Small Materials May be Key to Reducing Cardiovascular Disease Deaths, Researchers Say

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Cardiovascular diseases are the leading cause of death across the globe, responsible for about 17.9 million (32%) of all deaths worldwide every year. Monitoring and treatment may reduce the incidence of death, but the health care options are limited by the rigidity and biological incompatibility of conventional devices, such as blood pressure sensors. There may be an answer in nanomaterials, according to researchers from Peking University in China, although more research is needed before practical application.

The team reviewed the current state of nanomaterial-based flexible monitoring and treatment devices and recommended next steps to make such devices a practical possibility. Their paper was published on June 8 in Nano Research.

“Cardiovascular diseases are major diseases, with high incidence rates, high recurrence rates and a wide range of health- and life-threatening complications,” said lead author Haixia Alice Zhang, professor in the National Key Laboratory of Science and Technology on Micro/Nano Fabrication in Peking University’s School of Integrated Circuits. “The ability to better monitor and treat such diseases is of vital importance.”

The unique properties of nanomaterials make them an appealing option for wearable and implantable monitoring and treatment devices, according to Zhang.

Overview of nanomaterials based flexible devices for monitoring and treatment of cardiovascular disease deaths.

“Nanomaterial-based devices open up new opportunities with their excellent characteristics, including conductivity, softness, stretchability and biocompatibility, which are necessary to ensure user comfort and accurate signal acquisition,” said Zhang, who is also affiliated with Peking University’s Academy for Advanced Interdisciplinary Studies. “For example, soft and stretchable nanomaterials enable intimately conformal contact between devices and biological tissues, allowing for accurate monitoring without disturbing natural behaviors of the human body.”

Nanomaterials can also be made biocompatible for use as implantable devices, such as cardiac mesh, Zhang said.

“Using bioresorbable nanomaterials is an effective method to avoid additional surgery after short-term cardiovascular therapies,” Zhang said, explaining that some nanomaterials might be used for temporary treatment and their ability to dissolve would allow patients to avoid device-removal surgeries and the associated risks, such as infections.

According to Zhang, despite these recent advances in nanomaterial-based flexible devices, there are still challenges to solve for wide practical application. One such problem is an undesirable property of nanomaterials: self-aggregation caused by strong interactions in the materials, leading to non-uniform dispersion.

“Researchers are working to address this issue, but there is still a long way to go to achieve repeatable and stable uniformity that can be commercialized,” Zhang said.

The two other major areas of concern, Zhang said, are the nanomaterials’ long-term biocompatibility and their incompatibility with conventional semiconductor processes, the latter of which limits the size of nanomaterial-based devices.

“Although the short-term nontoxicity of many materials has been verified, the long-term biocompatibility remains suspicious,” Zhang said. “And incompatibility with conventional semiconductor processes blocks further miniaturization, which is of great importance for

precision medicine. Nanomaterial-based flexible devices have so many excellent properties for monitoring and treating cardiovascular diseases, but there is still a long way to go before they can be used for practical applications."

Zhang and her team plan to continue researching nanomaterial-based flexible devices with the goal of solving the identified challenges to offer better options for cardiovascular disease care.

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