

THIS WEEK



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Way of the dragon

To boost its research quality and innovation, China must strengthen its scientific foundations and let researchers — not policymakers — set the agenda for innovation and discovery.

There is increasing excitement over China's scientific rise. The nation has more researchers than any other country and it is rapidly catching up with the United States in the number of scientific papers published. But there are lingering questions — both within China and outside — about the quality and inventiveness of science coming out of the country.

Concerns over science in China go to the very top. Xi Jinping, China's leader, offered a particularly harsh assessment late last month at a meeting of the country's leading scientific academies. He went so far as to say "the country's S&T foundation remains weak".

Xi has a point. Many of the inventions that gave rise to some of the most important scientific work in China — CRISPR-Cas9 gene-editing tools among them — are the products of colleagues overseas. Xi put it like this: "The situation, in which our country is under others' control in core technologies of key fields, has not changed fundamentally."

From that angle, China still looks like a nation of large-scale implementers. Take an idea, especially one that requires scale, and China is there to jump on it. That is not a bad place to be — the genome-sequencing giant BGI and a new generation of sequencing rivals are a clear sign of just how productive scale can be. But that is application, not the kind of breakthrough that Xi seeks.

That's why the country's first scientific Nobel prize, awarded last October to Tu Youyou for her role in developing the antimalarial drug artemisinin, provoked pride but also soul-searching. It was a discovery from a bygone era, not a product of the current research structure — and many wonder whether today's system will yield any big discoveries.

In a special issue this week, *Nature* looks at China's potential and the obstacles it faces (see www.nature.com/chinafocus). Xi told the meeting that "scientists should be allowed to freely explore and test the bold hypotheses they put forward". He encouraged the development of a system in which science policy is created by scientists, rather than at the whim of officials, and alluded to experts who "should no longer have to follow their superiors' orders".

If anyone can break the bureaucrats' hold on scientific policy-making, it is Xi, who has emerged as China's strongest leader in decades. He has already taken on, and taken down, numerous political foes. And yet, as China implements its latest five-year plan and overhauls its major funding mechanisms, there is reason to wonder how much things will change.

Xi couches much of his support for science as the quest for translatable results. Scientists should, he says, solve urgent economic and industrial problems. Support for technology firms is a high priority. These are fine

objectives, but they suggest continued top-down policymaking. The balance between encouraging basic research and demanding technological output must be guarded closely, or scientists will be pressured to do only translatable research and China will tread on the freedom of scientific pursuit that Xi holds is essential.

Although Xi seems to understand the scientific thirst for independence and freedom, the ongoing question is whether China will offer that. This includes freedom to use tools such as Google Scholar.

"Truly pioneering science is to be cultivated, not commandeered."

Xi faces some of the greatest battles of China's recent past: military tussles in the South China Sea have raised the political stakes abroad, economists talk of a dangerous slowdown, and environmental problems are frustrating citizens at home and threatening the country's international stature. Xi vows to raise spending on science, but it would be a mistake to think that increasing spending on research and development will solve all the issues of the homeland, make food and drugs safe, resolve the problem of an ageing population and get rid of the disparities between urban and rural China.

At the meeting, Xi said: "Currently, the state needs the strategic support of science and technology more urgently than any other time in the past." But truly pioneering science is to be cultivated, not commandeered. How well that distinction is maintained will determine much of what lies ahead. ■

Data sharing

Pooling clinical details helps doctors to diagnose rare diseases — but more sharing is needed.

When doctors in Ottawa saw a child with an unusual developmental disorder last year, they were stumped. Their patient had an abnormally small head and face and had been slow to develop. They sequenced the child's genome hoping to find a genetic explanation, but came up with too many possible candidate genes to pinpoint a likely culprit. This still happens a lot in medicine: people with rare problems go undiagnosed. And that's one reason behind a big push in science in recent years — the pooling and sharing of clinically relevant information.

In the Ottawa case, the doctors got lucky. They were able to search a database that contained information about other patients with undiagnosed diseases, and when they did so they found a second person with similar symptoms — and an identical mutation in one



SCIENCE IN CHINA
A Nature collection
nature.com/chinafocus

gene, *EFTUD2*. The finding allowed the Ottawa doctors to diagnose their patient with a disease called mandibulofacial dysostosis with microcephaly, and to begin to understand why mutations in *EFTUD2* cause the disease's symptoms.

That's the upside of the new era of data sharing. But there is a possible downside too: invasion of privacy. Massive genetic studies in countries such as the United States, Qatar, Saudi Arabia and Brazil are collecting genetic data on millions of people, so there is a chance that a person's identity could be dragged from those data — especially if they are linked to clinical information, such as medical history. The risk is that someone who volunteers their DNA could see their medical problems opened to public scrutiny.

This is a legitimate concern for many researchers, and is one reason why data sharing is easier said than done. Others include the lingering sense of ownership, and the career benefits offered to those who have privileged access. Those concerns relate to the standard model of data sharing, in which different groups of scientists deposit their results into centralized databases. This model has had some success, but researchers have already encountered problems, such as how to grant and control access to the pooled information.

