown from induced pluripotent stem cells, in a softer "bio-ink" gel than previous attempts had employed.

"The tissue still has enough structure to hold together but it is soft enough to allow the neurons to grow into each other and start talking to each other," Zhang says.

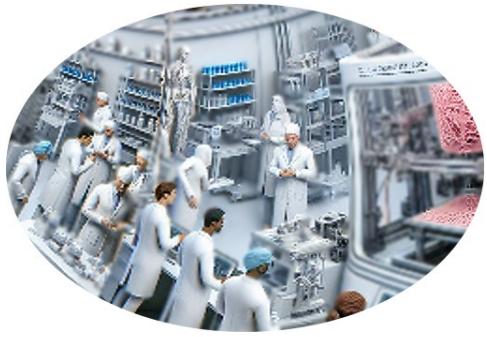
The cells are laid next to each other like pencils laid next to each other on a tabletop.

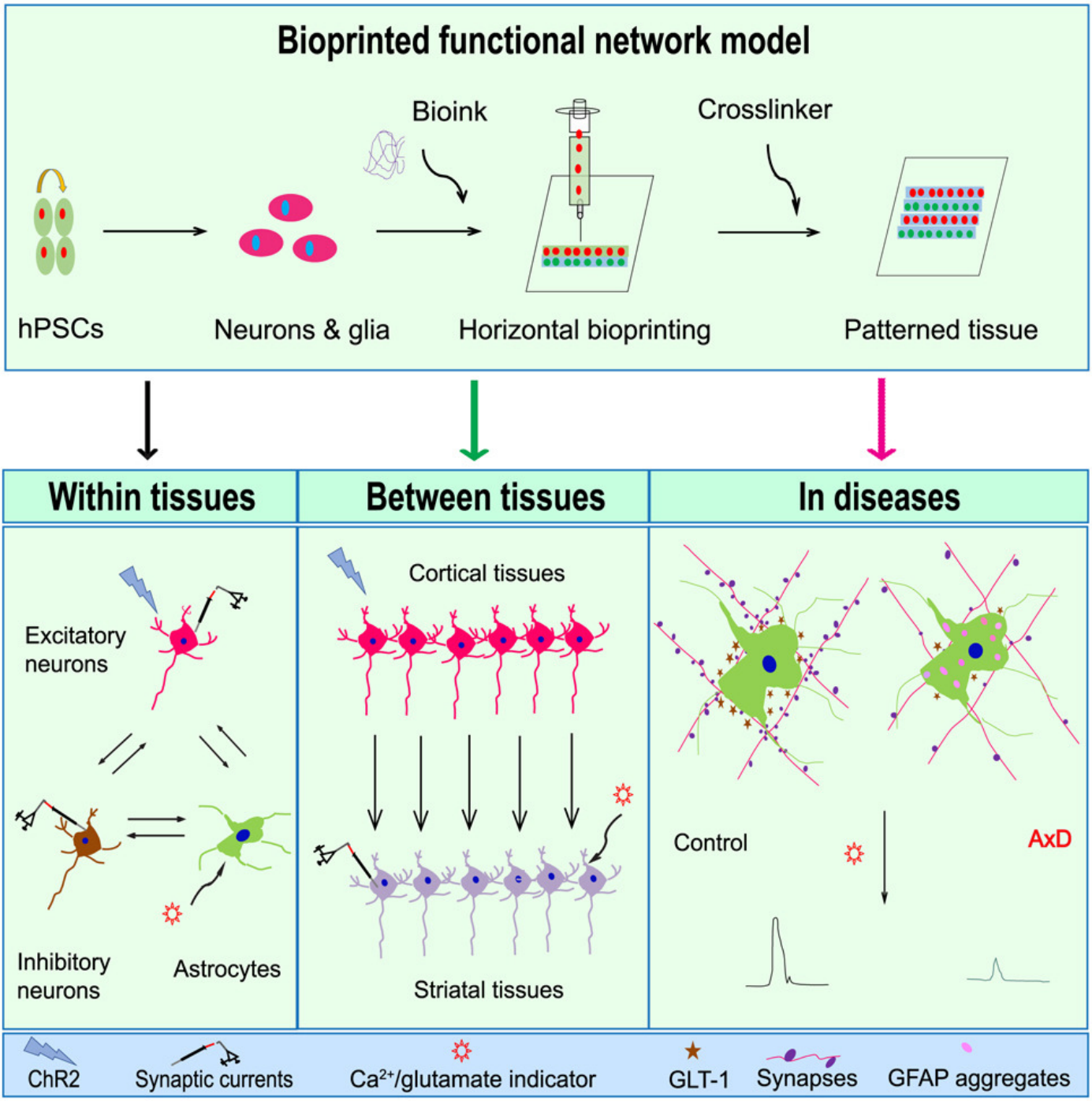
"Our tissue stays relatively thin and this makes it easy for the neurons to get enough oxygen and enough nutrients from the growth media," Yan says.

The results speak for themselves – which is to say, the cells can speak to each other. The printed cells reach through the medium to form connections inside each printed layer as well as across layers, forming networks comparable to human brains. The neurons communicate, send signals, interact with each other through neurotransmitters, and even form proper networks with support cells that were added to the printed tissue.

