



ANDY WONG/AP/SHUTTERSTOCK

China has hundreds of clinics offering *in vitro* fertilization, and some practitioners lack awareness of the importance of ethics training.

Reboot ethics governance in China

The shocking announcement of genetically modified babies creates an opportunity to overhaul the nation's science, argue **Ruipeng Lei** and colleagues.

As we walked off the aeroplane in Hong Kong in November last year, on the eve of the Second International Summit on Human Genome Editing, we had no idea that we were stepping into the epicentre of an unfolding human drama. Just hours earlier, He Jiankui had made his YouTube announcement claiming to have helped make genome-edited babies. As soon as we switched on our mobile phones, they started to vibrate furiously.

Two of us (R.Q. and X.Z.) worked until 4 o'clock the following morning, answering phone calls, helping China's academic institutions and government agencies to respond to the event, and modifying our plenary presentations for the summit later that day.

In the months since, China's scientists and regulators have been going through a period of soul-searching. We, our colleagues and our government agencies, such as the

Ministry of Science and Technology and the National Health Commission, have reflected on what the incident says about the culture and regulation of research in China. We've also thought about what long-term strategies need to be put in place to strengthen the nation's governance of science and ethics.

In our view, China is at a crossroads. The government must make substantial changes to protect others from the potential effects of reckless human experimentation. Measures range from closer monitoring of the nation's hundreds of clinics offering *in vitro* fertilization (IVF), to incorporating bioethics into education at all levels.

SHOCKED AND CONFUSED

Summit attendees were confused as they gathered in the auditorium of the University of Hong Kong on 27–28 November. Few had heard of He, a biophysicist then

at the Southern University of Science and Technology in Shenzhen. Judging by the questions they were asking us, Chinese reporters were also unprepared and struggling to understand what was going on, or what was at stake.

In China, unlike in the United States and Europe, there have been few public debates about genome editing. Most people don't know what it entails, or the difference between modifying germ cells (sperm or eggs) or other (somatic) cells, let alone the deeper issues — ethical, legal and societal — that are raised by genetically altering future generations.

He's work violated international norms. And it contravened China's 2003 Regulations on Human Assisted Reproduction, which prohibit the transfer of a genetically modified human embryo to a person's uterus¹. Moreover, He's actions potentially put the

health of the babies at risk — as well as that of their potential descendants — because of the likelihood of errors in genome editing. This goes against the traditional Chinese view of medicine established as far back as 600 BC. When the Chinese philosopher Confucius put forward the concept of *ren* (humane-ness) as the core principle of Confucianism, many doctors followed his teachings, perceiving medicine to be the art of humaneness (*yi ben ren shu*).

SO WHY DID IT HAPPEN?

Two weeks before the summit, He had attended China's biannual bioethics conference in Shanghai — along with one of us (R.L.), who chaired a session on how to avoid the premature application of gene editing in clinical trials. That He said nothing about his research at that meeting, but waited until the eve of the Hong Kong summit to make his announcement of the birth of twin girls with edited genomes, speaks to the heart of the problem (see 'Under investigation').

Over the past decade, the Chinese government has increasingly invested in translational medicine, both in academia and in industry. This push for marketable products has fostered a science culture that is plagued with *jigong jinli* — the desire for quick successes and short-term gains. And transferring devices or approaches to the clinic is not always backed by solid basic research².

Moreover, researchers who can declare that they are the first to discover something, both in Asia and in the world, are disproportionately rewarded when it comes to peer review, hiring decisions and funding. Take Chunyu Han, for instance, a molecular biologist at Hebei University of Science and Technology in Shijiazhuang, China, who co-authored a paper in *Nature Biotechnology* in 2016 describing how an enzyme called NgAgo could edit genomes nearly as well as the widely used CRISPR–Cas9 gene-editing tool^{3,4}. The paper was retracted in 2017, but, soon after the initial publication, Han was made vice-president of the Hebei Association of Science and Technology, and his university planned to invest 224 million yuan (US\$33 million) into a research centre for gene editing with Han's team at its core⁵.

In our view, researchers in China are increasingly motivated by the promise of fame and fortune, rather than by a genuine desire for discovery, or a wish to help people and society.

Equally important in explaining why He managed to push ahead are the weaknesses in the ethical governance of research — long the Achilles' heel of China's endeavour to develop science and technology.

He's is not the first unethical research to have been pursued over the past decade. In one example, hundreds of Chinese hospitals offered unproven stem-cell therapies to both Chinese and foreign patients before

UNDER INVESTIGATION

Many questions remain about He Jiankui's work

Biophysicist He Jiankui claims that he used the CRISPR–Cas9 gene-editing tool to disable the *CCR5* gene in human embryos and help a father who carries HIV to have healthy babies. (*CCR5* encodes a protein that allows HIV to enter and infect cells.)

