Sarah Alger: Welcome to Proto, a podcast that explores the frontiers of medicine. I'm Sarah Alger.

Dr. Stuart Harr...: And I'm Dr. Stuart Harris. Not every medical emergency happens near a well-paved road. An ambulance can't reach you on top of a mountain.

Sarah Alger: And when you're up among the clouds a lot of things can go wrong, as experienced mountaineer Ron Crystal recently discovered on a trip to Mount Everest when he began to have a hard time breathing.

Ron Crystal: I'm a pulmonary physician so I had my own oxygen meter with me so I could check my oxygen level. If I saw somebody coming into our emergency room with an oxygen tension of 45 I'd probably put them on a respirator.

Dr. Stuart Harr...: We'll look at how the body responds at high altitudes and some of the challenges and advances in heading off medical disasters up there.

Sarah Alger: Medicine on The Mountain. Coming up on this episode of the Proto Podcast, brought to you by Massachusetts General Hospital.

Humans have seemingly been fascinated with climbing mountains since the very beginning. The oldest mummy in Europe, discovered in 1991, was found in the Alps at a height of more than 10,000 feet. Mountain peaks have been the sites of pilgrimages, a metaphor in art and a perennial destination for the adventurous.

The modern sport of mountaineering is commonly dated to 1760, when a reward was offered by geologist, Horace-Benedict de Saussure for climbing Mont Blanc. Saussure was fascinated by the geology and atmospheric conditions at high altitudes, as well as the organisms that could thrive there. His reward was claimed in 1786 by two men and the sport of mountaineering has been, so to say, scaling new heights ever since.

But where the mind soars, the flesh is not always so willing. Here to talk with us about high altitude medicine is Dr. Stuart Harris. Dr. Harris is a physician in the Department of Emergency Medicine at MGH and chief of its division of wilderness medicine.

Welcome, Dr. Harris.

Dr. Stuart Harr...: Thank you very much, Sarah. It's a great pleasure to be here.

Sarah Alger: Great. We're glad to have you. So first of all, what is wilderness medicine?

Dr. Stuart Harr...: I typically describe wilderness medicine as the practice of resource-limited medicine under austere conditions and so if you take those two Venn diagram and where they overlap that's really where we do our best work.

The resource-limited part of the equation is you don't have most of the medical tests and technology that we can readily throw at patients. So you may not have labs. You may not have a CT scanner or an MRI. And the under austere conditions is a part that I think people are sometimes less aware of.

In the hospital you presume that you have light, you have heat or air conditioning. You have clean water. You have the ability to get rid of your sewage but none of those things are true in large portions of the planet where people require medical care. So if you can take care of people under those conditions, that's what wilderness medicine training teaches.

Sarah Alger: Wow. So to get back to the mountainside, you have a special focus on high altitudes. What are the medical risks up there and why are they different from what you might see in a coastal area like Boston?

Dr. Stuart Harr...: One, I love mountains and I think they're extraordinarily beautiful, but I think as far as a scientific and a medical area they're just a great way to understand what is ultimately one of the most fundamental threats to human life because low oxygen states are typically the way that most of my patients might ultimately die. So all a heart attack is, is a low oxygen state for the heart. All a stroke is, is a sudden low oxygen state for the brain.

Similarly, a lot of infections, trauma, other things that we might not think of being low oxygen state related are ultimately it's our inability to effectively deliver oxygen to the cells that kill us. That's why high altitude is so interesting to me because things we learn at high altitude directly can impact our ability to treat common sea level conditions.

Sarah Alger: On a similar vein, altitude sickness isn't just a problem for extreme mountaineers. Apparently, it causes about 1300 visits a year to Colorado's emergency departments. So who are these people and what's happening with them?

Dr. Stuart Harr...: Probably you and me. The most obvious risk factor for developing altitude sickness is a rapid recent change in elevation. So if you're coming from sea level you're going very quickly above 8000 feet you're much more likely to develop altitude illness. That being said, definitely you can come from Denver, you can come from 6000, 8000, 10,000 feet and if you go very rapidly to the summit of Denali at 20,320 you're very likely to be sick, if not really, really sick.

But so that rapid change can lead to changes in the brain, the common form of altitude illness we call acute mountain sickness, which is just a change in the brain that is really poorly understood but it can also cause fatal swelling in the brain, what we call high altitude cerebral edema, and changes in the lung that cause fluids to drain into the air spaces of the lung and so they don't work, which we call high altitude pulmonary edema.

Sarah Alger: So what are some of the mountaintops that you've personally experienced?

