Gene Editing Lulu, Nana, and Their Children

James C. Peterson

He Jiankui announced November 25, 2018, that his lab had successfully edited the genes of two embryos to protect them from inheriting HIV from their father. He declared pride in the birth of Lulu and Nana, but many geneticists condemned his process, and now the Chinese government has declared it illegal. Why?

As readers of this journal will know, earthly life in all its variety has the instructions for form and function in its genes. When geneticists first found ways to change DNA, the initial techniques were rather clumsy and slow, but they could be deeply formative. Recombinant DNA was used to create human insulin that had never been in a human body. Instead of injecting diabetics with insulin from pigs, the DNA recipe for human insulin was edited into bacteria so that they followed the new instructions to make human insulin. For decades now, diabetics around the world have been staking their lives on it.

But the geneticists realized that these gene-editing techniques could also do damage, such as if they altered a common organism in the environment in a way that would sicken other life forms and possibly escape into the environment where it could multiply. In 1975, the founders of recombinant DNA gathered at Asilomar State Park in California, to develop safety guidelines that have been largely followed voluntarily ever since.

The change that came recently was the discovery of CRISPR, "clustered regularly interspaced short palindromic repeats." It is a natural defense system that bacteria use to defend themselves from viruses. Emmanuelle Charpentier, Jennifer Doudna, Zhang Feng, and others discovered that they could direct it with Cas-9 to find and cut DNA wherever they wanted. What was particularly noteworthy was that this could be done quickly, accurately, and inexpensively. The opportunities to use this in research—research that could lead to medical cures, but also to harms—were immediately evident. The US National Academy of Sciences, the US National Academy of Medicine, the Chinese Academy of Sciences, and the Royal Society called for a meeting of several hundred leading genetics researchers and a few advisers to think through how to best guide this new technique to positive use. The conference met in Washington, DC, December 1–3, 2015.

A one-page report was published and widely quoted, although it was overshadowed by a terrorist attack in the news that day. The communiqué reminded its readers that medical research has saved countless lives, and pointed out that this new technique of CRISPR would dramatically accelerate ongoing research. It then noted that using these techniques to help particular patients with harmful diseases seemed a reasonable use, in line with other medical care. It went on to say that therapies that could be inherited, hence affecting the patients' children and grandchildren, should not be acceptable at this time. The main concerns were that (1) future generations could not be consulted about the changes being made on their behalf, (2) it is difficult to project long-term effects, and (3) there was not yet widespread discussion and acceptance of the wider society. The agreement from the meeting was not that there would never be inheritable (germline) gene editing, but rather that it would not be attempted until safety was assured and a widely discussed societal consensus was developed. To build on that agreed understanding, ongoing meetings were held in Paris in 2016, again in Washington, DC, in 2017, and most recently in Hong Kong in 2018.

It was at the Hong Kong meeting that He Jiankui announced the birth of twins who had been gene edited to protect them from their father's HIV. As more details have trickled out, it seems more likely that the girls are genetic mosaics, so it is not clear yet that the intended purpose was achieved. What alarmed other geneticists was not that He Jiankui was trying to protect people from HIV, rather, that he had done so with disregard for the safeguards that had been widely agreed to for gene editing. He failed to "include strict independent oversight, a compelling medical need, an absence of reasonable alternatives, a plan for long-term follow-up, and attention to societal effects."[1] The consensus at the

conference was that germline editing could become acceptable in the future if it is shown to be safe for the recipient and if these procedural safeguards are followed. What was alarming was that He Jiankui had ignored the agreed upon guidelines and that others might be doing so too.

This situation has caught the attention of Beijing health authorities who have discovered other gene-editing attempts in embryos and adults, attempts that have been pursued without following up on those so treated, including after recipient deaths. *The Wall Street Journal* reports (December 29, 2018, A1) that Beijing officials have stated now that implanting a gene-edited human embryo is illegal in China. In contrast, it is not illegal in the United States. In the USA, such an experiment would not be funded by the federal government, but there are no legal limitations on this being pursued in private labs with their own funding. The academies and conferences described above have been counting on self-regulation, particularly to avoid clumsy government regulation. It remains to be seen if He Jiankui is an outlier who can be quickly directed back on track, or if he is a harbinger of many cases that will eventually come to light.

So what might be a Christian perspective on gene editing? The basic intention to heal disease was central to the earthly ministry of Jesus and so has always been at the center of the Christian tradition. Jesus taught not only to love God, but also to love one's neighbor as much as oneself. We certainly care about our own suffering and seek to relieve it, just as we should seek to relieve the pain and suffering of all those whom we are able to help. Christians have established thousands of hospitals around the globe and have invested millions of dedicated lives, in seeking to heal and prevent disease. To the degree that He Jiankui was pursuing the goal of preventing a devastating disease, there is good reason for a hearty amen from the Christian community. But the Christian tradition is also deeply aware of our human drives toward self-absorption, compounded by self-deception. The proffered safeguards are needed.

In particular, is there a challenge from the Christian community concerning making changes that are inheritable? It is the human condition that we make choices for our children. We decide for children what their birth citizenship will be, what food they will eat in their earliest years, and what language will be their native tongue; we vaccinate them against polio and whooping cough. We cannot help but make formative decisions on their behalf. Our choice is more in whether we will make such decisions well, not in whether we will make such decisions at all. If it comes to be shown that gene editing for the presenting patient, that is then inherited, is safe and efficacious to prevent a child and their children from getting HIV, then that seems a worthy use. For now, it has not been confirmed that gene editing is consistently safe for the presenting patients, let alone for the following generations. It will take time to be sure of that—much longer than for fruit flies or zebra fish. Hopefully, the quickly expanding group of people who can apply CRISPR-Cas techniques will follow consensus protocols to develop and implement it with care, or there will be a reaction of government regulation that could strangle much life-changing service before its full birth. ✧

Note

[1]Full statement at http://www8.nationalacademies.org/onpinews/newsitem.aspx?recordid=11282018b&_ga=2.86916507.283298593.1546974499-1513591976.1546530576.

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