LEUKEMIA & LYMPHOMA SOCIETY®

THE BLOODLINE WITH LLS

A PODCAST FOR PATIENTS AND CAREGIVERS

Episode: 'Visions of Hope: Continuing to Beat AML'

Description:

The fight to effectively treat and cure the complex disease of acute myeloid leukemia (AML) continues.

In this episode, we speak to Dr. Elie Traer, Dr. Karin Rodland and Dr. Lee Greenberger about an exciting new study for AML. The doctors share about a longtime collaboration between Oregon Health & Science University (OHSU) and Pacific Northwest National Laboratory (PNNL) using patient samples from LLS's Beat AML Master Clinical Trial to further understand the proteins on the cancer cells, resulting in the development of more targeted treatments for AML patients.

Transcript:

Elissa: Welcome to *The Bloodline with LLS*. I'm Elissa. Thank you so much for joining us on this episode. In honor of AML Awareness Day, we have a special episode to discuss an exciting new study on acute myeloid leukemia or AML. We will be speaking to Dr. Elie Traer, Dr. Karin Rodland, and Dr. Lee Greenberger on this continuation of the Beat AML Master Clinical Trial as we continue to look for new treatments for this complex disease.

Dr. Traer is a hematologist/oncologist at Oregon Health & Science University, or OHSU, in Portland. His clinical focus is on treating patients with AML, myelodysplastic syndromes or MDS, and myeloproliferative neoplasms or MPNs. Dr. Traer is also active in several clinical trials evaluating targeted therapies for these diseases, including investigating how to develop drugs to more effectively treat residual and treatment-resistant leukemia cells and improve outcomes for patients.

Dr. Rodland is a Professor Emeritus of the Cell Development and Cancer Biology Department at OHSU. Prior to this, she was the Chief Scientist for Biomedical Research at the Pacific Northwest National Laboratory, or PNNL and the Founding Director of the OHSU-PNNL Precision Medicine Innovation Co-Laboratory, which is dedicated to improving patient outcomes through precision medicine.

Dr. Greenberger is the Senior Vice President and Chief Scientific Officer of The Leukemia & Lymphoma Society. His Responsibilities focus on planning and executing the strategy for all LLS research programs, including the Beat AML Master Clinical Trial. Dr. Greenberger guides LLS's mission to translate innovative research that ultimately will pave the way for new therapies to treat blood cancers.

Welcome, Dr. Traer, Dr. Rodland, and Dr. Greenberger.

Elie Traer, MD: Thank you.

Lee Greenberger, PhD: Thank you.

Elissa: So, our episode today is on acute myeloid leukemia or AML. Some long-time listeners of *The Bloodline* may know that I'm an AML survivor, diagnosed in 2016. Dr. Traer is my oncologist, so I am particularly excited to have him on the program today. So, Dr. Traer, let's start with you. Could you tell our listeners what AML is?

Dr. Traer: Acute myeloid leukemia or AML is a disease of the blood cells in the bone marrow. The blood cells are intended to become normal white blood cells, which normally would fight infection. But there's mutations that happen in the DNA that cause them not to be able to become mature white blood cells; and so, they stay in these immature cells. We call them blasts. Eventually, it fills up the bone marrow, and it causes all the other normal cells in the bone marrow to go down. And so, it can come on rather quickly at times, and it can be a difficult disease to treat.

Elissa: What is the prognosis of AML, and what makes it such a complex disease?

Dr. Traer: The prognosis varies quite a bit. So there are some subtypes of AML that are more favorable; and this is based on the genetic changes in those certain types of AML cells. Now, favorable isn't necessarily a guarantee, but there are some patients that we can cure more readily. And then there's some AML patients who have very difficult-to-treat disease; and unfortunately, most patients have the more difficult-to-treat disease. So, we really have to try to get patients into remission if we can and then move onto what we call a stem cell transplant as our curative approach.

Elissa: Now, before we get into this new study, could you tell us about the current treatments for AML, particularly the higher risk subtypes?

