Imagining the future

Mobile technology, molecular medicine, and 3D bioprinting predicted to influence diagnosis and treatment

By Jan Bowers, contributing writer, March 03, 2014

The year 2020 is only six years away, but the accelerating rate of technological advancement and scientific discovery will likely bring dramatic changes in the practice of dermatology by that time. *DW* asked seven prominent physicians, representing several areas of expertise, to speculate about what dermatologic diagnosis and therapy might look like in 2020 and beyond.

**TRENDS IN DIAGNOSIS**

**Technology that facilitates patient-doctor communication**

*Jack Lewin, MD, president and CEO of the Cardiovascular Research Foundation and chairman of the National Coalition on Health Care*

Computer-aided diagnosis [and other applications of technology] will be a game-changer for doctors and patients. We’re going to be looking for ways to promote value, and utilizing information technology more and more to do that. We’re talking about going beyond electronic health records: we’re looking at clinical decision support attached to EHRs, and also interfaces with patients. Patients are going to have their own version of what their symptoms are, and they’ll be inputting some of their own information. So both patients and doctors will be entering information about particular circumstances — either disease management, or a specific acute medical issue — that will allow us to reduce the disturbingly frequent rate of misdiagnosis and/or use of therapeutics that will not be helpful to a patient for a number of reasons: maybe because of their genetic individuality, maybe because of a history of allergy.

We’ll be able to get more value out of health care by virtue of these communication tools. It will be the patient’s choice of device and app; there is already a multiplicity of new apps developing. There are all kinds of ways we can get at becoming more accurate, and also more effective in producing value, which is better care at lower cost for everyone concerned.

*Daniel M. Siegel, MD, clinical professor of dermatology at the State University of New York at Downstate School of Medicine and past president of the AAD*

By 2020, we should be at a point where we’re practicing routine store-and-forward teledermatology on a common basis. It’s just a matter of time until patients can get a consumer version of a device where they...
stabilize the area they’re told to put it on, they hold still, a little sensor tells them when they’re steady enough, somebody hits the remote control, it captures the image, and it goes off to the doctor — I think that’s not too far down the road.

I can see a point where, from pretty much anywhere in the world, you could have an interactive call with a patient, and have the patient take their device, stick on a dermascope, and let you look at things just as you might in the office. You won’t have the tactile feedback, but even that might be coming at some point.

**Non-invasive imaging**

*Dr. Siegel*

Remember the tricorder from *Star Trek*? Imagine that a patient comes in, you put a hand-held device on the patient, and you’ll non-invasively be using some clever mix of optical coherence tomography, confocal microscopy, ultrasound, and maybe some molecular analysis. You hit the button on the device, and you’ll get back a pathology look-see that you can view on a screen. Maybe you’ll also get a biochemical analysis of markers and essentially you will be able to make a diagnosis non-invasively. I doubt we’ll get to the point where we can fix things the way they did on *Star Trek*, and heal them right away, but diagnostically we’re getting there pretty fast. And that will mean fewer biopsies and more rapid and accurate diagnoses. I’m thinking that will be closer to 2030 than 2020.

*Orit Markowitz, MD, assistant professor of dermatology at The Mount Sinai Medical Center*

The best way to predict how things are going to look in the future is to take a look at how things have changed over last 10 to 20 years. If you look at where we were 20 years ago, we’ve made a leap from the clinical exam to using non-invasive technologies like dermoscopy. There is a movement toward non-invasive in general, because we want additional information before we cut the skin and do a biopsy.

So the question becomes, where do you go from here? That’s where some of these other non-invasive devices come into play. In addition to using these devices to look at the skin and decide whether something actually needs to be biopsied, we will also be trying to monitor treatment, and using the devices in clinical trials.

The two I’ve used are confocal microscopy and optical coherence tomography. Confocal microscopy, I think, is better for diagnosis than for treatment monitoring. It has a lot of cellular resolution, but the depth is only 3 micrometers; it’s good for visualizing changes in pigmented lesions. Optical coherence tomography is very good for lesion monitoring, including non-pigmented lesions; it sort of mimics what we would think an ultrasound of the skin looks like. It’s a black and white, almost flip-book animation of a vertical section, and it goes to about 2 mm of depth, so it’s significantly deeper but has less cellular resolution than confocal microscopy. That’s the device that we’re currently using to sort of monitor and understand better what some of the ideal non-invasive treatments for non-melanoma skin cancer are.

