How nanotechnology could keep your heart healthy

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Since the heart is such a delicate and critical organ, clinicians usually opt not to intervene with the dead cells that remain after a heart attack or cardiac disease. "But we think that all heart attacks deserve some kind of treatment because it puts so much stress on the rest of the heart," said Thomas Webster, professor and chair of the Department of Chemical Engineering. Even a square centimeter of dead heart tissue can put significant strain on the rest of the heart, which has to pick up the slack, he said.

Webster's earlier work demonstrated that adding nanofeatures to an implanted medical device like a titanium knee or hip joint helps the cartilage cells adhere to the device. This promotes tissue growth and allows the patient to heal more readily, he explained. While his team members don't know exactly why this happens, they have a good idea. They think the nanofeatures allow the surface to more accurately mimic the natural environment in the body, thus providing more habitable accommodations for the new cells.

But titanium hearts aren't a viable option. Instead, they utilized a hydrogel, which they'd developed previously, to mimic the heart cells themselves. They added carbon nanotubes to the hydrogel, making it conductive, and then injected the material into the heart, where it solidifies at body temperature. Because the hydrogel is "super sticky," it adheres extremely well to the tissue surface and immediately begins expanding and contracting in sync with the beating of the heart. While the team hasn't yet tested the material in an animal model, it has

simulated these conditions in the lab.

Once again, by mimicking the natural environment, they saw "improved ability of cardiomyocytes [cardiac muscle cells] to attach, to proliferate, and then to secrete the chemicals they secrete during normal, healthy heart function," Webster said. They also saw better blood vessel production. Further, the material seemed to dampen the function of fibroblast cells, which are formed in scar tissue. Since scar tissue is thick and inflexible, it is not particularly well suited for the heart, which is constantly changing shape, Webster said.

"We think we've gone as far as we can in vitro, perfecting it hopefully every step of the way," Webster said.

Provided by Northeastern University