Dr. Traer: Yeah, it's an evolving area, and it's really great. I've been doing this for quite some time, about 12-15 years. And just in the past 5 years, we've actually got quite a few new drugs that we've been able to incorporate in AML.

For younger patients, we still tend to stick with more intensive chemotherapy; and we do this for a couple of reasons. One is that younger patients can tolerate chemotherapy a little bit more easily, and they tend to have, more often, more favorable-risk leukemias where we have a potential to cure it with chemotherapy.

The median age of AML patients is 67 though, so most patients are, often in their 70s. And intensive chemotherapy is too much and didn't provide much benefit.

But recently venetoclax was approved, and the combination of azacitidine and venetoclax has actually been quite active in patients, even with higher risk disease. So, we're doing that for sort of the general patients, and then for patients with particular mutations that have drugs, we can really fine-tune their therapy, so if they have FLT3 mutations or FLT3 mutations, we can add specific drugs for that or there's drugs for IDH mutations. So, it's really becoming more complicated but better. It's good for patients.

Elissa: Okay. Now, Dr. Greenberger, the study that we'll be discussing today utilized patient samples from the Beat AML Master Clinical Trial. Could you tell our listeners about that trial and why it was needed?

Dr. Greenberger: So, Beat AML was set up initially in 2016, and at that point there was not that many approved drugs, not the 10 or so that Dr. Traer referred to. So, using what mutations exist in the cells and then having a drug that would target that mutation was the concept of precision medicine for AML.

Consider the fact that AML is not one disease, but actually many different types of diseases. So, if you got all these different types, you're going to have to treat it with different drugs. And so that was what Beat AML was predicated on.

In order to do that, you have to be able to define what changes actually took place in the AML cells for that particular patient. In fact, 6,000 patients have been looked at; and we biobank material from that trial, and we've characterized all the mutations that we can analyze in those patients and then assign people to different trials – Trial 1, 2, 3, 4, 5, for example, to match the therapy for Drug 1, 2, 3, 4, 5. So basically, to match the drug with the patient's particular mutation. That was the concept of Beat AML, and that trial's been running now for 8 years, and many individual trials have been run.

Elissa: And that's for older patients that we're utilizing for that trial?

Dr. Greenberger: Yeah, mostly, and it's really for newly diagnosed patients. That was the initial concept that was at the outset of that. We've since adapted it for relapsed-refractory patients, but mostly for newly diagnosed patients.

Elissa: Now, what have the results been so far for the trial and the impact that it's had on patients?

Dr. Greenberger: There have been many individual therapies that have been tried. There is the so-called IDH inhibitors, where it has helped in getting the approvals and

for the indications and what insurance will allow for those particular patients. We've also demonstrated that, in order to get this mutational analysis quickly to have impact, you really have to turn around the results rapidly, would be able to show that if you can get the analysis done within 7 days, hold the therapy until you understand what the mutation is, and then begin the therapy. That's been a critical step in AML because, as Dr. Traer suggested, this can be an aggressive disease where something has to be done quickly. And so, getting the analysis back within seven days has been a pivotal step in terms of designing what the treatment should be for a newly diagnosed patient.

So, we've got a few indications approved, demonstrate that 7 days is a sufficient time to wait, and we biobanked a lot of samples. And, in fact, that biobank and that mutational analysis is being used by many different research projects that we have ongoing to examine what mutations exist and who might be responsive, and what's the basis for resistance to those patients.

Elissa: That's great. Now, Dr. Rodland, the study we are excited to share with our listeners today was titled, *"Mapping the Proteogenomic Landscape Enables Prediction of Drug Response in Acute Myeloid Leukemia."* Could you tell us the purpose of this study and why it was needed?

Karin Rodland, PhD: Yes, I'm glad to do that. So, Dr. Greenberger described very nicely the use of genetic mutations to inform what drugs you're going to give to AML patients. And in addition, the folks at OHSU did tests on the patient cells with maybe 1,000 different experimental drugs, different FDA-approved drugs to get information about what drugs were capable of killing cells from a specific patient. As Beat AML was initially envisioned, it was genomic. It was the DNA and the gene mutations and the RNA that was driven from those gene mutations.