According to the Xinhua News Agency, China's biggest media organization, the informed-consent form used in the study was forged. Various people, including an unnamed practitioner of *in vitro* fertilization, overseas personnel and He, are thought to be responsible for the procedure of genome editing for the purpose of reproduction, based on the preliminary findings of an

investigation by Guangdong's Health Commission, which was completed in January. We suggest that a further, more extensive inquiry is needed, and it must be as transparent as possible. It should establish which institutions were involved, who was responsible for what, and whether other procedures used by He were appropriate.

As part of that inquiry, we recommend that a committee of internationally renowned experts in gene editing assesses the data resulting from He's work¹⁵. They should also provide a blueprint for how the twins, Lulu and Nana, will be monitored and cared for throughout their lives. [R.L. et al.](#)

the government banned the practice in 2012 (refs 6,7). In another, researchers investigated in a 2012 study whether children between the ages of 6 and 8 could obtain as much β -carotene (a precursor of vitamin A) from genetically modified 'Golden Rice' as they could from spinach or from β -carotene capsules. Although the researchers informed the children's parents that they were testing the uptake of a nutrient, no mention was made of genetically modified rice⁸. And last year, a proposed trial in China to transplant the head of a person who was paralysed from the neck down onto the body of a recently deceased donor nearly took place, until it was called off by the National Health Commission⁹.

In the case of stem-cell therapies, regulations in China were lacking until July 2015, when the National Health Commission and the Food and Drug Administration released their joint guidelines¹⁰. Beforehand, those eager to cash in on this type of therapy had been quick to take advantage. In He's case, a lack of investment in regulation overall is probably more to blame. Resources are still an issue in a vast and fast-developing country. In our view, such investment is also limited because of the entrenched belief that science is always right, or that scientific knowledge should be prioritized above all else.

There is a lack of awareness about the importance of ethics training among health-care professionals in China, including those at IVF clinics, for instance. Many members of ethics committees, especially those associated with hospitals in cities such as Hangzhou, Guangzhou and Shenzhen — let alone smaller ones — are probably not in a position to evaluate emerging technologies rigorously, because they lack both ethics training and scientific knowledge. Moreover, education in the humanities, including in medical ethics, is inadequate for students at all levels — undergraduate, master's and doctoral — as well as for research scientists.

WHAT NOW?

We think that six steps could help to reduce the chances of further unethical or illegal uses of emerging technologies occurring in China.

Regulate. The government should collaborate with scientific communities and bioethicists to establish clearer rules and regulations to govern the use of promising technologies that could be prone to abuse. These include gene editing, stem cells, mitochondrial transfer, neurotechnologies, synthetic biology, nanotechnology and xenotransplantation (the transplanting of organs or tissues between members of different species). And corresponding codes of conduct should be developed and implemented by professional associations, such as the Chinese Medical Association and its affiliated Society for Medical Genetics, and the Genetics Society of China.

Self-regulation of scientists is unlikely to be enough, given their potential conflicts of interest under market pressures. Thus, top-down regulation is crucial. In our view, penalties for offenders should be severe — the loss of funding, licences or employment, say. Moreover, to be effective, the governance of research should be the purview of the State Council (China's cabinet). The current approach — in which various government ministries are responsible for oversight — is fragmented and hampered by staff incompetence or resistance. A step in the right direction came in February, when the National Health Commission issued draft regulations for the clinical application of new biomedical technologies¹¹.

Register. A national registry dedicated to clinical trials involving such technologies would promote greater transparency. Before a trial begins, scientists could document ethics review and approval, and list the names of all participating scientists and institutions.

Likewise, a government certification system could be set up, in which only people with appropriate training can qualify to serve on ethics review committees.

Monitor. Organizations such as the National Health Commission must monitor all gene-editing centres and IVF clinics in China to establish what clinical trials are going on. They should assess whether ethics approvals and other procedures (especially relating to informed consent) are adequate; whether the use of eggs and embryos is in line with the Regulations on Human Assisted Reproduction; and whether any other CRISPR-modified embryos have been transferred to a person's uterus. Training in bioethics (research and clinical) should also be made compulsory for all health-care professionals at gene-editing centres and IVF clinics, regardless of whether such people are currently running a clinical trial. In principle, workshops and courses, supported by the government or non-profitable foundations, could be offered for a fee to physicians and researchers.

Inform. An institution such as the Chinese Academy of Sciences or Chinese Academy of Medical Sciences could disseminate the relevant rules and regulations for each emerging technology. It could also advise on appropriate informed-consent procedures and on the latest scientific developments in the field. This would provide a resource for people who are interested in participating in trials, and offer researchers a point of contact if they become aware of possible breaches of ethical guidance.

Educate. With government support, universities and research institutes should strengthen education and training in bioethics (including in clinical, research and public-health ethics) as well as in scientific and

medical professionalism. Students of science, medicine and humanities at all levels should be targeted, as well as research scientists, from technicians to professors.