"We printed the cerebral cortex and the striatum and what we found was quite striking," Zhang says. "Even when we printed different cells belonging to different parts of the brain, they were still able to talk to each other in a very special and specific way."

The printing technique offers precision – control over the types and arrangement of cells – not found in brain organoids, miniature organs used to study brains. The organoids grow with less organization and control.





Graphical abstract, 3D bioprinting

Efficient Tensor Network Simulation of IBM's Eagle Kicked Ising Experiment

Joseph Tindall, Matthew Fishman, E. Miles Stoudenmire, and Dries Sels

PRX Quantum **5**, 010308, 23 Jan. 2024, https://journals.aps.org/prxquantum/abstract/10.1103/PRXQuantum.5.010308.

Abstract

We report an accurate and efficient classical simulation of a kicked Ising quantum system on the heavy hexagon lattice. A simulation of this system was recently performed on a 127-qubit quantum processor using noise-mitigation techniques to enhance accuracy [Y. Kim *et al*., Nature, 618, 500–5 (2023)]. Here we show that, by adopting a tensor network approach that reflects the geometry of the lattice and is approximately contracted using belief propagation, we can perform a classical simulation that is significantly more accurate and precise than the results obtained from the quantum processor and many other

classical methods. We quantify the treelike correlations of the wave function in order to explain the accuracy of our belief propagation-based approach. We also show how our method allows us to perform simulations of the system to long times in the thermodynamic limit, corresponding to a quantum computer with an infinite number of qubits. Our tensor network approach has broader applications for simulating the dynamics of quantum systems with treelike correlations.

From: Quantum computing is outperformed by new type of traditional computing

Eric Ralls, Earth.com, 19 Feb. 2024, https://www.earth.com/news/quantum-computing-outperformed-new-type-traditional-computing/, accessed 11 Feb. 2024.

Quantum computing has long been celebrated for its potential to surpass traditional computing in terms of speed and memory efficiency. This innovative technology promises to revolutionize our ability to predict physical phenomena that were once deemed impossible to forecast.

The essence of quantum computing lies in its use of quantum bits, or qubits, which, unlike the binary digits of classical computers, can represent values anywhere between 0 and 1. This fundamental difference allows quantum computers to process and store information in a way that could vastly outpace their classical counterparts under certain conditions.

However, the journey of quantum computing is not without its challenges. Quantum systems are inherently delicate, often struggling with information loss, a hurdle classical systems do not face. Additionally, converting quantum information into a classical format, a necessary step for practical applications, presents its own set of difficulties.

Contrary to initial expectations, classical computers have been shown to emulate quantum computing processes more efficiently than previously believed, thanks to innovative algorithmic strategies. Recent research has demonstrated that with a clever approach, classical computing can not only match but exceed the performance of cutting-edge quantum machines.

The key to this breakthrough lies in an algorithm that selectively maintains quantum information, retaining just enough to accurately predict outcomes. "This work underscores the myriad of possibilities for enhancing computation, integrating both classical and quantum methodologies," explains Dries Sels, an Assistant Professor in the Department of Physics at New York University and co-author of the study.

Sels emphasizes the difficulty of securing a quantum advantage given the susceptibility of quantum computers to errors. "Moreover, our work highlights how difficult it is to achieve quantum advantage with an error-prone quantum computer," Sels emphasized.

The research team, including collaborators from the Simons Foundation, explored optimizing classical computing by focusing on tensor networks. These networks, which effectively represent qubit interactions, have traditionally been challenging to manage. Recent advancements, however, have facilitated the optimization of these networks using techniques adapted from statistical inference, thereby enhancing computational efficiency. The analogy of compressing an image into a JPEG format, as noted by Joseph Tindall of the Flatiron Institute and project lead, offers a clear comparison.

Three-dimensional imaging of single atoms in an optical lattice via helical point-spread-function engineering

Tangi Legrand, Falk-Richard Winkelmann, Wolfgang Alt, Dieter Meschede, Andrea Alberti, Carrie A. Weidner

Phys. Rev. A 109, 033304, 5 March, 2024, https://journals.aps.org/pra/abstract/10.1103/PhysRevA.109.033304.

Abstract

We demonstrate a method for determining the three-dimensional location of single atoms in a quantum gas microscopy system using a phase-only spatial light modulator to modify the point-spread function of the high-resolution imaging system. Here, the typical diffracted spot generated by a single atom as a point source is modified to a double spot that rotates as a function of the atom's distance from the focal plane of the imaging system. We present and numerically validate a simple model linking the rotation angle of the point-spread function with the distance to the focal plane. We show that, when aberrations in the system are carefully calibrated and compensated for, this method can be used to determine an atom's position to within a single lattice site in a single experimental image, extending quantum simulation with microscopy systems further into the regime of three dimensions.

From: 3D positions of atoms mapped precisely using a quantum microscope

David Nield, *Physics*, 26 Mar. 2024, https://www.sciencealert.com/3d-positions-of-atoms-mapped-precisely-using-a-quantum-microscope, accessed 26 Mar. 2024.