Well, cells are a little bit more complicated than that. The program that's written in the DNA and copied into the RNA is actually executed by proteins. So, what we did

was add protein measurements to the DNA and RNA measurements. That allowed us to have a much more nuanced and complicated picture of how the body was responding to the drugs. And we used those patient samples along with the protein complement of those patients from the samples to try to understand the signaling pathways within a patient that were responding to the drugs.

So, in this way we wanted to build up an atlas of how the body responds with both FDA approved and experimental drugs and develop a tool that could predict response so that you could go beyond the DNA mutation; and beyond that we really wanted to understand the mechanism of resistance because all of these new therapies that are selected on the basis of gene mutations work beautifully for a short term. And then the patient develops resistance; and we really wanted to understand the process of resistance so that we can overcome it.

Elissa: Now, I'm curious because the public doesn't often hear of national laboratories doing cancer research. So how did OHSU and PNNL come together to do this study?

Dr. Rodland: Well, Pacific Northwest National Lab is a DOE (Department of Energy)-funded laboratory. It has had a long history of doing biomedical research in radiation exposure to humans and other animals. The DOE invests very heavily in developing new scientific instruments and new scientific technologies.

I went to Pacific Northwest National Lab on sabbatical when I was a Professor at Oregon Health Sciences University to learn proteomics so that we could study the proteins. And it just kind of became a collaboration that was very organic between my medical colleagues at OHSU and my new instrumentation proteomics colleagues at PNNL. It was a very important area to research, and people were eager to do it.

Elissa: That's great. Now, let's get into the study a little bit more. As I mentioned earlier, these are patient samples from the Beat AML Trial. Were there particular gene mutations that were focused on in this study?

Dr. Traer: We did enrich somewhat in the study for patients with FLT3 mutations, and the reason for that was is that we wanted to be able to use some of the patients' leukemia cells and their response to drug in the lab. We can put the cells into cell culture and then watch them and then give them different drugs and see how they respond in the lab.

And FLT3 was one of the mutations that was a little bit more reproducible in terms of responding to drugs. So, we tried to enrich a little bit for that, just so that we'd have enough samples to do the statistical analysis. However, outside of that, the selection was mostly based on the number of patient samples we had where we had enough material to allow us to do a complete proteomic analysis.

And what was nice, as Karin was saying, is there's a sort of a layer cake, that you have the DNA mutations that happen in the cell, and then there's additional mutations that happen in the RNA, which is transcribed from the DNA and then the proteins. And so, we really had all the levels of information, and we could understand how each of them was regulated separately and together and then correlate that with the drug response and the lab.

Elissa: That's really interesting. In the study, you ended up putting these samples into clusters or groups. Could you tell us more about these clusters and how you ended up separating those out?

Dr. Rodland: Clustering is a way of grouping patients by similarity, so who is most similar to whom? And it's a very complicated mathematical algorithm that I don't even understand. There are other people in the group who do this.

But the end result is that we can match people up by other patients who are more similar to them. And then we can look at pathways that are enriched in these groups that clump together. And we can see, for example, that if you have a lot of pathways related to making more copies of yourself, we call that cell proliferation, then that's a bad sign. That's associated with a bad developmental outcome. If you have pathways

that are associated with a mature cell that has differentiated to doing the job it's supposed to do, that is a good sign that you're likely to have a good outcome. And then we can start to tease apart the things that indicate a bad outcome or a good outcome so that we can understand the disease better and perhaps treat it in a more integrated fashion.

Elissa: Okay. So, what did you end up finding when looking at the proteins versus the gene mutations within these groups?

Dr. Rodland: Well, the genes did a good job of predicting drug response; the RNA did an even better job than the genes; and the proteins did the best job. Gave us the most power to predict which drug you will actually respond to.

We also observed that the more highly differentiated cells that were doing their own job were tightly associated with a better outcome for the patients.