Relevant ministry-level agencies (especially the National Health Commission, the Ministry of Science and Technology and the Chinese Academy of Sciences) should also foster a greater awareness among the public of the science and ethical implications associated with nascent technologies — and promote an open dialogue about each. Media training to help reporters grasp the nuances and complexity of such technologies should be part of that effort.

End discrimination. Finally, China should step up its efforts to counter prejudice against people with disabilities and the eugenic thinking that has persisted among a small proportion of Chinese scholars¹². In at least nine textbooks on medical ethics, published by mainstream publishers between 2010 and 2015, scholars claim that people with disabilities are *liesheng* (meaning inferior or a burden to society). They argue that people living with disabilities should not be allowed to have children — even that forced sterilization should be used if necessary^{13,14}. China's Law on the Protection of Disabled Persons, enacted in 1990, prohibits discrimination on the basis of disability in employment and other contexts. Clearly more must be done.

It has been only around 30 years since bioethics was established in China. And it is worth remembering that unethical research practices were rife in the West in the early days of ethics governance. Take the infamous Tuskegee study, in which the US Public Health Service tracked — but did not treat — 399 black men with syphilis from 1932 to 1972. Just as the revelation of that research prompted the 1978 Belmont Report, which

protects human participants in studies or clinical trials, the 'CRISPR babies' scandal must catalyse an overhaul of science and ethics governance in China. ■

Ruipeng Lei is professor of bioethics at the School of the Humanities and Centre for Bioethics, Huazhong University of Science and Technology, Wuhan, China, and vice-president and secretary-general of the Chinese Society for Bioethics. **Xiaomei Zhai** is professor of bioethics and health policy at the Centre for Bioethics, Chinese Academy of Medical Sciences, Peking Union Medical College, Beijing, China, and president of the Chinese Society for Bioethics. **Wei Zhu** is associate professor at the Centre for Applied Ethics, Fudan University, Shanghai, China, and a member of the board of directors of the Chinese Society for Bioethics. **Renzhong Qiu** is professor of philosophy of science and bioethics at the Institute of Philosophy, Chinese Academy of Social Sciences, Beijing, China. e-mail: qiurenzhong@hotmail.com

1. National Health Commission. *The Technical Norms for Human Assisted Reproduction Technologies* [in Chinese] (2003); available at <https://go.nature.com/2jeevdj>
2. Yan, A. 'Has China Found a Cure for Cancer in Malaria?' *South China Morning Post* (14 February 2019).
3. Gao, F., Shen, X. Z., Jiang, F., Wu, Y. & Han, C. *Nature Biotechnol.* **34**, 768–773 (2016).
4. Cyranoski, D. *Nature* <https://doi.org/10.1038/d41586-018-06163-0> (2018).
5. Gan, X. & Cheng, W. 'The Results of the Han Chunyu Incident Are Difficult to Convince the People' [in Chinese]. *Science Daily* (3 September 2018); available at <https://go.nature.com/2uvizxp>
6. Qiu, R. Z. [in Chinese] *Sci. Soc.* **1**, 8–26 (2013); available at <https://go.nature.com/2umndgt>
7. Cyranoski, D. *Nature* <https://doi.org/10.1038/nature.2015.18252> (2015).
8. Qiu, J. *Nature* <https://doi.org/10.1038/nature.2012.11998> (2012).
9. Lei, R. P. & Qiu, R. Z. [in Chinese] *Chinese Med. Ethics* **31**, 545–552 (2018); available at <https://go.nature.com/2dzs5tx>
10. National Health and Family Planning Commission & Food and Drug Administration. *Tentative Regulations on Stem Cell Clinical Research* [in Chinese] (2015); available at <https://go.nature.com/2pbtndf>
11. National Health Commission. *Announcement on Public Consultation on the Regulations on the Clinical Application of New Biomedical Technologies (Draft For Comment)* [in Chinese] (26 February 2019); available at <https://go.nature.com/2j2sctr>
12. Lei, R. P., Feng, J. Y. & Qiu, R. Z. [in Chinese] *Med. Phil.* **40**, 5–10 (2019); available at <https://go.nature.com/2xjs9tf>
13. Wang, C. X. & Zhang, J. F. *Medical Ethics* [in Chinese] (People's Publishing House, 2015).
14. Wu, S. *Medical Ethics* [in Chinese] (Guangdong Higher Education Publishing House, 2013).
15. Zhai, X. M., Lei, R. P., Zhu, W. & Qiu, R. Z. 'Chinese Bioethicists Respond to the Case of He Jiankui' (The Hastings Center, 2019); available at <https://go.nature.com/2vi6y3c>

ANTHONY KWAN/BLOOMBERG/GETTY



A spokesperson at the Hong Kong genome-editing summit in November, at which He Jiankui gave results.

CORRECTION

The Comment 'Protect our right to light' (*Nature* **568**, 451–453; 2019) failed to accurately describe Taiwan and Hong Kong.