Dr. Stuart Harr...: There are great mountains in New England. We've got the Gully's, the ice Gully's of Mount Washington. Some great glaciated peaks out west in the Cascades in Rainier, Denali in Alaska. I was able to spend five weeks with the National Park Service doing rescue medicine with them. And then spent some time in Japan and in Nepal and some of the high mountains there.

Sarah Alger: So have you ever had a close call?

Dr. Stuart Harr...: I'll say no because my mother might be listening.

Sarah Alger: Fair enough.

Dr. Stuart Harr...: Yeah, I think anybody who spends time in these areas who thinks they haven't had a close call is not aware. It was never without, I think a fair consideration of the risks and a careful mitigation of the risk. I'm not somebody who seeks to in any way put myself in danger.

I'm happily married. I've got kids. I want to come home. But the reality is that ... and I see this in the emergency department too, nobody leaves home thinking it's going to be a really bad day. So every day we're exposed to some level of risk. That's something I can live with.

Sarah Alger: All right. To get back to altitude sickness, have there been any big advances in recent years about why certain people get it and others don't and how to treat them?

Dr. Stuart Harr...: You can think of it as two separate regions of where things go wrong. So the brain is one area where things go wrong and that's acute mountain sickness, which is very common but not necessarily dangerous and it typically shows up as a headache, maybe poor sleeping, poor appetite, some nausea.

That can span all the way to the high altitude cerebral edema, the potentially deadly swelling of the brain that's very uncommon but if you get it, very high likelihood of your actually dying of it. So that's one constellation of symptoms.

Then it's the lung symptoms. So high altitude pulmonary edema where you have fluid being released into the lungs where essentially the lungs are typically a very low pressure system in the venous structures that feed them but when we are exposed to low oxygen states the blood vessels clamp down and this is completely different from any other organ in the body.

We've evolved with low oxygen states being the life threat. So if you don't have enough oxygen you typically relax your blood vessels, get more blood in, get more oxygen in. Where the lungs you can think if you were 50,000 years ago on the savanna, running around and you got a pneumonia you don't want to be shoving blood into an area of the lung that's not working.

So it makes sense that if you've got an area of the lung that's blocked off with pneumonia it doesn't get oxygen. You want to clamp down those blood vessels, which that makes it more likely for you to pass along your genes and for it to become part of the normal human experience. But, what we didn't anticipate, the celestial design committee 50,000 years ago didn't take into account that we'd be hopping in our planes and flying from sea level Boston to Vail or to other high altitude locations.

So the rapid exposure to all of our lungs to low oxygen states can cause a clamping down of those blood vessels and that's what causes the trouble. So that happens to all of us as we go to high altitude but in certain people ... and it's not clear why in certain conditions some people can be very tolerant to altitude and then go to even a lesser altitude and have a real clamping down of these blood vessels to the point that the lungs essentially start filling up with fluid because the hoses in the lungs aren't doing their job and there's leaking.

Sarah Alger: Wow. Thank you so much, Dr. Harris.

Dr. Stuart Harr...: You're very welcome.

Sarah Alger: What happens when a physician goes on a once in a lifetime mountaineering trip and diagnoses a serious problem along the way?

Dr. Stuart Harr...: Coming up next on the Proto Podcast, brought to you by Massachusetts General Hospital.

Sarah Alger: Every disaster on a mountaintop is a different story but sometimes that story has a happy ending. With more, here's Proto editor, Jason Anthony.

Jason Anthony: Dr. Ron Crystal is the former chief of pulmonary medicine at Weill Cornell in New York City and as one of the pioneers of gene therapy he currently heads up their Center for Genomic Medicine. He is also at 78 years old an intrepid mountain climber.

Ron Crystal: I was a marathon runner and realized I was never going to break three hours so I gave up after running the Boston Marathon 13 times. And I decided to take up mountain climbing and mostly with snow and ice. I'm not very good at rock climbing but I found that snow and ice climbing was something I really liked. So in the winters, I climb frozen waterfalls. In the summer, big mountains with snow and ice.

Jason Anthony: That interest has led him up a number of impressive peaks through the years including Mount Rainier in Washington state and Mexico's Pico de Orizaba. But as with many serious climbers the call of Everest eventually became too strong to resist. Two years ago Dr. Crystal decided that it was time to head up the world's highest mountain and he decided to take a slightly unorthodox route.

Ron Crystal: Well, what I tried to do was not to reach the summit but I thought a good goal would be to reach the height that the British got to in their 1921 first expedition. So I thought I would try to go to that height, which was 6000 meters, which is a real goal. I decided to do it on the north side, which is the less traveled side.

Most of what you read about at Everest is from the Nepal side. I decided to go from the Tibetan side, which is the north side. And also climbing up to 6000 meters on Everest involves some ice climbing and a little technical work, which I thought would be interesting as well.