We also, interestingly, observed that the different groups of patients responded as a group to some drugs better than to other drugs. So those proliferating cells responded very well to venetoclax. And so, if you had the type of cluster that indicated poor outcome, we could choose a better drug regime for you. That has to be tested in clinical trials. This is laboratory experiments. And that's why the partnership with Beat AML and with physicians like Dr. Greenberger and Dr. Traer are so important because we can develop a hypothesis from the proteins and then test it in the patients.

Elissa: You mentioned the different things that you could look at – proteins, the RNA, and then the mutations. With all of those, is there a best way now to predict if a patient will respond to certain drugs?

Dr. Rodland: We're in the process of developing that best way. We have a preliminary predictor that would be able to, that's based on protein and phosphoprotein. That's proteins that have a little phosphate group stuck onto them as

part of talking between one protein and another. They add and subtract phosphate groups, like passing along a piece of paper.

So, we have an experimental predictor, and Dr. Greenberger mentioned how important it was to turn those DNA results around quickly because AML is such an aggressive disease.

So, what we need to do now is take our proteins and turn them away from a very complicated test that needs a very expensive mass spectrometer and turn them into a very quick lab test that a lab tech can do in an hour or three hours. And that's the future direction. We need to go there. We're not there yet.

Dr. Traer: I can add onto that from a physician perspective. One thing that we've always known is that these mutations are actually quite useful; and we really depend upon them to try to help stratify patients. But we know they're not perfect, and so while they work most of the time, there's always patients who don't respond the way we expect them to.

And so that's always been a little bit of a puzzle as to understanding why a particular genetic mutation, which normally would be responsive or unresponsive, is swamped. And I think these studies are quite interesting because we start to look at other components of the cells – the RNA, the protein – and we can see if we group it that way, actually, some of the mutations don't necessarily stay within their typical group. They sort of move into other groups, which suggests that there's some other biology there, in addition to the mutations, or maybe it's other mutations or combinations, that's actually changing how patients respond.

And ideally, we'd like to understand how that works because if we can quickly figure that out, we can become much more accurate about how we treat patients and which drugs to put them on. So, it's nice to be able to try to put all this together. It's a lot, and I would say that it's an ongoing effort. We're not there yet, but that's sort of the ultimate goal.

Dr. Greenberger: Yeah, I should add that this is a combination of understanding the biology and also a computational piece. And this is just the history of development of therapies for cancer is so woven into the technology end of things that this is becoming a critically important piece that we now have capabilities to do.

But doing computational analysis, getting somebody to understand it, to simplify it, to make the machines that can do it quickly, this is all part of that dance with technology that cancer research has done for the last 40, 50 years to improve outcomes.

Dr. Traer: And The LLS has graciously supported and thank you for that. Because a lot of this was supported by The LLS, and it's a huge effort to collect these samples and try to tie them to the response and patient outcomes.

Dr. Greenberger: And that's one of the things that LLS invests not only from the very early and discovery technology but also to the clinical trials. You have to do the wide scope if you're really going to make progress and wed those together to really move the field forward. And that's happening.

Dr. Rodland: So, I'm going to add to that that one of the objects of this particular project was to build up a very detailed molecular map at the DNA, RNA, and protein level of these Beat AML patients. And all of those that have been deposited in a way that other scientists can access them, and other scientists can ask questions of the data and make hypotheses and test them with lab experiments.

And so, we're very grateful to The LLS and to the Beat AML project for giving us this very rich database of patients where we can supply all the molecular measurements, and then future generations of researchers can use those measurements and the outcomes data on the patients to do an even better job of treating patients.

Elissa: I'm curious. You mentioned the testing, and we know that the cytogenetics will come from the bone marrow. What about the proteins? Can that come from a simple blood test, or is that also coming from a bone marrow biopsy?

Dr. Rodland: It can come from the peripheral blood. We have measured AML cells that we took out of the blood and AML cells that we took out of the bone marrow. And at the protein level they're the same. We can do the same measurements. We can make the same predictions.

