Flu vaccine supply gaps can intensify flu seasons, make pandemics deadlier

January 8 2019

A tent lazarette during the 1918-19 Spanish flu pandemic, which killed 50 million people or more worldwide. Credit: National Archives

More than 50 million people died in the Spanish flu pandemic of 1918-1919. Its 100th anniversary this flu season serves as a reminder to close flu vaccine supply gaps that may be costing lives now and could cost many more when the next "big one" strikes, researchers say.

U.S. flu vaccine distribution logistics could use an update, according to Pinar Keskinocak. The researcher at the Georgia Institute of Technology co-led a recent study that compared the current approach with a proposed allocation method calculated to save many more lives in a pandemic.

The study's recommendations, which apply to resupplying vaccine stocks during a running outbreak, boil down to this: To put a bigger dent in the spread of flu, replenish vaccine stocks in regions where they are being used up and don't replenish them in areas where vaccines are just sitting on shelves because few people are getting flu shots there.

A simple tweak

The tweak in the supply chain could also save thousands of lives in a regular annual flu season in the U.S., which can be plenty deadly. Reportedly, 80,000 people died in the 2017-18 flu season. For comparison's sake, murder took about 19,300 lives in 2017 in the U.S.

"Even seasonal flu kills thousands to tens of thousands of people each year, so we would benefit immediately," said Keskinocak, who is William W. George Chair and Professor in Georgia Tech's H. Milton Stewart School of Industrial and Systems Engineering and Director for the Center of Health and Humanitarian Systems. "In a pandemic, nearly no one would have natural immunity, so the death toll could be significantly high if we don't improve vaccine coverage."

In a pandemic, the flu virus represents a mutation that human immune

systems may not have had a chance to build prior resistance to, thus the lack of natural immunity. When the next one strikes, in addition to the many lives saved, the researchers' recommendations could massively prevent flu infections, secondary infections like bronchitis, hospitalizations, and unnecessarily high medical costs.

Keskinocak, co-principal investigator Julie Swann from North Carolina State University, and first author Zihao Li of Georgia Tech published their results in the journal *PloS One* in October 2018, around the start of the 2018-19 flu season. The research was supported by the Harold R. and Mary Anne Nash Junior Faculty Endowment Fund.

A logic breakdown

When a pandemic hits, vaccine supply may become limited but then catch up over time. When that happens, the vaccine distributors commonly take what's called the population-based approach.

"Areas with larger populations get more vaccine, proportional to the population. It's a straight-forward approach that seems fair," Swann said.

As more vaccine becomes available over time, restocking follows the same principle, and that is where distribution logic breaks down. In some regions, few people get vaccinated, but under population-based allocation, resupply stocks go there anyway and may go to waste. Meanwhile, restocking may fall short of demand elsewhere, where people are lining up for inoculations.

A mathematical fix

As a result, in a pandemic, people eager for a vaccination might not get one despite adequate vaccine production, and the resulting additional

unvaccinated people are more likely to get the flu and also spread it to others. That intensifies the outbreak for the entire population.

The wasted vaccine stocks also drain medical finances.

"Production, storage, and delivery of vaccine are costly, and unused inventory can't just be thrown away. It costs money to dispose of," Keskinocak said.

Restocking doses where they are actually being used would benefit the entire population by boosting the total number of vaccinated individuals, who would then be less likely to get sick and to infect other people. That would tamp down the flu wave for everybody.

A data dearth

Leftover inventory could be slashed to about 20 percent of current levels, saving considerable costs, and the data about which areas were not resupplied could be used to identify areas where more people need encouragement to get vaccinated.

"The data would tell you where you need continued education about the importance of vaccination, and some of the money saved from unnecessary resupplying could be invested in public health campaigns," said Swann, who collaborated with the Centers for Disease Control and Prevention during the 2009-2010 H1N1 Swine flu pandemic.

But the needed data is missing at present in the U.S. vaccine distribution system.

"Surprisingly few states have systems in place that tell them how much vaccine has been administered where and how much is still left in inventory at provider locations," Swann said.

The next "big one"

The next "big one" flu will sneak up on humanity someday.

Ultimately, the best way to cut its death toll by more than half and save possibly hundreds of thousands of lives will be for virtually everyone to get vaccinated against influenza annually. Currently, fewer than 50 percent of Americans do.

The 1918-19 outbreak, which may have consisted of multiple concurrent influenzas, killed 678,000 people in the U.S. Other "big ones": The 1957 "Asian flu" killed 116,000 in the U.S.; the 1968 "Hong Kong flu" killed 100,000. The 2009 bird flu pandemic, which was a less contagious virus, killed 12,500 people in the U.S. and hospitalized some 275,000.

More information: Zihao Li et al. Value of inventory information in allocating a limited supply of influenza vaccine during a pandemic, *PLOS ONE* (2018). DOI: 10.1371/journal.pone.0206293

Provided by Georgia Institute of Technology