Steering Pathology Into the Future

When informaticist John Gilbertson, MD, thinks about the future of pathology, he likes to relate it to the old weather instruments he once uncovered on his family’s New Hampshire farm. He recalls handling the instruments – a barometer, a thermometer, a weather vane – and marveling at the intense labor and expense that was once required to generate even the roughest predictions of the coming days’ conditions.

Just as modern-day farmers can get a remarkably accurate weather forecast for free by flipping on the TV or browsing the Internet, Gilbertson and other pathology innovators at the Massachusetts General Hospital and Brigham and Women’s Hospital predict that patients and physicians of the not-so-distant future will benefit from virtual health forecasts generated using the vast amounts of information reported in their medical records.

“Behind the weatherman in the funny tie giving the 30-second forecast is actually a tremendous amount of data and computational power,” says David Louis, MD, the Pathologist-in-Chief at MGH and the Benjamin Castleman Professor of Pathology at Harvard Medical School.

The answer, according to Louis and the Chair of Pathology at BWH, Jeff Golden, MD is an emerging field known as computational pathology.

“Similarly, with all the new technologies we have in pathology, we can generate huge amounts of data – millions of data points, if we wanted to,” Louis says. “The question is: How can we put that data together in a way that helps our patients?”

The bottom line is that we need to become more effective and efficient at delivering healthcare – for quality, for cost, for outcomes. For all the right reasons, we need to provide a better value,” says Golden, who also serves as the Ramzi Cotran Professor of Pathology at HMS. “To do that, we need to more effectively use the data that we already collect to get a better idea of what will happen the next day, the next week, the next month. We’re squandering the opportunity to understand our patients better by not utilizing all the data that we collect today.”

Golden and Louis have spearheaded an initiative to develop a common pathology platform for all Partners Healthcare hospitals, an effort that Golden estimates is about a third of the way complete. “Once we have that, we can really begin to plumb the whole system for information. It gives us a tremendous power,” he says.

In addition, the pair established a joint training program that has produced the largest number of pathology informaticists in the country to date.

“As digital technology adoption has been disruptive in other industries, digital pathology is expected to have a similar effect in healthcare. More broadly, Computational Pathology will change the nature and scope of competition. Diagnostic platform companies will expand into informatics and informatics companies will reach deeper into healthcare. Computational pathology will also enable new opportunities for providing clinical services as it offers the ability to diagnose more effectively and adopt novel assays more quickly, at the same time as it lowers cost”, says Pat Fortune PhD, Pathology Market Sector Leader for Partners Innovation, and former top executive in several healthcare companies.
Machines, in conjunction with pathologists, will increasingly have the ability to recognize significant features on and within cells. Guided by input from pathologists, machine learning will enable workflow processing to become much more informative and automated. “Collaborations that capture insights from leading pathology groups are a gating item in this value creation process,” Fortune says.

A number of collaborations are underway with computer science and artificial intelligence scientists at MIT, Louis says. “They’re fascinated with the prospect of using laboratory data to build these models. This is what they do for all sorts of other industries. They’ve found it harder to do this for healthcare.”

“In addition, over the last 5 years, we’ve seen an explosion in interest from companies wanting to get into this area.”

Current projects range from digital imaging in pathology to next-generation sequencing and molecular diagnostics for cancer.

“Just to give you an example, when the CBC machine does an annual check of your red blood cells and your white blood cells, the machine actually generates a lot of numbers that physicians either don’t see or don’t look at in any detail, because the significance of those numbers is not clear,” Louis explains. Researchers at the MGH have created a larger dataset of the parameters, examined how those parameters change in a given population of blood cells, and developed a mathematical model of the changes.

“By doing this, we’ve been able to diagnose patients who get anemia 2 to 3 months in advance of when they would be diagnosable by standard testing,” Louis says.

At the BWH, associate pathologist at Georg Gerber, MD, PHD, is developing an algorithm that accounts for a patient’s genetic makeup, gut microbiome, and gut metabolome – inventories of the bacterial species and metabolites, respectively, that are present in that individual’s gut.

“He’s going to combine all of these extraordinarily large datasets together and build an algorithm that will predict who’s at risk for developing C. difficile enteritis, one of the most common and debilitating and major cause of morbidity and mortality from a hospital-acquired infection across the United States,” Golden says.

Identifying at-risk patients could help physicians target prophylactic treatments, Golden notes.

“That’s how you can use these massive amounts of data to address very important questions in healthcare.”