ONLY CONNECT **Nicholas A Christakis**

Medicine may change our genes

The prospect of medical technology modifying genetic evolution is as amazing as it is troubling

A lot of hot air is around at the moment—and quite a bit of overselling—about advances in genetics, personalised genomics, and gene therapy. Only a small part of the variance in human illness is explained by genetics; most is explained by lifestyle, behaviour, and social factors such as poverty. Yet large sums are spent in a quixotic pursuit of the genetic basis for everything.

The hope—some say fear—is that we will be able to use advances in medical technology to reshape the genome of individual patients, curing ailments by changing somatic genes. Some even hope that we will be able to modify our species for the better by introducing changes into our germline.

Ethicists hotly debate this topic, arguing about the case for or against "perfection." Do we have the right to develop technologies that would allow us to change the human genome? Some would say this is a duty. After all, if we could develop a genetically based treatment for patients with sickle cell disease, cystic fibrosis, or diabetes, who would not support that?

But overlooked in all this debate is the ways in which—just possibly—medical advances may already be changing our genes at the population level.

It used to be thought that our genes were historically immutable and that it was not possible to imagine a conversation between culture and genetics. It was thought that we as a species evolved over a timescale far too long to be influenced by human actions. But evidence has been mounting for the past decade that we as a species are evolving genetically in real time, under the pressure of discernable social and historical forces.

The best example so far is the evolution of lactose tolerance in adults. The ability of adults to digest lactose confers evolutionary advantages only when a stable supply of milk is available, such as after milk producing animals (sheep, cattle, goats) were domesticated. The advantages are several, ranging from a source of valuable energy to a source of necessary hydration during times of water shortage or spoilage.

Amazingly, several adaptive mutations have occurred in widely separated populations in Africa and Europe just over the past 3000 to 9000 years, all conferring the ability to digest lactose. These mutations are principally seen in populations of people who are herders and not in nearby populations who have retained a hunter gatherer lifestyle. This trait is sufficiently advantageous that those with the trait have many more descendants than those without.

A similar story can be told about relatively recent mutations that confer advantages in terms of surviving epidemic diseases such as typhoid in Europe. As these diseases were made more likely when the density of human settlement increased and far flung trade became possible, here we have another example of how cultural change may affect our genes.

Of course, our biology and our culture have always been in conversation. For example, rising socioeconomic status with industrial development resulted in people becoming taller (a biological effect of a cultural development), and taller people required a change in architecture (a cultural effect of a biological development). Anyone marvelling at the small size of beds in medieval houses knows this at first hand. But it seems that it is also possible for genetic change to take place over relatively short time periods.

Why does this matter to medicine? Because many of the things we are already doing may be modifying our genes. Maybe we are all more myopic as a result of medieval lens grinders.

PAUL SCHNAITTACHER

"Maybe we are all more myopic as a result of medieval lens grinders. Maybe our bones are weaker since we have had bone setting technology for thousands of years . . . Maybe the introduction of penicillin and childhood immunisation is changing our genes"

Maybe our bones are weaker since we have had bone setting technology for thousands of years. Maybe the changes in survival of patients with all sorts of conditions that are wholly or partly attributable to single or multiple genes (ranging from sickle cell disease to type 1 diabetes) are resulting in changes in the human genome. Maybe the introduction of penicillin and childhood immunisation is changing our genes. Some have noted that the number of children with Down's syndrome is falling in many industrialised societies as a result of selective abortion. With the onset of personal genetics, it is not hard to imagine this being taken a step further. Medical technology might change our genes indeed.

Medicine is not the only thing doing this in ways relevant to health and wellbeing. There may be genetic variants that favour survival in cities, consumption of alcohol, or a preference for complicated social networks. There may be altruistic genetic variants that favour living in a democratic society. Maybe even the more complex world we live in nowadays really is making us smarter.

Unfortunately, this also means it may be the case that particular ways of living and particular medical technologies create advantages for some but not all members of our species. Certain groups may acquire (admittedly, over centuries) certain advantages. The idea that the application of medical technology modifies what kind of offspring we have is as amazing as it is troubling. However, it provides a way for us to begin to think about the inevitable genetic revolution in medicine that is around the corner.

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