For the first time, scientists have measured the positions of individual atoms in 3D space in a single image, opening up a new way of observing quantum interactions in materials. The new approach, developed by researchers from the University of Bonn in Germany and the University of Bristol in the UK, makes use of a precise quantum gas microscopy setup, trapping atoms of an ultra-cold gas inside cages of light and measuring their characteristics in what's known as quantum gas microscopy. While scientists have charted atoms across three spatial dimensions before, current methods require multiple image exposures and lack the high resolution of quantum gas microscopy. Now it can be done much more quickly, with all three dimensions measured in a single snap.

Previous applications of quantum gas microscopy have provided descriptions of atomic arrangements on flat planes, giving researchers X and Y coordinates of pairs of atoms. By deforming the light given off by the atoms, the researchers have now added a vertical Z position that describes how far 'up' an atom sits. "Instead of the typical round specks, the deformed wavefront produces a dumbbell shape on the camera that rotates around itself," says quantum physicist Andrea Alberti, from the University of Bonn. "The direction in which this dumbbell points is dependent on the distance that the light had to travel from the atom to the camera."

By calculating that distance through some clever math applied to the shape of the 'dumbell', the location of the atoms along the Z axis can be measured. This new insight gives researchers sharper tools for quantum experiments where precision and control are required. "The dumbbell thus acts a bit like the needle on a compass, allowing us to read off the Z coordinate according to its orientation," says quantum physicist Dieter Meschede from the University of Bonn. The team is confident that the technique they've developed can be improved further in the future, and that it can be adapted to work in different setups beyond quantum gas microscopy.

Formation of memory assemblies through the DNA-sensing TLR9 pathway

Vladimir Jovasevic, Elizabeth M. Wood, Ana Cicvaric, Hui Zhang, Zorica Petrovic, Anna Carboncino, Kendra K. Parker, Thomas E. Bassett, Maria Moltesen, Naoki Yamawaki, Hande Login, Joanna Kalucka, Farahnaz Sananbenesi, Xusheng Zhang, Andre Fischer, Jelena Radulovic

Nature **628**, 145–153, 27 Mar. 2024, https://www.nature.com/articles/s41586-024-07220-7.

Abstract

As hippocampal neurons respond to diverse types of information, a subset assembles into microcircuits representing a memory. Those neurons typically undergo energy-intensive molecular adaptations, occasionally resulting in transient DNA damage. Here we found discrete clusters of excitatory hippocampal CA1 neurons with persistent double-stranded DNA (dsDNA) breaks, nuclear envelope ruptures and perinuclear release of histone and dsDNA fragments hours after learning. Following these early events, some neurons acquired an inflammatory phenotype involving activation of TLR9 signaling and accumulation of centrosomal DNA damage repair complexes. Neuron-specific knockdown of *Tlr9* impaired memory while blunting contextual fear conditioning-induced changes of gene expression in specific clusters of excitatory CA1 neurons. Notably, TLR9 had an essential role in centrosome function, including DNA damage repair, ciliogenesis and build-up of perineuronal nets. We demonstrate a novel cascade of learning-induced molecular events in discrete neuronal clusters undergoing dsDNA damage and TLR9-mediated repair, resulting in their recruitment to memory circuits. With compromised TLR9 function, this fundamental memory mechanism becomes a gateway to genomic instability and cognitive impairments implicated in accelerated senescence, psychiatric disorders and neurodegenerative disorders. Maintaining the integrity of TLR9 inflammatory signaling thus emerges as a promising preventive strategy for neurocognitive deficits.

From: Making long-term memories requires DNA damage, researchers discover

Albert Einstein College of Medicine, 27 Mar. 2024, https://medicalxpress.com/news/2024-03-term-memories-requires-dna.html, accessed 29 Mar. 2024.

Just as you can't make an omelet without breaking eggs, scientists at Albert Einstein College of Medicine have found that you can't make long-term memories without DNA damage and brain inflammation. Their surprising findings were published in the journal *Nature* in a paper titled "Formation of memory assemblies through the DNA sensing TLR9 pathway."

"Inflammation of brain neurons is usually considered to be a bad thing, since it can lead to neurological problems such as Alzheimer's and Parkinson's disease," said study leader Jelena Radulovic, M.D., Ph.D. "But our findings suggest that inflammation in certain neurons in the brain's hippocampal region is essential for making long-lasting memories."

The hippocampus has long been known as the brain's memory center. Dr. Radulovic and her colleagues found that a stimulus sets off a cycle of DNA damage and repair within certain hippocampal neurons that leads to stable memory assemblies – clusters of brain cells that represent our past experiences. Elizabeth Wood, a Ph.D. student, and Ana Cicvaric, a postdoc in the Radulovic lab, were the study's first authors at Einstein.

The researchers discovered this memory-forming mechanism by giving mice brief, mild shocks sufficient to form a memory of the shock event (episodic memory). They then analyzed neurons in the hippocampal region and found that genes participating in an important inflammatory signaling pathway had been activated.

