THE MATH BEHIND CHINA'S FIGHT AGAINST HIV

How mathematical models have provided more than just a medical solution to the epidemic

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The remote communities of Liangshan Yi Autonomous Prefecture dot the valleys and cliffsides of a lush, mountainous landscape in the Chinese province of Sichuan. Photos touting the tourism potential of the region paint it as a paradise, but hidden from sight are a slew of socio-economic problems such as illiteracy, poverty and a lack of consistent employment. For the most part, these burdens are borne by the Yi people, the ethnic minority group that makes up about half the prefecture's population.

Now, added to that list is the threat of HIV infection. The prefecture was one of the first regions hit hard by China's burgeoning HIV epidemic. By 2010, about 40,000 of Liangshan Yi's 4.6 million residents were infected with the virus, accounting for more than half the total number of HIV infections in Sichuan, which is home to 80 million people.

HIV spread quickly in the region through the sharing of contaminated needles used to inject heroin and other drugs that arrive via a major trafficking route connecting Southeast Asia's Golden Triangle (an area where the borders of Myanmar, Laos and Thailand meet) to China's interior.

Treatment has included traditional prevention-and-control measures such as antiviral drugs and addiction-management programs, but these are difficult to administer in an impoverished rural area with poor infrastructure such as Liangshan Yi. What's more, whatever treatments are dispensed end up being inefficient because HIV-positive people are constantly moving to new regions to look for work instead of staying put to get well, and thus help prevent the spread of infection.

But what if the socio-economic factors that drive labour migration and addiction — poverty, lack of employment, lack of access to treatment and lack of community support — were improved? Would that change treatment outcomes? To find out, in 2009 Dr. Yiming Shao, a professor at the **Chinese Center for Disease Control and Prevention**, or CDC, partnered with Jianhong Wu, a **Canada Research Chair** in industrial and applied mathematics. They created a team to develop mathematical models that examined the effectiveness of HIV-AIDS treatment and intervention under various socio-economic conditions linked to the epidemic. The work was supported by **IDRC and the Canada Research Chairs program**. "We thought the modelling work could help the government design more efficient prevention programs," says Shao.

The team found that the most effective way to control the epidemic would be to develop something called Rural Economic Enterprise programs, or REE. These would combine medical treatments, including methadone substitution and antiviral drugs, with social

Dr. Yiming Shao (in suit) and two other doctors speak to an HIV-AIDS patient at a hospital in Liangshan Yi Autonomous Prefecture in 2009. (Photo: Chinese Center for Disease Control and Prevention)

support, such as providing local jobs that let people work together in a farm-like environment. HIV-AIDS education and needle exchanges would also be integrated into this environment. "It's a paradigm shift from only reacting medically to taking out the root of the epidemic," says Wu.

To test the strategy, the team surveyed 1,000 HIV-positive and HIV-negative drug users in Liangshan Yi. About 80 per cent were willing to work locally and participate in an associated prevention care program. When modelling results showed that the rate of infection decreased when at least 30 to 60 per cent of injection drug users participated in the program, the local government adopted the REE model as one of its top three HIV-AIDS control strategies, says Shao.

And it appears to be working. Since the REE programs were piloted in 2012, HIV transmission from injection drug use in Liangshan Yi has declined. "When we did our study, drug users accounted for about 70 per cent of the epidemic locally," says Shao, noting that they now account for less than 30 per cent.

It's an important step forward, but there's still work to be done nation-wide.

The disease is proliferating as it moves from rural areas to major cities such as Shanghai and Beijing. The way it's spreading, however, has changed. In 2018, 95 per cent of reported HIV-AIDS cases in China were a result of sexual contact, not blood transmission. This national trend is why the Liangshan Yi government is considering expanding its HIV-AIDS control model beyond injection drug users. Says Shao, "We need to figure out how to apply the same modelling technique — but a different strategy — to mitigate new risks and guide a targeted intervention."

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READING AS THINKING

1. Describe the landscape in Liangshan Yi Autonomous Prefecture and outline some socioeconomic problems that exist in the region.

2. Why was Liangshan Yi Autonomous Prefecture one of the first regions to be hit hard by China's HIV epidemic?

3. What was the main cause of the quick spread of HIV throughout the region?

4. Who is Dr. Yiming Shao and what role did he play in addressing the quick spread of HIV in China?

5. What was the name of Dr. Shao's program that aimed to control the HIV-AIDS epidemic? How does it work?

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6. What was the result of Dr. Shao's program?

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7. What challenges is the program facing now as Dr. Shao's team begins to expand the program throughout China?

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THINK-PAIR-SHARE

Think

8. Use the diagram below to outline the process Dr. Shao took to create a solution to the growing problem of the HIV-AIDS epidemic in China.