Jason Anthony: In the months leading up to his climb he did intense aerobic activity every day and met with a trainer three times a week. He also staged summits of the Manhattan variety, donning a backpack to climb the 36 flights of his Upper West Side apartment building. When he finally got to the mountain's base camp he was as prepared as he could be and the thrill was undeniable.

Ron Crystal: It's very interesting because it's all, at least on the north side, there's all these climbing expeditions from all over the world and then there's the Sherpas and these guys are just amazing. You talk with them and you say, "Well, have you ever climbed Everest? Have you reached the summit? And they'll say, "Ten times," or, "Eight times." It's just amazing.

Jason Anthony: As they gathered up their gear to head higher Dr. Crystal quickly realized that something had gone terribly wrong.

Ron Crystal: I just didn't feel well. I was clearly short of breath and we ... I'm a pulmonary physician so I had my own oxygen meter with me. So I could check my oxygen level. And my oxygen saturation had gone down to 78. To put that in context, the arterial oxygen tension would be about 45. If I saw somebody coming into our emergency room with an oxygen tension of 45 I'd probably put them on a respirator.

Jason Anthony: What Dr. Crystal suspected was high altitude pulmonary edema, a potentially deadly condition of the lungs.

Ron Crystal: There are others and I'm sure many of your listeners have had the problem of going to ski resorts, for example, and they may develop some nausea, not feeling well, and sometimes some GI symptoms as well, often headaches. So that's very common. I don't get any of those when I go to high altitude but there's more serious problems that you can get at high altitude, one of which is high altitude pulmonary edema, which essentially is fluid from your bloodstream leading into your lung, into your air sacs.

My other symptom was I had orthopnea, which is an inability to ... or a sensation of breathlessness when you lie down. So I'd go into my tent and lie down and I just couldn't tolerate it. And that's another early symptom. So I made the diagnosis, but very early. So I didn't have the florid expression of the whole disease.

Jason Anthony: Expeditions on Everest prepare for a wide range of medical crises. They have tanks of oxygen, physicians along to monitor for signs of danger and on Dr. Crystal's team they also had a special piece of equipment called a Gamow bag.

Ron Crystal: We didn't use it but it's actually like a mummy bag, if you can think of a bag you go inside and you zip it up and then you pump it up with a bicycle pump and so it essentially brings you down to a lower altitude and you can use that in an emergency.

Jason Anthony: In the end, Dr. Crystal opted for something more drastic. He decided, after traveling half of the world, to turn around and come home. Mount Everest has seen more than 300 deaths and many times they occur when someone doesn't heed the warning signs of bad weather or the beginnings of a medical crisis. Dr. Crystal didn't want to be a statistic, which means, he says, showing a little humility in the face of nature.

Ron Crystal: So my advice to individuals is make sure you're prepared, know what the symptoms are and I mean, I had the advantage of being a pulmonary doctor. But the other aspect of it, which you read about in terms of the problem is that trying to climb mountains like Mount Everest or any mountain, you train for long periods of time. It's expensive and there's an enormous psychological push to be successful.

And so there's an enormous, for each individual, at least I certainly felt it, trying to disregard your symptoms and say, "Well, that's not really happening to me and I'm going to just get through and I'm going to get to the summit," or get to whatever your goal is. And my advice is, pay attention to your symptoms.

Jason Anthony: His team brought him down 3000 feet, which helped his symptoms almost immediately. They made it to a hospital and while it was a poor consolation prize he got to have a long and fascinating conversation with the physician who treated him.

The man saw dozens, if not hundreds of cases of high altitude lung diseases every year. Dr. Crystal did have to pay for that privilege out of pocket, however, for the transportation to the hospital and all of his medical fees and the total ...

Ron Crystal: It cost $360.

Jason Anthony: Holy moly.

Ron Crystal: Which I paid gladly.

Jason Anthony: For Proto, this is Jason Anthony.

Sarah Alger: My co-host today is Dr. Stuart Harris, a physician in the Department of Emergency Medicine at MGH and chief of its division of wilderness medicine. So Dr. Harris, if Dr. Crystal had pushed through and had a medical crisis a little higher on Everest what would have been the process to help him?

Dr. Stuart Harr...: Depending on how high you get and on which mountain, the options you might have can be pretty limited. So sometimes you can be carried down in litters but sometimes that's not possible. You don't have the manpower or the training to do that safely, depending on how high you are up on the mountain.

Helicopter rescues on Denali, the National Park Service, we did a lot so-called longlining where the mountain's too steep to land with a helicopter on the mountain but if you have somebody, a Ranger, attached to the rope on a rope hanging 60 to 100 feet below the helicopter.