One other device is high-resolution ultrasound, which has been studied in clinical trials. It goes deeper into the epidermis and the dermis, but the deeper you go, the less cellular resolution you have. At Mount Sinai, Robert Bard is using high-resolution ultrasound to look at in-transit metastases and nodes.

Non-invasive imaging is the future; I think these types of devices will become much more commonly used. Of course, I’m a little bit biased because that’s where my work has been centered. If you look at what happened from 20 years ago to today, you see that this is where it went, and I just feel like that’s the direction we’ll have to head in.

**Detecting and treating melanoma**
In five to 10 years, biopsy rates and biopsy ratios will be scrutinized by insurance companies and organized medicine as a metric for diagnostic accuracy and specificity. Dermoscopy and its various algorithms, as well as computer-aided devices, such as Melafind, will be used to enhance sensitivity and specificity. There will be increased use of total body photography and more observation of photos of lesions which were not biopsied but were felt to warrant closer scrutiny. [More dermatologists will follow] the recent trend established by Stuart Goldsmith and others to disregard “D for diameter” and substitute “D for dark” and add “E for evolution,” or change; the logic is that this will increase sensitivity over specificity.

One thing that’s very intriguing is Melanoscan, an imaging technology created by [Connecticut dermatologist] Rhett Drugge. He has taken psoriasis light boxes and put in about 30 cameras. The patient goes in and does two poses (it only takes about a minute), and the photography captures the entire skin surface. What is interesting is that right now, his business model is having technicians look at this and do periodic updates and look for change. But imagine a computer powerful enough to match up every lesion and look for change automatically, even if you’re slouching one day, or you’ve put a little weight on. Or imagine an app for your iPhone where you mount it a certain way, hit the button, and you photograph yourself. Then it asks you to take a picture of a spot that has changed — say, a mole that was perfectly round but now is oval and has a notch in it. That technology exists now, and it’s called edge recognition technology. The application could be five to seven years in the future.

With melanoma drugs, it’s a brave new world out there. We’ve got the BRAF inhibitors and the MEK inhibitors, but it’s still such early days. Gradually, just as we’re getting more targeted with biologics, we’ll hopefully get to a point where we’ll have smaller molecules that won’t have all the toxicities of current drugs and that can really be targeted so that you can look at someone’s genome and the disease they’ve got and come up with medication that’s really customized for them.

In terms of competing technologies that might prove to be better than Melafind, there are several out there under development. Will they be ready for prime time by 2020? My own sense is that it’s possible but not likely. But, will they be good enough for a first-pass screen to be used by patients over the Internet? Maybe. There are already over 100 iPhone apps for dermatology out there. So I think that by the year 2020, patients will be able to take reasonable-quality skin images and send them to the dermatologist; that’s going to be a big game-changer.

I would predict that the dermatology electronic medical record will be image-based, and that mobile imaging for dermatologic triage is going to be routine. And that the dermatologists themselves will, as a result, be seeing much more highly pre-selected patients. In order to maintain their relative expertise to the other professions, they will need to apply more cutting-edge technologies like confocal microscopy. Because of their clinical acumen, that’s where the insights are going to be, and that’s going to be what differentiates the dermatologist.

One of the biggest challenges that we have in dermatology is that while all of this imaging is going forward, no one has created standards for it. The International Skin Imaging Collaboration Melanoma Project is an effort to develop standards around technology, techniques, and terminology. We’re starting with melanoma, with the idea that if we get it right in melanoma it will be generalized to other areas of dermatology. I’m
talking about at least agreeing what kind of cameras make sense to use and how to use them. And then how to describe what those images show.

It’s beginning to use technology for the low-hanging fruit while these fancier technologies develop that I think is where dermatology is going to be.

**ADVANCES IN THERAPY**

**Genetics and molecular medicine in the treatment of psoriasis**

*Johann Gudjonsson, MD, PhD, assistant professor of dermatology at the University of Michigan Medical School*

Part of my work is translating the findings from genetic studies into the biology of psoriasis, determining how specific risk genes shape information on psoriasis and influence the inflammatory process. In the past six or seven years, there has been enormous progress in identifying the risk genes involved, with 36 risk genes identified to date, and that’s only the first step. Now we are working to actually translate those findings into biological context, determining how these mutations and risk variants influence the disease process.