Socioeconomic issue

Growing Problem

Addressing the problem

Implementation

Results

Next Steps

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Pair

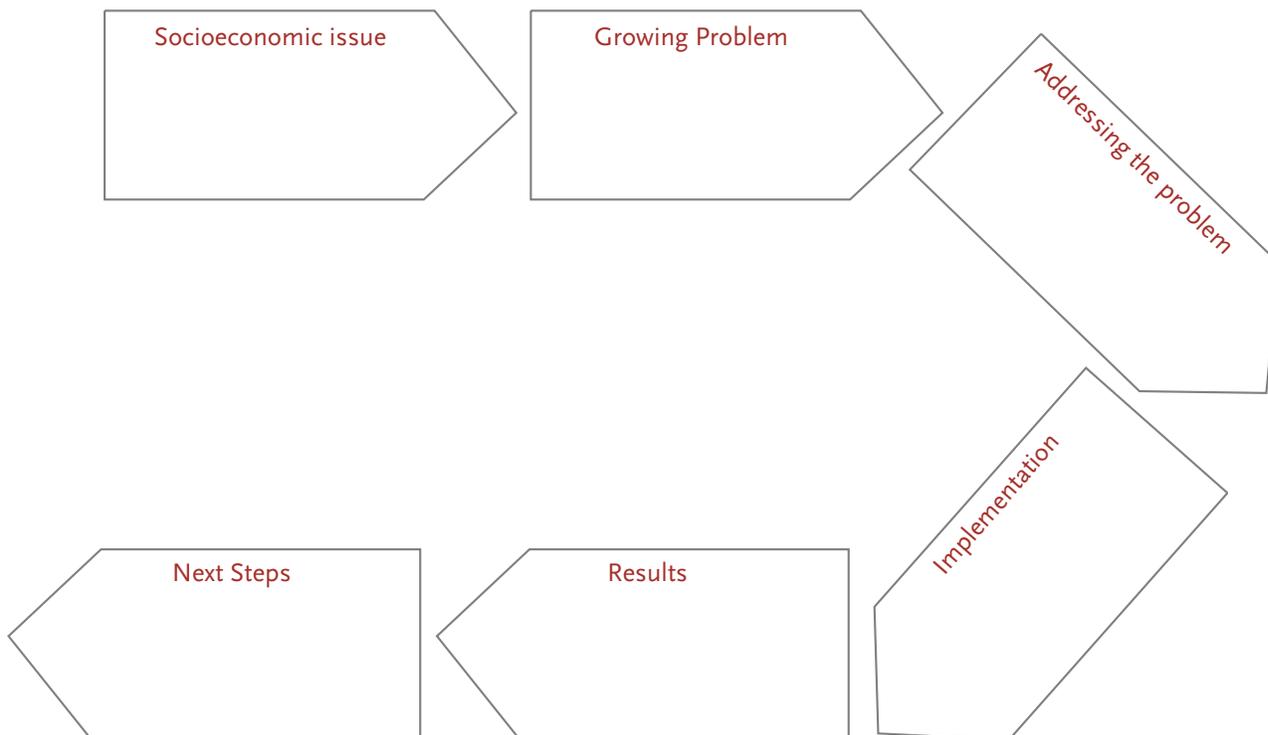9. With a partner, discuss and research a socioeconomic issue in Canada. Create a similar diagram to the one in the previous question to help you with your research.

Share

10. Share your research with the rest of the class (Note to teachers: students can do this by presenting to the entire class, or by creating a class gallery with their findings using their diagram).

ONLINE

Resources describing HIV/AIDS

- **World Health Organization**

- **Canadian AIDS society**

- **Avert: Global information and education on HIV and AIDS**

- **Our World in Data: HIV/AIDS**

Resources to assist with research on socio-economic issues in Canada

- **Economic, social and cultural rights**

- **Ontario Human Rights Commission**

- **United Nations Economic and Social Council**

- **Canada without poverty**

- **Canadian Council on social development**

- **Centre for social justice**

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CROSSWORD:

Across

3. HIV-AIDS is spreading to this city, one of China's largest
6. The use and sharing of this contaminated instrument led to the quick spread of HIV
8. What the "R" stands for in Shao's program "REE"
9. To make less severe
11. To increase rapidly in numbers
12. The action or process of spreading something from one place or person to another
13. A widespread occurrence of an infectious disease
14. How the landscape of Liangshan Yi Autonomous Prefecture was described

Down

1. HIV-AIDS is a disease but it is also referred to as this
2. One of the socioeconomic issues Sichuan province faces
4. An action taken to improve a situation or problem
5. The type of model used to examine the effectiveness of HIV-AIDS treatment and intervention
7. A person or an area made poor
10. Home to 80 million people, this is the province in China where Liangshan Yi Autonomous Prefecture is located