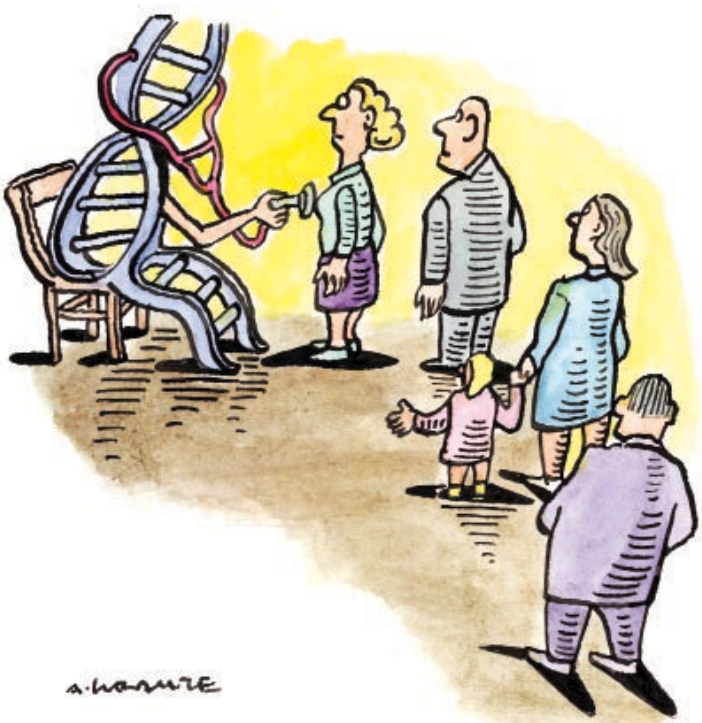
Testing times

The problems of the consumer genetics revolution go well beyond the accuracy of $99 spit tests, warns **Donna Dickenson**

IT'S 2008. The *New Yorker* is chronicling a celebrity "spit party", at which notables – nicknamed the "Spitterati" – eject saliva into tubes to find out their risk of developing illnesses such as diabetes, heart disease and cancer. The firm involved is 23andMe, a direct-to-consumer genetic testing company whose service was named Invention of the Year by *Time* magazine.

Fast-forward five years. 23andMe receives a demand from the US Food and Drug Administration (FDA) to stop selling its health-related tests pending scientific analysis. In a separate event, a Californian woman, Lisa Casey, files a $5 million class action lawsuit alleging false and misleading advertising. 23andMe suspends sales of its test, putting paid to its target of reaching 1 million customers by the end of 2013. Where did it all go wrong?



In November, after what the FDA describes as years of "diligently working to help [23andMe] comply with regulatory requirements", the agency sent a scathing letter to the firm's CEO Anne Wojcicki. It stated that 23andMe's Personal Genome Service was marketed without approval and broke federal law, since six years after it began selling the kits, the firm still hasn't proved that they work.

Doubts go back a long way. In the year of the spit party, the American Society for Clinical Oncology commissioned a report that concluded the partial type of analysis involved wasn't clinically proven to be effective in cancer care. In 2010 the US Government Accountability Office concluded that "direct-to-consumer genetic tests [involve] misleading test results… further complicated by deceptive marketing".

What 23andMe offered was a $99 test for 250 genetically linked conditions, based on a partial reading of single-nucleotide polymorphisms (SNPs). These are points where the genomes of different individuals vary by a single DNA base pair. There are some 3 billion base pairs in the human genome – this test targets only a fraction of them. Different companies sample different SNPs and so return different results for the same person.

To illustrate this point, in his book *Experimental Man*, science writer David Ewing Duncan recalled how he received three conflicting assessments of heart attack risk from three different companies. The director of one, deCODEme – no longer offering such tests – telephoned him from Iceland to urge him to start taking cholesterol-lowering statins. Yet the other two tests – one from 23andMe, one from Navigenics, which no longer offers consumer tests – had rated him at medium or low risk. Given that some statins carry side effects such as muscle weakness, Duncan might have been ill-advised to follow deCODE's urgent advice.

"Six years after it began selling the genetic-testing kits, 23andMe hasn't proved they work"

This is the root of the FDA's concerns. In its letter to 23andMe, it raised the risk that customers could get false information that leads to drastic and misguided medical steps. Wojcicki now says: "We want to work with [the FDA], and we will work with them." But is it too little, too late?

And what of the class action lawsuit, brought by Casey after buying a test? It focuses on the test's accuracy but goes further, targeting what Casey's attorney calls "a very thinly disguised way of getting people to pay [23andMe] to build a DNA database".

