Local News

Two Texas Tech researchers working toward universal flu vaccine

By: News Release & Posted By Staff | newsweb@everythinglubbock.com
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LUBBOCK, Texas (NEWS RELEASE) - The following is a news release from Texas Tech University:

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The flu is nothing to sneeze at.

The Spanish flu pandemic of 1918 killed an estimated 50 million people worldwide; by comparison, about 16 million people died in World War I. And flu pandemics aren’t just a thing of the past. Despite advances in both technology and vaccines, the 2009 swine flu pandemic caught the world unprepared and an estimated 150,000 to 500,000 people died.

The Centers for Disease Control and Prevention (CDC) estimate that, each year since 2010, between 9.3 million and 49 million people have become ill from flu infections, 140,000 to 960,000 people have been hospitalized, and 12,000 to 79,000 have died. The flu's economic impact is an estimated $10 billion per year, with a loss in earnings of about $16 billion per year.

With flu vaccines widely available, why does this keep happening? One obvious reason is that many people don't get vaccinated each year. A larger problem, however, is that current vaccines cover only the three or four strains of the flu that the World Health Organization expects to be the most prevalent each year: trivalent vaccines contain two influenza A strains and one influenza B strain, while quadrivalent vaccines contain two influenza A and two influenza B strains. That means all the other strains that exist are able to infect people, unchecked.

Thanks to a five-year, $3.46 million grant from the National Institute of Allergy and Infectious Diseases, part of the National Institutes of Health, two Texas Tech University researchers already widely known for their work in immunotherapy and infectious diseases are trying to solve this. Harvinder Gill, the Whitacre Endowed Chair in Science and Engineering and an associate professor in the Department of Chemical Engineering within the Edward E. Whitacre Jr. College of Engineering, and Steve Presley, a professor and chairman of the Department of Environmental Toxicology within the College of Arts & Sciences, have teamed up to develop a universal flu vaccine.

"Since flu viruses continuously change – what we call 'drift' – it is not easy to predict the strains that will circulate in the human population in the future," Gill said. "Predictions can and do go wrong. For example, in the 2014-2015 flu season, the overall vaccine effectiveness was just about 19 percent. Instead of small drifts, flu strains also can make big shifts, and in such cases the vaccine becomes ineffective. Such new flu strains are what can lead to flu pandemics.

"The concept behind a universal flu vaccine is to create a vaccine that shows enhanced breadth of protection and ideally protects against strains that are significantly different from each other. Such a vaccine is expected to offer many advantages, including not having to change the formulations every year and providing greater and consistent vaccine efficacy year after year. Naturally, the universal
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vaccine also will be capable of preventing flu pandemics."

To develop an effective universal flu vaccine, Gill and Presley are targeting parts of the flu virus that don't change significantly from strain to strain. Although much of the flu virus has a high propensity to change, some of its protein segments remain highly consistent. By directing the vaccine-induced immune response toward these segments, the pair are confident they can create a single vaccine that will protect against many strains.

"We are exploiting two of these protein segments to make a universal vaccine," Gill said. "These two segments lie on proteins found on the surface of a flu virus: one is an ion channel called M2 and the other is called neuraminidase (NA). The M2 segment is highly conserved in influenza A strains, but the NA segment is conserved in both influenza A and B strains. Thus, we are hopeful of making a universal flu vaccine against both type A and type B flu viruses."

Part of the problem is these two protein segments are short, only 23 and 9 amino acids long, respectively, compared to a full protein, which is typically made up of hundreds of amino acids. This means the segments alone are not able to generate a strong immune response. Therefore, another goal of this research is to develop a vaccine formulation that can increase the protein segments' effectiveness.

"For this purpose, we have developed a nanovaccine using gold nanoparticles," Gill said.
"We attach the small protein segments onto gold nanoparticles. This significantly enhances the immune response, which is boosted further using CpG, a vaccine adjuvant made of a short DNA fragment that mimics bacterial DNA. This research will optimize the vaccine formulation, including the size of nanoparticles, the dose and the immune response generated by the vaccine."

Another benefit of the vaccine Gill and Presley have been developing is that, unlike current vaccines, it does not require refrigeration so it can have a longer shelf life and be more readily transported to places where refrigeration is not feasible.

"We have seen that our vaccine formulation can be dried into a solid powder, which even after storage at 50 degrees Celsius for two weeks can be re-suspended in water and maintains efficacy in protecting vaccinated mice against lethal flu infection," Gill said. "Current vaccines must be stored under refrigeration. As a result, 'cold chain' is required for their storage and transportation. However, due to the excellent thermal stability, this nanovaccine has the potential to be readily distributed across the globe and could break the need for a cold-chain.

"This also means the nanovaccine could be stockpiled without expensive refrigeration. This can lead to huge cost savings and allow for transportation into parts of the world that lack such expensive infrastructure."

The vaccine ultimately will be tested against a broad range of type A and type B flu strains, but it is already showing promise.

"Until now, we have tested the vaccine with just the M2 protein segment and it was able to protect vaccinated mice against four different strains, including the 2009 pandemic strain and the highly
pathogenic H5N1 bird-flu strain," Gill said. "It is difficult to predict success; however, with the addition of yet another conserved protein segment – the NA segment – we expect the vaccine to be even more effective."

While new flu strains could still emerge that would be immune to the universal vaccine, Gill said the likelihood of such an occurrence is low.

"If two conserved protein segments are used, and further, each of them is from two different proteins, the chances of strains emerging that will evade vaccine immunity are low, because the virus must then change both M2 and NA proteins," he explained. "Chances of successfully changing both proteins and still maintaining their function are lower than if the virus had to just change one protein to evade immunity. We thus hope to have 'one vaccine to conquer them all.'"

Vaccine development, especially for the flu virus, is a complex task, but if anyone can do it, it's these two researchers. Gill has been working in the field of influenza vaccines and has interdisciplinary experience in nanomedicine, bioengineering and micro-nanotechnology. He will lead the effort to design the gold nanoparticle-based nanovaccine and test it against different flu strains that can be handled safely in a biosafety level 2 environment.

However, to test the true reach of the vaccine, it also must be tested against non-human flu strains such as bird, swine and equine flu. These strains are much different from flu strains that circulate in humans and could emerge as the next pandemic strain. Testing the vaccine against them will demonstrate the breadth of the vaccine, but as such, they require a greater biosafety level. Presley is the director of Texas Tech's Biological Threat Research Laboratory, which is a biosafety level 3 CDC-registered select agent lab. There, he will lead the effort to test the vaccine against these strains.

Separately, collaborator Bart Tarbet at Utah State University will lead the effort to test the vaccine against the H5N1 and H7N9 bird-flu strains in animals.

"This collaborative effort will thus focus and accelerate the effort for making the universal flu nanovaccine," Gill said. "We hope this research can lead to the development of a universal flu vaccine candidate, which can potentially be taken forward for clinical tests in the future."

(News release from Texas Tech University)

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