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GENE EDITING IS HERE, AND DESPERATE PATIENTS WANT IT

TWO-THIRDS OF AMERICANS SUPPORT THERAPEUTIC USE, BUT REGULATORS ARE STILL STUCK IN THE 1970S.

By

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Should Americans be allowed to edit their DNA to prevent genetic diseases in their children? That question, which once might have sounded like science fiction, is stirring debate as breakthroughs bring the idea closer to reality. Bioethicists and activists, worried about falling down the slippery slope to genetically modified Olympic athletes, are calling for more regulation.

The bigger concern is exactly the opposite—that this kind of excessive introspection will cause patients to suffer and even die needlessly. Anachronistic restrictions at the Food and Drug Administration and the National Institutes of Health effectively ban gene-editing research in human embryos that would lead to implantation and births. These prohibitions are inhibiting critical clinical research and should be lifted immediately.

Curing genetic diseases has been a goal of biotechnology since the 1970s, when the molecular techniques for modifying DNA were invented. So far most of the clinical work on "gene therapy" has involved treating the "somatic" cells that make up, say, the liver or the blood. That altered DNA cannot be passed down to the patient's offspring. In 1990 a 4-year-old with "bubble boy disease," a genetic defect called Severe Combined Immunodeficiency, was first treated at the National Institutes of Health. A string of qualified successes followed, with promising early results for afflictions ranging from fatal genetic diseases to Parkinson's.

More controversial is editing the DNA of eggs, sperm and embryos, since those changes would be passed on to future generations. Pre-clinical research is moving swiftly: A multinational team led by Shoukhrat Mitalipov, an embryologist at Oregon Health and Science University, has corrected in human embryos an abnormal gene called MYBPC3, which can cause a condition marked by cardiac

arrhythmia, heart failure and sudden death. That research, published in August, represents a major advance for three reasons.

First, of the 58 embryos manipulated with a gene-editing system called Crispr, the MYBPC3 gene was repaired in 42—a rate of success that's unprecedented in this kind of study. Second, the gene-editing system appears to have worked with extraordinary accuracy, avoiding the unwanted ("off-target") changes to DNA that had plagued earlier attempts. Third, all of the cells in the successfully modified embryos contained the normal DNA. If one of the study's corrected embryos had been implanted in a woman's uterus, there's a reasonable chance it would have become a healthy baby.

This type of research is also taking place abroad. Last month a Chinese group led by Junjiu Huang announced it had used a refinement of the Crispr system on human embryos to correct the mutated gene responsible for a blood disorder called beta-thalassemia.

As to the ethics, it would be unacceptable to modify normal embryos—the cliché about "designer babies"—but nobody is proposing to do that, and no American regulatory agency would approve it. If the concern is that embryos may be destroyed, parents with genetic diseases are already discarding many while using in vitro fertilization as a way to avoid passing on abnormal DNA. Today's state-of-the-art approach is to create a set of embryos, test them for the faulty gene, implant a normal one, and discard the rest. The use of Crispr gene-editing to correct abnormal embryos would likely result in fewer being destroyed.

These recent studies demonstrate how rapidly the field is moving. Using a more primitive approach, the MYBPC3 mutation was first corrected in mice only three years ago. Now, after the Oregon study, the technology is arguably at the stage where clinical trials could be undertaken to see whether gene-edited human embryos can develop into healthy babies. The potential to help millions of people avoid horrific genetic conditions is nearly within scientists' grasp.

What's holding researchers back, at least in America, is outmoded regulations. The FDA is blocked by law from accepting applications for research involving gene editing of the human germ line—meaning eggs, sperm and embryos. The NIH, whose approval also would be needed, is similarly barred from even considering applications to conduct such experiments in humans. These rules date as far back as the 1970s, when the technology was in its infancy. It's easy to invoke hypothetical fears when actual lifesaving interventions are decades away.

Today they aren't—and desperate patients deserve access to whatever cures this technology may be able to provide. The public thinks so, too. A survey this summer found that nearly two-thirds of Americans support therapeutic gene editing—in somatic and germ-line cells alike. Popular opinion is in tune with scientific reality. Legislators and regulators need to catch up.

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