"We observed strong activation of genes involved in the Toll-Like Receptor 9 (TLR9) pathway," said Dr. Radulovic. "This inflammatory pathway is best known for triggering immune responses by detecting small fragments of pathogen DNA. So at first we assumed the TLR9 pathway was activated because the

mice had an infection. But looking more closely, we found, to our surprise, that TLR9 was activated only in clusters of hippocampal cells that showed DNA damage."

Brain activity routinely induces small breaks in DNA that are repaired within minutes. But in this population of hippocampal neurons, the DNA damage appeared to be more substantial and sustained. Further analysis showed that DNA fragments, along with other molecules resulting from the DNA damage, were released from the nucleus, after which the neurons' TLR9 inflammatory pathway was activated; this pathway in turn stimulated DNA repair complexes to form at an unusual location: the centrosomes.

These organelles are present in the cytoplasm of most animal cells and are essential for coordinating cell division. But in neurons – which don't divide – the stimulated centrosomes participated in cycles of DNA repair that appeared to organize individual neurons into memory assemblies.

Human iPSC 4R tauopathy model uncovers modifiers of tau propagation

Celeste Parra Bravo, Alice Maria Giani, Jesus Madero-Perez,…, Martin Kampmann, Shiaoching Gong,…

Cell Reports Methods 4(5) 100777, 20 May 2024, https://www.cell.com/cell-reports-methods/fulltext/S2667-2375(24)00121-8.

Summary

Tauopathies are age-associated neurodegenerative diseases whose mechanistic underpinnings remain elusive, partially due to a lack of appropriate human models. Here, we engineered human induced pluripotent stem cell (hiPSC)-derived neuronal lines to express 4R Tau and 4R Tau carrying the P301S MAPT mutation when differentiated into neurons. 4R-P301S neurons display progressive Tau inclusions upon seeding with Tau fibrils and recapitulate features of tauopathy phenotypes including shared transcriptomic signatures, autophagic body accumulation, and reduced neuronal activity. A CRISPRi screen of genes associated with Tau pathobiology identified over 500 genetic modifiers of seeding-induced Tau propagation, including retromer VPS29 and genes in the UFMylation cascade. In progressive supranuclear palsy (PSP) and Alzheimer's Disease (AD) brains, the UFMylation cascade is altered in neurofibrillary-tangle-bearing neurons. Inhibiting the UFMylation cascade in vitro and in vivo suppressed seeding-induced Tau propagation. This model provides a robust platform to identify novel therapeutic strategies for 4R tauopathy.

Graphical abstract, next page

From: A breakthrough in Alzheimer's research: An innovative neuron model sheds light on tau protein spread

Eric W. Dolan, *Alzheimer's Disease*, 06 Apr. 2024, https://www.psypost.org/a-breakthrough-in-alzheimers-research-an-innovative-neuron-model-sheds-light-on-tau-protein-spread/, Accessed 07 Apr 2024.

In a study conducted by Weill Cornell Medicine scientists, a novel human neuron model has been developed that simulates the spread of tau protein aggregates in the brain. This phenomenon is a key driver behind cognitive decline observed in Alzheimer's disease and frontotemporal dementia. The study, published in *Cell*, helps to identify potential targets for drug development that could block the spread of tau aggregates.

In a healthy brain, tau proteins help stabilize microtubules, which are critical for maintaining the structure of neurons and for the transport of nutrients and other molecules within the cell. However, in certain diseases, tau proteins undergo abnormal chemical changes, causing them to fold improperly and stick together, forming aggregates. Over time, these aggregates accumulate to form larger structures known as neurofibrillary tangles, contributing to the progressive cognitive decline seen in affected individuals.