Pooling it in the first place becomes more difficult as the data sets get larger and the underlying techniques more varied. Imagine the difficulty of finding a specific book by gathering all the contents of a dozen different national libraries and then devising a way to integrate the numerous ways in which they are filed, tracked, recorded and made available. It would be much easier to ask each library whether it holds that book. What if data sharing in science could go the same way?

The diagnosis of the Ottawa child shows that it can. The doctors tapped into a system that is part of the Matchmaker Exchange, which allows researchers to query multiple databases of information on patients with undiagnosed rare diseases. A doctor can feed the system information about a patient's symptoms and genetic make-up, and then ask it whether other people have them too. (Normally, it's hard

for doctors to find other patients with similar rare diseases; often they learn about such cases by word of mouth.)

The Matchmaker Exchange exemplifies a subtle shift in how researchers think about data sharing — and one that more scientists should engage with. It was created by the Global Alliance for Genomics and Health, a 3-year-old organization with more than 700 members from 70 countries that aims to help researchers, doctors and patients to make scientific progress by sharing data (see *Global Alliance for Genomics and Health Science* 352, 1278–1280; 2016).

“As technology to permit targeted data access improves, so will smart sharing.”

The alliance is creating technological tools that allow researchers to find out where data that are relevant to their patients are held around the world. It aims to make data not just shareable but discoverable, too. Doing this allows those who produce the data to keep more control of the information. It also streamlines searches. For example, researchers looking for a diagnosis want to know the symptoms that other doctors have seen in people with particular genetic traits. Thus they just want to know who might have seen these mutations and what symptoms might have been observed in patients who have them; they don't want to comb through all the existing databases of genetic information themselves.

Of course, there are still many instances in which accumulating and sharing large amounts of data — on particular genetic traits, for example — is essential and valuable. The gene-testing company Myriad Genetics is locked in a tussle with doctors and patients who want it to open up its massive database of information on variations in the *BRCA1* and *BRCA2* genes, which are linked to a higher risk of breast and ovarian cancer. (Another alliance project, the BRCA Exchange, seeks to provide easily searchable interpretations of BRCA variants that have been shared by groups outside Myriad.)

But in other cases, data access works best, for both sides, when the requests for information are targeted at specific traits. And as the technology to permit that improves, so will smart sharing. ■

At gunpoint

The problem of gun violence in the United States must finally be addressed.

It has been a bloody year in the United States. So far, the country has lost around 6,000 lives to gun violence — dozens of them in mass shootings in public spaces. The attack that left 49 men and women dead in Orlando, Florida, this month is, by some counts, the 136th mass shooting in the United States just this year.

Mourning — and then moving on — in the wake of a mass shooting has become a sombre tradition. But after Orlando, a new development emerged. On 14 June, the American Medical Association (AMA) declared gun violence a public-health crisis, and announced that it will apply its considerable lobbying power to pressure Congress to fund research into this violence. It is cause for optimism that a lengthy freeze on federal funding for such research — particularly at the Centers for Disease Control and Prevention (CDC) — may soon thaw.

It makes sense that this push would come from the medical community: it has a front-row seat on the violence. “Here we are again,” physicians wrote in a *New England Journal of Medicine* editorial in January, following a shooting in San Bernardino, California, that killed 14 and injured 22. Six months later, at a press conference following the Orlando tragedy, one surgeon choked back tears as he described the chaos in an emergency room filled not only with the injured, but also with hundreds of their panicked friends and families. Another coolly

described the reality that surgeons at his Orlando trauma centre face daily: people wounded by high-calibre assault rifles, once considered to be the exclusive domain of the military, now flooding into civilian emergency rooms.

Yet while doctors struggle to treat the wounded, the CDC has been hamstrung in tackling fundamental public-health questions about the causes of gun violence and its possible solutions. An amendment placed on appropriations bills since 1996 has prohibited federally funded research from advocating gun control — a provision that some have interpreted as making gun-violence research broadly off limits.

In 2013, US President Barack Obama explicitly stated that such research should take place and need not be interpreted as advocacy, but Congress failed to allocate funds in the CDC budget to support it. (The US National Institutes of Health, which has more discretion in how it applies its funding, has sponsored some gun-violence research following Obama's announcement.)

The AMA is a lobbying powerhouse: in 2015, it was the fourth-largest lobbyist in the country. If it chooses to make gun-violence research a high priority, it has the resources to make headway. But it will take a tremendous push — and coordination with other stakeholder organizations — to do so.

In the wake of the Orlando shooting, lawmakers followed what has become a legislative post-mass-shooting tradition: the rapid-fire proposal — and equally rapid rejection — of bills intended to address the country's gun-violence crisis. Earlier this week, the US Senate defeated five such measures. Similar proposals, including one intended to explicitly allow research into gun violence, met the same fate last December. But with concerted effort from the AMA and others, perhaps the United States will break with these traditions. ■