But we need to do a simple blood test to know exactly which proteins give us the most information so we can make an antibody-based test that can be done in a couple of hours instead of a long drawn-out mass spec test.

Elissa: Okay. Dr. Traer, Dr. Rodland, you mentioned venetoclax throughout your talk. But are there other particular drugs or combinations that you tested against these groups?

Dr. Traer: We did use a number of drugs, and there were some FLT3 inhibitors that came out as interesting in the study, which is what we expected. We actually sort of enrich for those mutations. And a certain drug, sorafenib, was actually sort of an interesting result. That's an older FLT3 inhibitor. We don't use that in the clinic as much. We tend to use gilteritinib. And quizartinib was recently approved for FLT3-mutated AML.

But sorafenib was interesting because, again, it didn't perfectly correlate with just the FLT3 mutations and actually correlated a little bit better with the protein grouping in terms of its efficacy. So, again, another suggestion that maybe the genetics aren't telling us the whole story. And then we looked at venetoclax, which as Dr. Rodland mentioned, was sort of more broadly effective against rapidly dividing and more immature cells.

And then another drug, panobinostat, which is an HDAC inhibitor, was actually used a while ago. It's been tested a number of times. And that has an interesting opposite effect as venetoclax, so that tended to have more effects in mature cells. So, we started to think about how you could pair these types of drugs and put them together,

based upon how they worked for these groupings, which is defined by the proteins in the cells.

Elissa: Okay, I think it will be interesting to see how pairings might work together on these different groups of patients. Now, based on this study, where do you think we can go from here with AML research?

Dr. Traer: I will say that the work continues. We've really enjoyed this collaboration, both with the support of The LLS but also with PNNL and, actually, we have a number of ongoing projects right now.

One of those, in particular, as Dr. Rodland mentioned, was resistance. And I think that's a key area. As we're making more progress and getting more targeted drugs into the clinic, we find that they work better and it's great. Patients live longer. But they don't work forever, and eventually there's a subset of leukemia cells that figures out how to grow through even our better treatments.

And so, I think now our goal is really to understand what are those changes, and sometimes they're genetic, but sometimes they're more protein and RNA. And what are those things that are changing and how can we better target those resistant cells? Because, ideally, we could sequence and put together different treatments and keep patients in remission for much longer and then improve outcomes. So, I think that's a major goal right now that we're working on, and we have a number of projects that I think are quite exciting.

Elissa: So, do you feel like the results from this could really potentially change the protocol you will use for the treatment of AML patients?

Dr. Traer: I think eventually. It's one of the things about doing research and treating patients is that you realize the transition from what we do in the lab to the patients can be quite a long process. But it really is important. It's the work we put in now that 5 to 10 years can kind of change the way we do things in the clinic. And so, that's

why I love what I do because if you spend enough time, you can actually see that happen.

Dr. Rodland: And I'm going to put in a plug for the basic science because to me the beauty of this experiment really was having all three kinds of information and other kinds of information so we can better understand what is broken in an AML cell compared to its normal counterpart.

And how that process happens. How you go about breaking the normal control processes in a cell that controls when it differentiates and when it divides. And the better we understand how a leukemia cell got to be a leukemia cell, potentially we could do a better job of prevention or of nipping the disease early in the process before you're 67 or 70 and can't stand up to too harsh treatment.

So, the pursuit of knowledge of how the disease works is very important to me, and I think we've opened up a lot of insight into how the process of resistance develops, how the relationship between differentiation and outcome. So, some of the future research is just going to be understanding the system better.

Dr. Greenberger: I should add that from LLS, we're funding that type of work. We're also funding to see if we can use the immune system to kill AML cells. So, in other words, sometimes these mutations that occur inside the cell, we don't have drugs that can target them. But there might be something on the surface of these cells, and we know that the immune system can recognize the surface of tumor cells. We've certainly done that for lymphoma and for myeloma. Leukemia's been tougher.