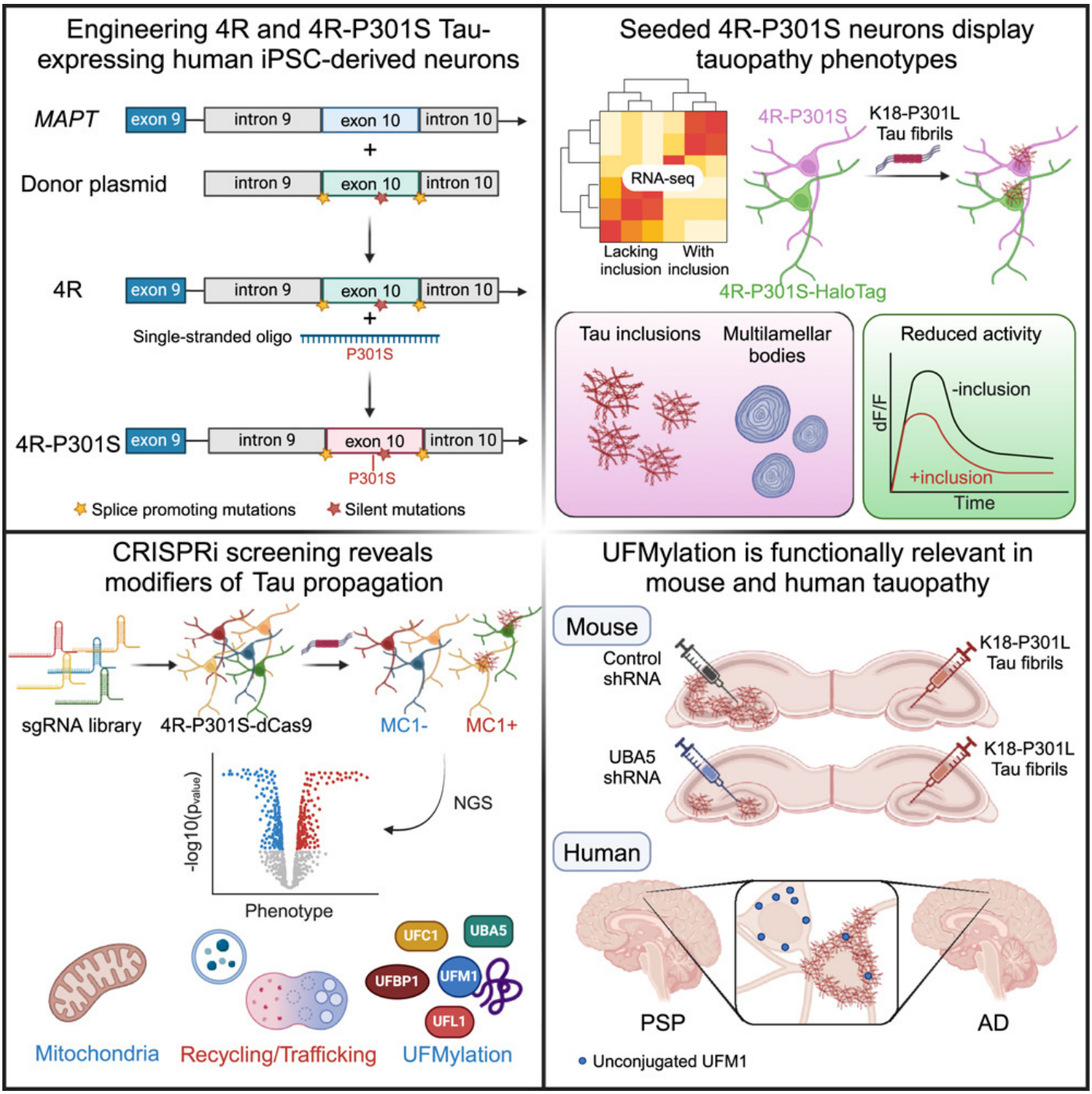
Despite considerable research efforts, there are currently no therapies available that can halt or reverse the spread of tau aggregates in the brains of patients. To address this challenge, the research team aimed to develop a novel human neuron model that could more accurately simulate the spread of tau protein aggregates.

The researchers began with human pluripotent stem cells, which have the potential to develop into any cell type in the body, including neurons. They used CRISPR/Cas9 technology to introduce specific mutations into the genomes of these stem cells, causing them to express pathological forms of the tau protein similar to those observed in aging brains affected by neurodegenerative diseases.

Under normal conditions, modeling the propagation of tau aggregates in neurons derived from human pluripotent stem cells is challenging due to the slow, decades-long course of tau pathology in the human brain. To overcome this, the team employed a novel strategy. By genetically modifying the stem cells to express the diseased forms of tau, they created a neuron model in which tau spread could be observed within weeks, significantly accelerating the timeline for studying tau pathology.

A pivotal component of the study's methodology was the use of CRISPRi screening. This technique allowed the researchers to temporarily "turn off" approximately one thousand genes in the neuron model to assess their role in tau spread. Through this large-scale screening, they identified 500 genes that significantly impacted the abundance of tau, indicating their potential role in the disease process.

Among the most significant discoveries from the CRISPRi screening was the involvement of the UFMylation cascade, a cellular process related to protein modification and signaling. The researchers found that altering this cascade could block tau propagation in their neuron model.



Graphical abstract, Human iPSC 4R tauopathy model

Neuronal activity rapidly reprograms dendritic translation via eIF4G2:uORF binding

Ezgi Hacisuleyman, Caryn R. Hale, Natalie Noble, Ji-dung Luo, John J. Fak, Misa Saito, Jin Chen, Jonathan S. Weissman, Robert B. Darnell

Nature Neuroscience **27**, 822–835, 08 Apr. 2024, https://www.nature.com/articles/s41593-024-01615-5.

Abstract

Learning and memory require activity-induced changes in dendritic translation, but which mRNAs are involved and how they are regulated are unclear. In this study, to monitor how depolarization impacts local dendritic biology, we employed a dendritically targeted proximity labeling approach followed by

crosslinking immunoprecipitation, ribosome profiling and mass spectrometry. Depolarization of primary cortical neurons with KCl or the glutamate agonist DHPG caused rapid reprogramming of dendritic protein expression, where changes in dendritic mRNAs and proteins are weakly correlated. For a subset of pre-localized messages, depolarization increased the translation of upstream open reading frames (uORFs) and their downstream coding sequences, enabling localized production of proteins involved in long-term potentiation, cell signaling and energy metabolism. This activity-dependent translation was accompanied by the phosphorylation and recruitment of the non-canonical translation initiation factor eIF4G2, and the translated uORFs were sufficient to confer depolarization-induced, eIF4G2-dependent translational control. These studies uncovered an unanticipated mechanism by which activity-dependent uORF translational control by eIF4G2 couples activity to local dendritic remodeling.