I believe we’ll gain a much deeper understanding of what psoriasis actually is by mapping out the key pathways involved. It’s going to become more and more clear, and I think most people today agree, that it’s probably not a single disease entity, but more like a spectrum of overlapping diseases. Thus, there’s a large difference from one individual to the next in terms of how patients respond to any given treatment, how many risk genes they carry, and the shape and direction of the inflammatory processes in psoriatic skin. I think within the next five to seven years we’re going to be able to tie all of this together.

Many individuals have been looking toward pharmacogenomics to help identify specific genetic markers of treatment response. It is likely that this will be problematic, particularly because there are so many risk genes involved and so many potential combinations. Some of these combinations are going to be synergistic and others may be antagonistic, and may not always work together in terms of treatment response. As psoriasis is a disease that can fluctuate in disease activity and sometimes change in terms of clinical presentation, I think what’s going to be more likely to be successful in terms of predicting treatment responses are specific markers in the inflamed skin, such as gene expression profiling. A lot of the work that is ongoing in my laboratory is geared toward this by mapping out qualitative and quantitative properties of the inflammatory network in psoriasis and attempting to use that as a predictor of treatment response.

It’s a very exciting time in psoriasis research. Things have moved so quickly that just in the past five or six years we have gone from having only one single risk gene for psoriasis up to at least 36 genes. Although there are many hurdles to cross, I think in the end this work will translate to more effective treatments and, hopefully, some kind of a predictor of treatment response in patients.

**Squamous cell carcinoma**

*Dr. Cognetta*

The role of cytokines in squamous cell carcinoma will be increasingly recognized and exploited as a potential role for therapy. We have long recognized that SCCs are often painful lesions as compared to their benign counterparts; it is likely that some type of cytokine has a role in this. The recognition that some SCCs exhibit pathergy, as do other inflammatory diseases such as psoriasis and pyoderma gangrenosum, suggests there may be a common denominator between them vis a vis the immune system.

**Cosmetic treatment**
Jeffrey Dover, MD, associate clinical professor of dermatology at Yale University School of Medicine, adjunct professor of medicine (dermatology) at Dartmouth Medical School, and adjunct associate professor of dermatology at Brown Medical School

I think we’ll start to take a more global approach to anti-aging; instead of fixing this line or that hollow, there will be ways to slow the aging process. It will probably be a few years from now, but there will be systemic agents that can be taken as a way to slow or reverse the aging process. We have very little right now — nothing, in fact that has been shown conclusively that you can take by mouth to slow the aging process.

Down the road, there will be agents that we can apply to the skin — through gene therapy — which will alter our appearance in a subtle and positive way. We will have creams which down-regulate the expression of telangiectasia, lentigines, wrinkles, and sagging. And there’s no reason why we won’t have a product that you can apply to the skin to stop pattern baldness from ever developing. We should be able to — in our lifetimes — have a treatment that will prevent hair from falling out in both but men and women as they age. The first development, which is right around the corner, is to clone and grow human hair in the laboratory, and to use this to transplant into areas of thinning.

Lasers will continue to get smaller, less expensive, more effective, and safer. And we’ll use more and more energy-based systems to produce desirable effects.

Radiofrequency devices are now being used to tighten skin and we’re now using selective cold and high-frequency ultrasound to reduce localized areas of unwanted fat. The next group of devices will be even more reliable, smaller, solid state and smart diode-based technology. These smart lasers will sense and fire only at the target but not at the surrounding adjacent skin.

**Tissue synthesis**

*Dr. Siegel*

[Regarding therapy for other disorders], there have been shots in the past at fusing tissues with lasers, as opposed to sewing. That may come to the fore again. We may come up with better biologic glues, or combinations of ultrasound and chemicals that may be used to heal wounds. Biochemically, we may find ways to turn genes on and off to get fat metabolized for us. Or if you have an older patient who is losing fat in their face, you could turn on the fat that’s left in those areas to produce more. I suspect we’ll discover ways to activate genes that we’re not even thinking about now.

There are already a couple of variations on 3D bioprinting of human tissue. It’s really experimental, and not being done commercially yet. There are a couple of cases you hear about every so often that make the science glossies, as opposed to our literature. But it’s only a matter of time. If you have someone who has a bad burn or someone who has vitiligo, you can just have the 3D printer spitting the right cells out to the right places or building up structural things like collagen or cartilage. I think that’s less likely to occur by 2020, but it is possible. Most of these neat technologies tend to not be evolutionary, gradual change, but one day someone pops up with something no one else has thought of, and it’s a revolutionary change. You just don’t know when dramatic change will come about.