But, all that said, we want to understand what is unique on the surface of AML cells because we can take the immune system, and we've learned in the past 10, 20 years how to activate the immune system by a whole variety of methods. And if we can do that and specifically target the AML cells, doesn't necessarily matter what's going on inside the cell. We just need that marker on the outside of the cell to kill the AML cells.

And, in fact, we already have drugs that are approved that do that, the so-called antibody drug conjugates or the antibody, the immune piece of it basically is tied to a toxic molecule and can bind to the surface of the cells, go inside the cells, and kill the AML cells. That's a simple example of what we've already accomplished, but we think that activating the immune system has a lot of potential for AML therapies in the future; and we're working very diligently and funding a lot of work to see if we can actually optimize that.

Dr. Traer: Lee, you bring up a good point because one of the reasons to focus on proteomics is that they coat the surface of the cell; and so, if you're just looking at genetics, you might miss something that was on the surface of the leukemia cell that could be a drug target. And many of our drugs actually target proteins, right? They're not necessarily targeting the DNA or RNA. So, understanding how the proteins work together is really helpful for thinking about therapeutic development.

Elissa: Dr. Greenberger, I'm glad that you mentioned LLS's role in continuing to fund this research. Now, since this study used Beat AML samples, is this something that we're continuing to do? Continuing to build on that trial and utilize samples?

Dr. Greenberger: Oh, definitely. The building on that is not only happening in this trial, but actually we have many other investigators that are using Beat AML information to advance their own work. I could tell you that there is an investigator at Dana-Farber that is looking at what's novel on the surface using the Beat AML as the starting material and then ultimately looking for something that's unique on AML cells, even a piece of a protein, and then training the immune system to recognize that small piece and making new immunotherapy. Basically taking normal immune cells, T cells, and making them hone on the AML cells because the Beat AML information is telling us what to hone in on.

Elissa: This is a question for all of you. What are you most excited about for the future of treatment of AML?

Dr. Rodland: Well, as the basic scientist, I'll just say being able to understand the process of resistance and perhaps stop resistance from coming about or else dividing, seeing the magic cocktail that prevents it from ever happening.

Dr. Traer: I'll add to that another plug for resistance because I think that's a really important concept in AML. Like I said, the combination of azacitidine and venetoclax now is something we use for a lot of older patients. And it works for many of them initially; but it doesn't last. So, I think we really need to think about how to sequence therapies and put them together, targeted therapies and understand resistance because I think if we can stay ahead of it, and especially if we can have protein markers that indicate how resistance is developing and how we can get around it, then we can really tailor our treatments to keep patients in remission without letting the disease relapse. Because you hate to have the patients relapse and then become sick again. That's hard because then you have to work very hard to get them back into remission if you're going to do that.

If you can treat at a low level, I think this is really the promise of this understanding resistance and being able to put medications together. Never let it get to that relapse. Try to keep it in a low level remission. That would be amazing, and that's what we're really working on hard in the lab and with these projects to figure out how we can do that.

Dr. Greenberger: I'll add that, I've been doing cancer research for 40 years; and the concept of resistance is nature is just smarter than us. For every method that we figured out how to attack it, nature usually figures out a way around it. And this has been the history of cancer research.

Nevertheless, being able to figure out the resistance mechanisms when they're starting or even before they're happening or developing combinations to block them from happening is going to be critically important.

I also think that eventually, looking ahead, we will be able to develop drugs that target more of these different proteins. That's one. Using the immune system for targeting, number two. Don't necessarily use the maximum dose. Use maybe a sub maximum dose that will still be effective and get to the same endpoint we need to control the disease with less side effects. And that actually is the exploration of using less venetoclax to maybe achieve the same efficacy with less toxicity, for example, which Beat AML is doing.

Elissa: That will certainly be great to see if we can develop more drugs with less toxicity. Now, our final question today. On our patient podcast home page, we have a quote that says, "After diagnosis comes hope." What would each of you say to patients and their loved ones to give them hope after a diagnosis of AML?