From: Neuroscience Breakthrough Unveils How We Learn and Remember

Rockefeller University, SciTech Daily, 11Apr. 2024, https://scitechdaily.com/neuroscience-breakthrough-unveils-how-we-learn-and-remember/, accessed 13 Apr. 2024.

Less than twenty minutes after finishing this article, your brain will begin to store the information that you've just read in a coordinated burst of neuronal activity. Underpinning this process is a phenomenon known as dendritic translation, which involves an uptick in localized protein production within dendrites, the spiny branches that project off the neuron cell body and receive signals from other neurons at synapses. It's a process key to memory – and its dysfunction is linked to intellectual disorders.

That makes the inner workings of dendritic translation a "holy grail for understanding memory formation," says Rockefeller's Robert B. Darnell, whose team just published a study in *Nature Neuroscience* describing a new platform capable of identifying the specific regulatory mechanisms that drive dendritic translation. The team leveraged a method, dubbed TurboID, to discover an entire suite of previously unknown factors in memory formation, revealing new mechanisms that underlie how protein synthesis in dendrites contributes to learning and memory. The findings may also have implications for intellectual disabilities, such as Fragile X syndrome.

"Technological limitations have long prevented a comprehensive inventory of the activity at the synapse involved in memory formation," says lead author Ezgi Hacisuleyman, who conducted the research as a postdoctoral researcher in Darnell's laboratory. She is now an assistant professor at The Herbert Wertheim UF Scripps Institute for Biomedical Innovation & Technology. "Our new techniques can accomplish this with extremely high resolution to look at neurons in vitro that are closely mimicking what we see in the brain."

Mid-infrared wide-field nanoscopy

Miu Tamamitsu, Keiichiro Toda, Masato Fukushima, Venkata Ramaiah Badarla, Hiroyuki Shimada, Sadao Ota, Kuniaki Konishi & Takuro Ideguchi

Nature Photonics 18, 738-43, 17 Apr. 2024, https://www.nature.com/articles/s41566-024-01423-0.

Abstract

Mid-infrared (MIR) spectroscopy is widely recognized as a powerful, non-destructive method for chemical analysis. However, its utility is constrained by a micrometre-scale spatial resolution imposed by the long-wavelength MIR diffraction limit. This limitation has been recently overcome by MIR photothermal imaging, which detects photothermal effects induced in the vicinity of MIR absorbers using a visible-light microscope. Despite its promise, the full potential of its spatial resolving power has not been realized. Here we present an optimal implementation of wide-field MIR photothermal imaging to achieve high spatial resolution. This was accomplished by employing single-objective synthetic-aperture quantitative phase imaging with synchronized subnanosecond MIR and visible light sources, effectively suppressing the resolution-degradation effect caused by photothermal heat diffusion. We demonstrated far-field MIR spectroscopic imaging with a spatial resolution limited by the visible diffraction, down to 120 or 175 nm in terms of the Nyquist–Shannon sampling theorem or full-width at half-maximum of the point spread function, respectively, in the MIR region of 3.12–3.85 μm (2,600-3,200 cm-1). This technique – through the use of a shorter visible wavelength and/or a higher objective numerical aperture – holds the potential to achieve a spatial resolution of less than 100 nm, thus paving the way for MIR wide-field nanoscopy.

From: Improved mid-infrared nanoscopy enables 30 times clearer view of the insides of bacteria

University of Tokyo, 17 Apr. 2024, https://phys.org/news/2024-04-mid-infrared-nanoscopy-enables-clearer.html, accessed 23 Apr. 2024.

Schematic image shows bacterium illuminated with mid-infrared, top left, with visible light from microscope underneath to help capture image. Credit: 2024 Ideguchi et al./ *Nature Photonics*

A team at the University of Tokyo have constructed an improved mid-infrared microscope, enabling them to see the structures inside living bacteria at the nanometer scale. Mid-infrared microscopy is typically limited by its low resolution, especially

when compared to other microscopy techniques. Their work has been published in *Nature Photonics*.

This latest development produced images at 120 nanometers, which the researchers say is a 30-fold improvement on the resolution of typical mid-infrared microscopes. Being able to view samples more clearly at this smaller scale can aid multiple fields of research, including into infectious diseases, and opens the way for developing even more accurate mid-infrared-based imaging in the future.

The microscopic realm is where viruses, proteins and molecules dwell. Thanks to modern microscopes, we can venture down to see the inner workings of our very own cells.

But even these impressive tools have limitations. For example, super-resolution fluorescent microscopes require specimens to be labeled with fluorescence. This can sometimes be toxic to samples and extended light exposure while viewing can bleach samples, meaning they are no longer useful. Electron microscopes can also provide very impressive details, but samples must be placed in a vacuum, so live samples cannot be studied.

