

CONVERSATIONS WITH MIKE MILKEN



Eric Lefkofsky

Founder and CEO, Tempus

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Mike Milken: Eric, thank you for joining us today.

Eric Lefkofsky: Thank you for having me.

When I look at how Tempus describes itself as having the world's largest library of clinical and molecular data and an operating system to make that data accessible and useful, tell us what that means and how it helps patients.

We started four and a half years ago with a very simple idea, which is: Could you, in cancer, collect large amounts of clinical and molecular data and put those together? And if you could, would you find patterns that were therapeutically relevant to patients? At the time, genomic profiling in cancer had just begun to take off. And yet all of this data that was piling up was often devoid of clinical context, meaning, so my patient has a particular mutation, but what

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does it mean in terms of what drugs should they take or how are they likely to respond to that drug?

You can start to see it even in infectious disease where today [if] somebody's positive for COVID-19, it still doesn't tell you what's likely to happen next. Are you likely to have an adverse immune reaction? And what we're trying to do by combining clinical and molecular data is really be able to contextualize these laboratory test results. So we don't just say positive or negative, we actually try to predict or at least help physicians stratify patients based upon their risk, or figure out what's likely to happen to them next. And so, it's just never been more important than obviously in today's pandemic.

Eric, all of us are affected by our life experience. I was faced with potentially life-threatening diseases directly in my own family with my father being diagnosed with melanoma in the early 1970s and eventually succumbing to it, my mother-in-law having breast cancer and eventually succumbing to multiple myeloma, and our children who had seizures constantly. The search for which treatment would suppress their seizures was a devastating process as you're trying to find the right medicine that could match up against their seizure profile. It forced us to redirect our life and focus on how we could accelerate medical science. What set of events caused you to want to set up Tempus?

I think for much of the same reason as you did. In my case it was my wife was diagnosed with breast cancer five-and-a-half years ago. And I remember going to the doctor with her and to different points you have decisions to make as a patient or a patient advocate. Having come from technology, I wanted large amounts of data to be guiding those decisions, and I wanted that data to be basically real-time.

Instead, what I found is that often the decisions that were being made were being made on scant amounts of data, and that the data was often old – in many instances, 5-, 10-, 15-, 20-year-old studies that had been done with relatively small cohorts of patients that were guiding care at scale a decade or two later.

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I remember just having this aha! moment – we would go into the hospital, she was having chemotherapy and I would just feel like I was going back in time. I had a Tesla and I had an iPhone and so I was firmly in the 21st century on the way into the hospital, and then the minute I would open up those doors I felt like I was teleported back in time 30 or 40 years even though she was treated at a great hospital. It became apparent to me that there was this unique moment in time all of a sudden, based upon cloud computing,

based upon advancements we've made in optical character recognition and natural language processing, based upon advancements we've made in artificial intelligence as it relates to image recognition, and low-cost molecular profiling.

Companies like Illumina and Google and Amazon and Microsoft, all these amazing companies had kind of laid the foundation for somebody like Tempus to show up and go into these medical records and structure vast amounts of clinical data in real time at very low cost.

Let's talk about the coronavirus. You've set out some sample approaches to not only find out whether people have the virus or not, and more accurate tests, but you've spoken about how to tell what would happen to this individual if they did get the virus. Tell us a little bit more about that.

We're simply testing too few people, even though we're six or seven or eight weeks into this pandemic at scale. And you hear stories all the time about people who took five days to get a result or seven days to get a result. And so the sheer throughput of testing has to go up. But on top of that, you can't just have a positive test result. You need to put that result in clinical context. So what does that mean for this particular patient?

We're looking at all kinds of other phenotypic data that's locked inside that medical record. Like what does it mean to be hypertensive and have an adverse event? Or what type of cardiac stress do you have to have to be at high risk? So we tend to put people in

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big buckets and say if you have hypertension or you have heart disease, you have a problem. Those are too big of buckets. There are just too many tens of millions of people in this country that have those conditions. And so, one of the things we're trying to do is not just speed up the amount of testing we do, but also help provide clinical context to these tests. You're going to have this period of say three, six, nine, 12 months where we don't really know the totality of who's infected, we don't know who has immunity, and we

don't know who's at the highest risk. Until we are working in a cohesive manner to solve those three problems, we're always going to be in the dark. And it's the dark, it's the blindness that is, I think, most paralyzing for our economy and most paralyzing to many of its citizens. So we've got to attack those three more testing, broader testing and intelligent test and actually help doctors triage patients and help patients understand their risks.

I think Eric, you've touched on a very important point: for us to return to any sense of normalcy, we have to have confidence in these three areas that you discussed. As we all know, COVID-19 has affected every part of our society. What impact has it had on your existing work with cancer patients and cancer therapy?