Then they can come in, lower the person who can then secure the patient and attach them to the helicopter and fly them out. But that requires an extraordinarily high degree of training. That's usually not available for the vast majority of mountain ranges in the world.

Sarah Alger: Oh my. One of the curious things that Dr. Crystal brought up with Jason is that he had actually been at a higher altitude before this trip and didn't have problems. He also said that Sir Edmond Hillary, one of the first two men to reach the summit on Mount Everest, finished that trip with a clean bill of health but on a later trip, at a lower elevation, he developed high altitude pulmonary edema. Do we know what triggers this condition and why it can happen at different times for the same person?

Dr. Stuart Harr...: Yes, so that was one of the reasons it was so relatively recent. It's only been since after 2000 that Dr. Erik Swenson, a friend and colleague at the University of Washington, really broke down whether this was a problem of inflammation, of whether may be infections preceding or other troubles and insults to the lung were the cause of the lung swelling or whether this was more just a pressure, that you have delicate vessels that pop because they're under high pressure.

Ultimately, he, through a carefully designed series of experiments, determined that yes, this is primarily a problem of essentially of popping vessels and so you get fluid leaking in. But there are a number of other features from environmental conditions to potential infections and other things that can make it more likely that you would have symptoms. And so that's the hypothesis I would have was that yes, he might have had pulmonary edema but he might have had something else contributing or making his threshold that much lower. So even though he's at a lower elevation he has symptoms of high altitude pulmonary edema.

Sarah Alger: So to continue on to talk about high altitude research, can you talk more about where this kind of research is taking place, including something called the Himalayan Rescue Association?

Dr. Stuart Harr...: Yes. So the Himalayan Rescue Association was established in 1975, as I remember, largely as an educational ... with an educational mission. So the idea being that no one should ever die of altitude illness. The vast majority of the people who were dying at that time were just unaware of the potential risks of altitude.

As far as where I think the most interesting work in the world is being done right now on altitude I would very ... and I'll excuse myself from the equation, but I've just come from our hypoxia super group where we have a broad range of MGH bench scientists and clinicians largely led by a former chair of anesthesia, Warren Zapol and one of the world's mitochondrial experts, Vamsi Mootha.

And it has just a beautiful array of talents really looking at the mitochondria. So the wee little powerhouses of the cells that ultimately are the users, the end organ users, or end organelle users of oxygen. I think that's where we're going to crack the, how the brain responds to low oxygen states that we still so poorly understand, that I think if we can dig deeper into how the mitochondria is responding to these low oxygen states I think we'll have a much better idea of how the brain itself and how we as organisms are responding to low oxygen states. So it's an exiting time to be doing this work.

Sarah Alger: So what on the surface appears to be a very specific space in medicine seems to have really broad applications. Are there any other lessons that we can take from the mountaintop?

Dr. Stuart Harr...: Yes. Sarah, I think one of the fundamental drivers of my career and that predates medicine is just the influence of a healthy environment on human health and how all of human health is ultimately derived from that environment. It can be very obvious, I think, when you're out on top of a mountain and you're limited in your food and your oxygen availability and other just heat and other things, what a tenuous line human health can sometimes run.

And so we're really interested in advocating for rational scientifically driven human health and energy policy, just in that it all ties together. None of this is discrete and it's apolitical. It's just these are what the scientific data argue and that's what we need to, as a medical community, we've been really sadly remiss in just advocating, again, not in a political manner at all but just saying, "These are the data."

Just as smoking was an area of deep interest. My father's a pulmonologist. I grew up in Central Virginia. But the battles around smoking and smoking cessation, in my mind were ultimately, they're just public health questions. And similarly, climate change is, in my mind, it's a public health question. It's how a healthy environment very directly feeds into human health in the cases that are showing up in my emergency department in urban Boston.

This isn't a problem for the future. This is a problem right now. And it's an accelerating problem and if we want to address this, being aware of the driver of environmental change, how it impacts human health right now is pretty fundamental and we as a community of physicians need to do a better job of getting out and just advocating for what is in our patients and all Americans, all global citizens, what's in our interest.

Sarah Alger: Thank you again, Dr. Harris.

Dr. Stuart Harr...: You're very welcome, Sarah. Thank you for this opportunity.

Sarah Alger: And listeners, thank you for tuning in to the Proto Podcast.

Dr. Stuart Harr...: Today's podcast was produced by Emily Silber, Bradley Klein and Jason Anthony.

Sarah Alger: Thanks also to our technical directors, Adam Keller and Chelsea Andes, like the mountains. Subscribe to the Proto Podcast on iTunes and Stitcher and follow us on Facebook, Twitter and Instagram. See you next time.