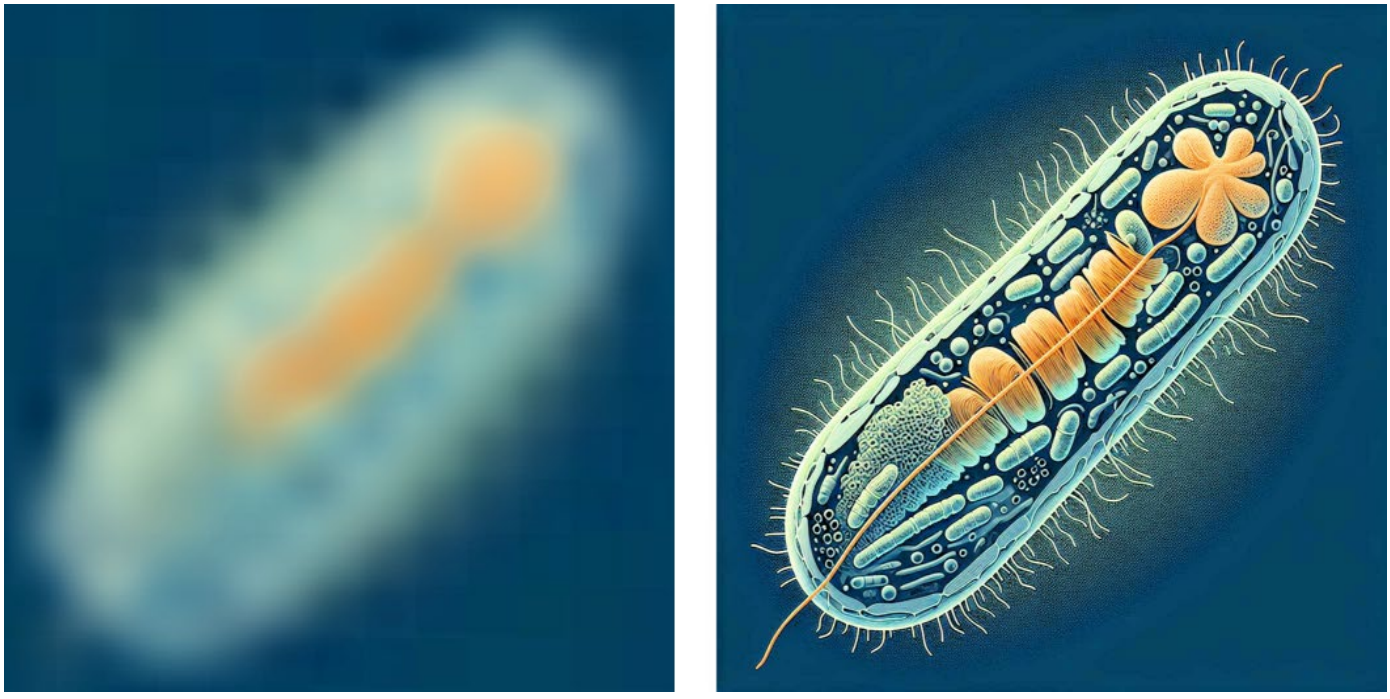
By comparison, mid-infrared microscopy can provide both chemical and structural information about live cells, without needing to color or damage them. However, its use has been limited in biological research because of its comparatively low-resolution capability. However, in a new breakthrough, researchers at the University of Tokyo have attained a higher resolution of mid-infrared microscopy than ever before.

"We achieved a spatial resolution of 120 nanometers, that is, 0.12 microns. This amazing resolution is roughly 30 times better than that of conventional mid-infrared microscopy," explained Professor Takuro Ideguchi from the Institute for Photon Science and Technology at the University of Tokyo.

The team used a "synthetic aperture," a technique combining several images taken from different illuminated angles to create a clearer overall picture. Typically, a sample is sandwiched between two lenses. The lenses, however, inadvertently absorb some of the mid-infrared light.

They solved this issue by placing a sample, bacteria (*E. coli* and *Rhodococcus jostii* RHA1 were used), on a silicon plate which reflected visible light and transmitted infrared light. This allowed the researchers to use a single lens, enabling them to better illuminate the sample with the mid-infrared light and get a more detailed image."We were surprised at how clearly we could observe the intracellular structures of bacteria. The high spatial resolution of our microscope could allow us to study, for example, antimicrobial resistance, which is a worldwide issue," said Ideguchi.

"We believe we can continue to improve the technique in various directions. If we use a better lens and a shorter wavelength of visible light, the spatial resolution could even be below 100 nanometers. With superior clarity, we would like to study various cell samples to tackle fundamental and applied biomedical problems."



E. coli from image by Copilot. Left shows bacterium to about 125 nm resolution, comparable to what was achieved in the study and dozens of times better than before with this gentle-to-the-cells technique; right is sharp image.

A Roadmap to Revival

Successful revival of cryonics patients will require three distinct technologies: (1) A cure for the disease that put the patient in a critical condition prior to cryopreservation; (2) biological or mechanical cell repair technologies that can reverse any injury associated with the cryopreservation process and long-term care at low temperatures; (3) rejuvenation biotechnologies that restore the patient to good health prior to resuscitation. OR it will require some entirely new approach such as (1) mapping the ultrastructure of cryopreserved brain tissue using nanotechnology, and (2) using this information to deduce the original structure and repairing, replicating or simulating tissue or structure in some viable form so the person "comes back."