We've become one of the largest sequencers of cancer patients clinically in the United States, and just in the last three weeks we have seen standard testing volumes can be down 30 or 40%. ... Just to put it in perspective for a minute, we can debate the case fatality rate of COVID, but I think a lot of people that are looking at this from a broader epidemiologic perspective peg the case mortality rate at about 1% to 2%. The case fatality rate of cancer is about 33%. About 1.7 million people will be diagnosed with cancer this year. About 600,000 will die. In terms of fatality, cancer is somewhere around 25 times more deadly than COVID, and yet here you have cancer patients that are not being sequenced. Especially in areas like New York, you have massive amounts of sequencing capacity that's just been shut down because the hospital systems are overwhelmed dealing with COVID.

Another great example is we work with thousands of folks that have a major depressive disorder and we've seen literally a 75–80% drop in the amount of face time that we're getting with patients that have major depressive disorder. And again, it's the same phenomenon where the hospital systems are so either overwrought dealing with COVID or are planning to be overwrought and so they've shut down elective surgeries, they've shut down elective visits, and in many instances they've shut down non-elective visits and surgeries that just take a lower priority to COVID.

And so we have a huge body of patients – tens of millions of patients – that we're going to have to figure out how to treat in the next month or two when we feel like we've stabilized the mania of this pandemic. It's similar to the economic detriment that we're going to have to reckon with – the medical problem of just pushing back millions of patients for a month or two or three in a system that is not designed to push these patients back.

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When we did our study in 2007 at the Milken Institute on an “Unhealthy America,” looking at the change in weight and the fact that this dramatic change in weight in 25 years in America is costing the country \$1.5 trillion a year, it was interesting that the number one cost at that time was not diabetes and not cancer, but depression. How have you used your data in the area of patients with severe depression?

Once you determine a patient has depression, then what ends up happening is unfortunately, as a physician you have a class of antidepressants and let's just say there are 30 different antidepressants that you could put a patient on that has major depressive disorder or is severely depressed. You don't know which one to put that patient on first. So, it is trial and error, one antidepressant to the next until you eventually hopefully get it right.

What we're looking at is pharmacogenomic markers that tell us if a particular patient is unlikely or likely to respond to an antidepressant. And when you combine all this multimodal data, you can begin to stratify patients and say: oh, wait a minute, patients like you – just like you with your molecular profile and your phenotypic profile – seem to respond best when they take this particular antidepressant. So we don't need to rely exclusively on historic trials or exclusively on small datasets that might be in an academic publication. We can also rely on this massive amount of real-world data to begin looking at how patients are actually responding.

Let's come back to COVID-19. If we could identify those individuals who have the potential to have the most adverse reaction if they get the disease, we might be able to sequester fewer people. How far are we away or are you away from being able to do that?

The actual machine learning – the big data, the data science, the artificial intelligence – is very basic. The hard part is the data. Where's the data? The algorithms that sit on top of it are actually quite simplistic. The challenge we're facing today is we now have in this country over 400,000 patients that have been tested positive for COVID-19. Where's that data? Why don't we have that data in one central place? Why are we still debating how hydroxychloroquine works or doesn't work or Remdesivir or whether or not patients with asthma are actually at higher risk or not?

Any of these data elements that would be relatively easy to map is hard because the data is not flowing. So the stage we're at now is trying to work with the federal government in some capacity and state governments and many hospitals to say, let's get the data in one place, at least some amounts of the data, and then we have offered to structure that data at least for first 10, 20, 30, 40, 50,000 patients for free.

But what's happening in many instances is the people that have the data, these large hospital systems, are so overwhelmed as you can imagine, for all the right reasons, that it's hard to have those conversations and figure out how to get the data in one place.

So Eric, I look forward to increasing our partnership with you in this area. And this is an area that our [FasterCures](#) is really focused on, not just domestically, but internationally. I think you've laid out a path for us. Lastly, what about your own employees? They are

essential for you to do your job and to build an answer quite possibly for us of who has the most adverse reactions. How are you operating these days?

It's incredible. We've got a fantastic team and of that there's about maybe 250 people or so that are coming in every day because they work in some way, shape or form in one of our two big labs. We have a large lab in Chicago and one in Atlanta. And these folks are coming in because they're performing a critical and necessary health care service and sequencing cancer patients or patients with other diseases that need that data to be treated. So it's really, you watch that kind of effort and commitment and you're just amazed, not just the people that show up to work every day in our labs, but obviously the people on the frontline of healthcare. And the rest of our staff is at home. We have probably about 900 people that are at home like I am, and trying to make sure that we don't be part of spreading disease any further.

We're going to have to see what the world looks like in a few weeks when we come out of this and people begin to return to work in some way, shape or form. That'll be I think the next big test as to how we're all going to work. If there's any positive to this, one of the bright spots has been just how efficient many companies are working in this remote capacity and so you will have an enduring impact I think on

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how all of us think about the office environment, the home environment and whether or not we want to have virtual workforces operating in a more virtual capacity.

Honestly I really am looking forward to just coming out of it and getting back to some new reality where you can have a little bit of balance.... I think we're still going to have to be distant. I think the days of hugging and handshaking and being in crowded spots, you're going to have a giant pullback from that. But I look forward to some amount of external contact and human interaction. So that'll be nice.

Eric, thank you for joining us today, and we look forward to seeing the important role Tempus might play here in controlling COVID-19.

And thank you for all the work you do. It's pretty amazing. So thank you.