By asking customers to fill in surveys about health and lifestyle, 23andMe has been creating a valuable "biobank" for patenting purposes and industry collaboration. The firm has always sought customer consent for use of identifiable data and hasn't disguised its aim. "The long game here is not to make money selling kits, although the kits are essential to get the base level data," says 23andMe board member Patrick Chung. "Once you have the data, [23andMe]… becomes the Google of personalised healthcare."

Last June, this strategy culminated in a potentially lucrative genetic patent related to Parkinson's disease. The company had offered its test free to people with the illness and might have expected praise. But an angry customer wrote: "I had assumed that 23andMe was against patenting genes. If I'd known

you might go that route with my data, I'm not sure I would have answered any surveys."

What impact will all this have on 23andMe's brand strategy? The firm has tried to create a sense of solidarity, emphasising what it called "common interests, affinities and passions". As the firm wrote on its blog in 2008: "Wikipedia, YouTube and MySpace have changed the world by empowering individuals to share information. We believe this same phenomenon can revolutionize healthcare."

If customer trust is threatened, that won't happen – even if the firm switches to sequencing the whole genome or exome (the protein-coding parts of the genome), avoiding the worst inaccuracies of SNP testing. Whole-genome sequencing has become cheaper, although it's still out of reach of the mass market the firm needs to build the biobank. Earlier this year the company piloted a whole-exome service for $999.

Given its status as the poster child of mass-market genetic testing, do 23andMe's travails affect personalised medicine more generally? In the year that it started operations, 2007, then-Senator Barack Obama introduced his Genomics and Personalized Medicine bill, remarking that "in no area of research is the promise greater than in personalised medicine". Many advocates expected the shift to start at the popular, consumer level.

So while the most consciously populist genetic testing service wrestles with its critics in the months ahead, there is a growing danger that wider public acceptance of personalised medicine in the clinical setting may also suffer in the fallout from 23andMe's woes. n

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ONE MINUTE INTERVIEW

Cosmic messengers

Neutrinos from deep space could hugely expand our understanding of the universe, says **Ray Jayawardhana**

PROFILE
Ray Jayawardhana is professor of astrophysics at the University of Toronto, Canada, and author of *The Neutrino Hunters* (Oneworld/Farrar, Straus and Giroux). He will be speaking at London's Royal Institution on 21 January

What's so interesting about neutrinos?
They are elementary particles with rather quirky properties. They hardly ever interact with matter, and that makes them really difficult to pin down. Trillions pass through your body every second but there's only maybe a 25 per cent chance that one will interact with an atom in your body in your whole lifetime.

Where do they come from?
Some come from the heart of the sun; others are produced in the upper atmosphere when cosmic rays hit atoms. Then there are geoneutrinos that are produced in the Earth's interior as radioactive elements decay. The vast majority of neutrinos that pass through Earth are from those three sources. But there's a great deal of interest in detecting neutrinos that come from much farther away – cosmic neutrinos.

Why are cosmic neutrinos such a big deal?
Some of the more violent phenomena in the universe produce neutrinos. So there are some really fundamental questions that cosmic neutrinos allow us to probe. So far, though, only two batches have been detected. The first were from the supernova 1987A, a star that exploded in a satellite galaxy of the Milky Way. More recently, the IceCube neutrino observatory in Antarctica reported some 28 energetic neutrinos that are almost certainly cosmic in origin.

How significant was the IceCube detection?
It marks the beginnings of neutrino astronomy. Astronomy is not like other sciences; we usually don't get to put our quarry under the microscope or analyse it in the lab. We have to depend on feeble light from distant sources. By now, we've fairly well explored the electromagnetic spectrum. There are only two other potential cosmic messengers that we know of. One is gravitational waves, which still have not been detected directly. The other is cosmic neutrinos.

Do the IceCube scientists know the precise origins of the neutrinos they saw?
Not yet. But the two candidate sources are the supermassive black holes at the hearts of galaxies and gamma-ray bursts, which are most likely produced by the deaths of incredibly massive stars.

What else could cosmic neutrinos reveal?
There should have been neutrinos produced seconds after the big bang. With existing astronomy we can only look back to about 380,000 years after the big bang. If we could detect these "relic" neutrinos, we could look back to within seconds of the birth of the universe. The problem is that they are now low in energy, and therefore extremely difficult to detect. Present detectors are nowhere close to being sensitive enough to see them.

Can neutrinos capture the public imagination in the same way as the Higgs boson?
The Higgs has been a terrific story. But neutrinos allow us to probe some really profound questions and I think that makes them truly interesting. They're ready to take centre stage.
Interview by Jon White

J.R. BERNSTEIN