The following is a list of landmark papers and books that reflect ongoing progress towards the revival of cryonics patients:

Jerome B. White, "**Viral-Induced Repair of Damaged Neurons with Preservation of Long-Term Information Content**," Second Annual Conference of the Cryonics Societies of America, University of Michigan at Ann Arbor, April 11-12, 1969, by J. B. White. Reprinted in *Cryonics* 35(10) (October 2014): 8-17.

Michael G. Darwin, "**The Anabolocyte: A Biological Approach to Repairing Cryoinjury**," *Life Extension Magazine* (July-August 1977):80-83. Reprinted in *Cryonics* 29(4) (4th Quarter 2008):14-17.

Gregory M. Fahy, "**A 'Realistic' Scenario for Nanotechnological Repair of the Frozen Human Brain**," in Brian Wowk, Michael Darwin, eds., *Cryonics: Reaching for Tomorrow*, Alcor Life Extension Foundation, 1991.

Ralph C. Merkle, "**The Molecular Repair of the Brain**," *Cryonics* 15(1) (January 1994):16-31 (Part I) & *Cryonics* 15(2) (April 1994):20-32 (Part II).

Ralph C. Merkle, "**Cryonics, Cryptography, and Maximum Likelihood Estimation**," First Extropy Institute Conference, Sunnyvale CA, 1994, updated version at http://www.merkle.com/cryo/cryptoCryo.html.

Aubrey de Grey & Michael Rae, "**Ending Aging: The Rejuvenation Breakthroughs That Could Reverse Human Aging in Our Lifetime**." St. Martin's Press, 2007.

Robert A. Freitas Jr., "**Comprehensive Nanorobotic Control of Human Morbidity and Aging**," in Gregory

M. Fahy, Michael D. West, L. Stephen Coles, and Steven B. Harris, eds, *The Future of Aging: Pathways to Human Life Extension*, Springer, New York, 2010, 685-805.

Chana Phaedra, "**Reconstructive Connectomics**," *Cryonics*

34(7) (July 2013): 26-28.

Robert A. Freitas Jr., "**The Alzheimer Protocols: A Nanorobotic Cure for Alzheimer's Disease and Related Neurodegenerative Conditions**," *IMM Report* No. 48, June 2016.

Ralph C. Merkle, "**Revival of Alcor Patients**," *Cryonics*, 39(4) & 39(5) (May-June & July-August 2018): 10-19, 10-15.

Robert A. Freitas Jr., "**Cryostasis Revival: The Recovery of Cryonics Patients through Nanomedicine**," Alcor Life Extension Foundation, 2022 (https://www.alcor.org/cryostasis-revival/).

"Revival of Frozen patients in the future," *left* image Dall-E 2, Feb. 2023.

What is Cryonics?

Cryonics is an attempt to preserve and protect human life, not reverse death. It is the practice of using extreme cold to attempt to preserve the life of a person who can no longer be supported by today's medicine. Will future medicine, including mature nanotechnology, have the ability to heal at the cellular and molecular levels? Can cryonics successfully carry the cryopreserved person forward through time, for however many decades or centuries might be necessary, until the cryopreservation process can be reversed and the person restored to full health? While cryonics may sound like science fiction, there is a basis for it in real science. The complete scientific story of cryonics is seldom told in media reports, leaving cryonics widely misunderstood. We invite you to reach your own conclusions.

How do I find out more?

The Alcor Life Extension Foundation is the world leader in cryonics research and technology. Alcor is a non-profit organization located in Scottsdale, Arizona, founded in 1972. Our website is one of the best sources of detailed introductory information about Alcor and cryopreservation (www.alcor.org).

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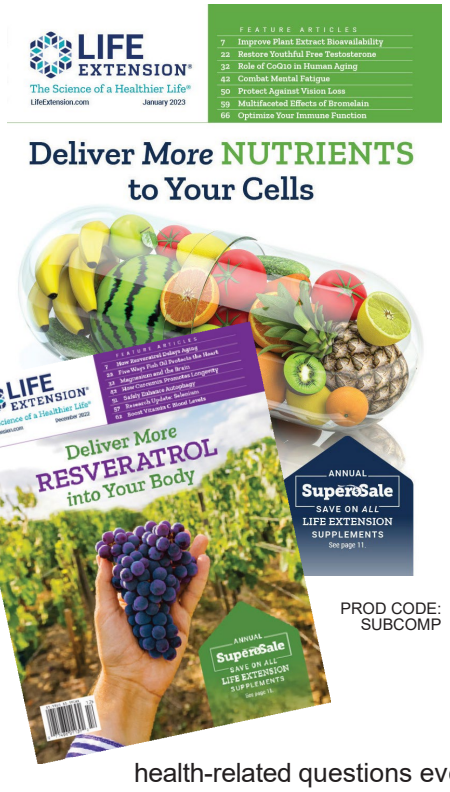

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