Dr. Traer: I would certainly say that, even if this is a very hard diagnosis to hear about. People can feel fine; and then all of a sudden, they discover they have AML, and it really just shocks their whole world. And so, especially when you take care of patients, you realize how hard that is.

But we do have a chance of treatment. Some people respond well to treatment. The immune therapy is real. We use that in the stem cell transplants and that can work for some patients.

And I think there's also all these new drugs and, and trials that we're trying so that we can improve the therapy, and we're getting better over time. And I also like to remind them that I'm on that journey with them. Right, I mean, there's people there; and I'm lucky to be at OHSU. We have such a great team of nurses and support staff. And so, I really try for the personal side to just let them know that we're going to be on that journey with them because it's always a little hard to know exactly how things are going to turn out at the beginning. And I think the fear of the uncertainty is one of the hardest things about this diagnosis and process. So, try to provide reassurance that we're going to keep working throughout the whole treatment.

Dr. Greenberger: I think as a researcher and a member of LLS for the last ten years, hope is - we're not giving up. We are actively pursuing alternative therapies working very closely with researchers worldwide. We have about 30% of our 200 grantees across the world are working on AML; and we see more progress than we did in the last 10 years, than we've actually have seen probably in the last 40, 50 years. We're getting smarter, and so there is hope and there is breakthroughs, which we've seen happen over and over again that makes us excited to think we're going to get a better handle on AML.

In addition to which, I will just say that having experienced this in my own family, hope is some patients are going to get a cure of AML. And that makes us think that we'll be able to do it more and more over time.

Dr. Rodland: So, there's not much I can add to those excellent visions of hope. But what I would like to say to a patient with AML is there are a very large number of very smart people who are working very hard on trying to cure this disease and on taking care of you as a patient. And there is an immense amount of brain power in the corner with you. And so, if we haven't got it figured out today; maybe we'll have it figured out in time.

Elissa: Yes, I love that.

Well, thank you all so very much for joining us today and talking all about AML and this exciting new study. I'm very excited to see where, this is going. I think the future is bright for AML patients. I can see already how much things have changed even since my own diagnosis in 2016 and all the new drugs that have come out and will continue to come out; and I hope that we can continue to look at the proteins and see how we might be able to help those higher risk patients that just aren't responding to the drugs or stop responding. And so, thank you again so very much for being here with us.

Dr. Traer: Thank you, Elissa. Really good to see you again.

Dr. Greenberger: My pleasure.

Elissa: And thank you to everyone listening today. *The Bloodline with LLS* is one part of the mission of The Leukemia & Lymphoma Society to improve the quality of lives of patients and their families.

Did you know that you can get more involved with *The Bloodline* podcast? Be sure to check out our Subscriber Lounge where you can gain access to exclusive content, discuss episodes with other listeners, make suggestions for future topics, or share your story to potentially be featured as a future guest. You will also receive an email notification for each new episode. Join for free today at TheBloodline.org/SubscriberLounge.

In addition to the Lounge, we could use your feedback to help us continue to provide the engaging content for all people affected by cancer. We would like to ask you to complete a brief survey that could be found in the show notes or at TheBloodline.org. This is your opportunity to provide feedback and suggested topics that will help so many people.

We would also like to know about you and how we can serve you better. The survey is completely anonymous, and no identifying information will be taken. However, if you would like to contact LLS staff, please email TheBloodline@LLS.org.

We hope this podcast helped you today. Stay tuned for more information on the resources that LLS has for you or your loved ones who have been affected by cancer.

Have you or a loved one been affected by a blood cancer? LLS has many resources available to you – financial support, peer-to-peer connection, nutritional support, and more. We encourage patients and caregivers to contact our Information Specialists at 1-800-955-4572 or go to LLS.org/PatientSupport. You can find more information on acute myeloid leukemia at LLS.org/Leukemia. All of these links will be found in the show notes or at TheBloodline.org.

LEUKEMIA & LYMPHOMA SOCIETY®

Thank you again for listening. Be sure to subscribe to *The Bloodline* so you don't miss an episode. We look forward to having you join us next time.