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IISc designs India's first needleless drug device

Companies and researchers across the world are working on needleless drug delivery systems, including nasal inhalers and skin patches, which will provide a painless, economical and more effective way of administering drugs

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Bangalore: Scientists at the Indian Institute of Science (IISc) have designed a pen-shaped, needleless drug delivery device, the first such in India that will use supersonic shock waves for painless delivery of medicines into the body.

Aerospace, molecular and cell biology researchers at the institute have combined their expertise to develop the prototype of the device that is expected to start selling in two-and-a-half years, after human trials are completed, said Dipshikha Chakravorty, a faculty member at the department of microbiology and cell biology at IISc and a co-author of the research paper. The device will cost \$200 (around Rs9,000) and can be reused, reducing the cost.



Painless method: Scientists at the Indian Institute of Science demonstrate the drug delivery system. Aniruddha Chowdhury/Mint

world."

So far, oral insulin has not really been a success and there have been no improvements on a "jet injector" attempt made in Italy and America decades ago, said Krishnaswamy.

IISc is the only organization that has developed a non-invasive, needleless drug delivery device in the world using a supersonic shockwave technology, said Gopalan Jagadeesh, a faculty member at the institute's department of aerospace engineering.

US-based Bioject Medical Technologies Inc. is also making such a device, but is using a different gas-based technology to create energy dissipation, he said. The device is still being developed. Yet another US-based firm, Bio-Rad Laboratories Inc., has developed a so-called gene gun.

Each year, unsafe injections cause an estimated 1.3 million premature deaths, the loss of 26 million years of life, and an annual burden of \$535 million in direct medical expenses, according to WHO estimates. In four out of six parts of the world, more than 30% of immunization injections are unsafe, it said. In poorer nations, the possibility of HIV transmission through contaminated injections is also very high.

"Nasal inhalers and patches are the needleless drug delivery system that are coming up in a big way in the market," said Dipta Choudhary, programme manager of pharmaceuticals and biotechnology for South and West Asia at **Frost and Sullivan**. "The need is for those who have to use injections every day like insulin."

At IISc, the researchers generated micro-blast waves— through a tiny controlled explosion—that travelled at supersonic speed, creating high pressure and temperature, which, in turn, ejected the vaccine filled in a miniature model device into the skin without damage.

"Two years ago, we started looking at generating tiny amounts of explosion at the lab to create a mini-Pokhran," said Jagadeesh, referring to the test site where India conducted its first nuclear weapon detonation. "We have used the mechanical impulse, which is loaded in the shock wave, to transfer that momentum of a drug particle without the use of needle to inject into the system."

The IISc team that included Jagadeesh, Chakravorty, Divya Prakash G., Rakesh S.G., Uday Sankar Allam, M. Gopala Krishna and Sandeepa M. Eswarappa published the paper in the *Clinical and Vaccine Immunology* journal last week.

Explaining the concept, Jagadeesh said: "Any sudden release of energy will invariably result in the formation of a shock wave, since it is one of the efficient mechanisms of energy dissipation observed in nature." Earthquakes and tsunamis are natural examples of such uncontrolled energy dissipation.

During clinical trials, a vaccine for typhoid-causing salmonella bacteria, developed by the department of microbiology and cell biology, was given to mice using the device. The results showed that the vaccine entered the upper layer of the skin without destroying the antigen-generating cells that provide protection to the body, thus maximizing the effect of the vaccine. These are otherwise ruptured when poked with a needle.

"There were no visible injuries like bleeding, oedema or any other reactions at the site of vaccination on the skin," said Chakravorty. "This means it is completely painless."

The prototype delivery device consists of an ignition system, explosive material-coated polymer tube, metal foil, drug-holding chamber and a cavity holder.

The device will limit infections at healthcare centres and will be cheaper than existing options such as disposable syringes. A shot will cost about Rs5, said Chakravorty.

Companies and researchers across the world are working on needleless drug delivery systems, including nasal inhalers and skin patches, which will provide a painless, economical and more effective way of administering drugs. Around 12 billion injections are used globally, IISc said, citing figures compiled by the World Health Organization (WHO). The market value of transdermal delivery, or injecting drugs through the skin, is estimated to increase to \$31.5 billion in 2015 from \$21.5 billion last year, according to Research and Markets, a researcher.

The device has applications in the medical world such as effective insulin intake and cancer cell treatment, among others.

"If these scientists are truly successful with their technology, they will get the Nobel Prize," said C.V. Krishnaswamy, a renowned Chennai-based diabetologist. "They will be helping some 150 million diabetics around the

"The other available drug delivery systems have their own limitations like cost, cross-contamination, pain and bleeding," he added. "The device is very cheap and the market potential appears to be huge."

The researchers have also discovered that vaccine given through this device provides better protection than when administered orally. The dose required was also 100-fold less compared with oral dosage.

"We are now looking at human trials and are in the process of tying up with some companies," Chakravorty said. "It will take two-and-a-half years from now."

Pune-based Serum Institute of India Ltd started selling a ready-to-sniff intra-nasal vaccine, Nasovac, last July priced at Rs158 a dose. It is available in a five-vial pack for Rs790.

"The researchers have made a good beginning and the device has several medical applications," said M.S. Shaila, a faculty member at the department of microbiology and cell biology at IISc, who is not involved in the research, but is aware of the programme.

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