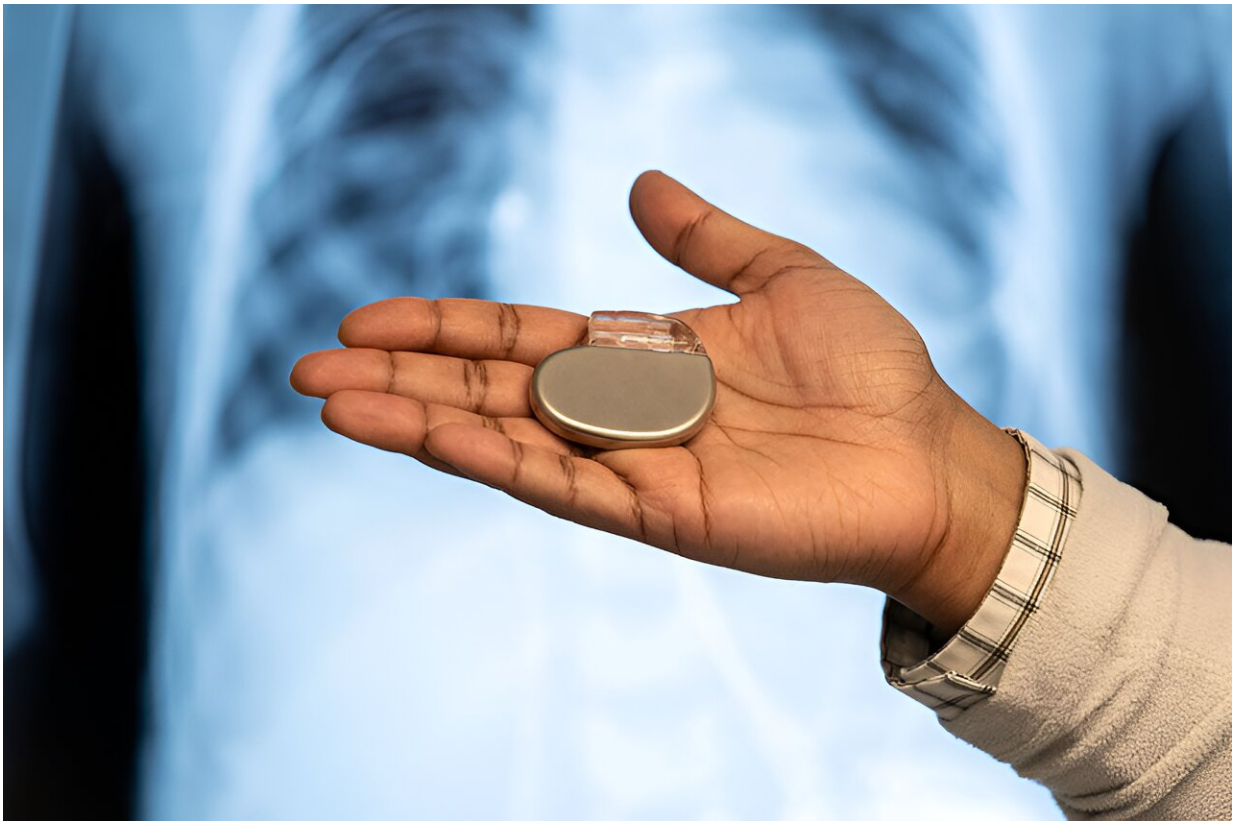


# Finding ways to reduce the financial and social costs of children's pacemakers

March 8 2024, by Albert McKeon

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Aside from the financial burden for families, pacemakers can make children anxious. Credit: Michael Goderre/Boston Children's Hospital

As the number of complex heart operations has increased over the years, so have cases of postoperative heart block, a form of arrhythmia that

often requires a pacemaker and more surgery. Heart block occurs when unseen conduction tissue—the cells and electrical signals that control the beating of a heart—is injured.

It is a complication that's universal to all hospitals, and it is why Boston Children's has dedicated resources toward reducing heart block, improving [health care costs](#) for families, and enhancing young patients' quality of life.

"Children who have pacemakers tell us their concerns about these devices. The idea of a machine controlling their hearts gives them doubts," says Douglas Mah, MD, director of Boston Children's Pacemaker and ICD Program.

Aiming to reduce the need for pacemakers, Boston Children's clinicians have created two new approaches to cardiac surgery that can identify elusive [conduction](#) tissue and potentially decrease heart block. The innovations have already shown promise. "We have to prevent heart block," says Aditya (AK) Kaza, MD, a Benderson Family Heart Center [cardiac surgeon](#). "We can't just dismiss it and say there's always going to be a percentage of patients who will need pacemakers. We have to get that number to the absolute minimum."

## **Pacemakers can put a strain on families**

Aside from causing anxiety in children, pacemakers can be costly. But no one had ever looked at the economic impact on families, prompting Kaza, Mah, and other Boston Children's researchers to look at those costs.

Reviewing Boston Children's medical records of congenital heart disease surgeries from 1960 to 2018, they found that 968 out of 28,225 [pediatric patients](#) needed a [pacemaker](#) because of postoperative heart block. Two

other statistics illustrate how heart block has been related to the increasing complexity of heart surgery: As the number of operations increased by 2.2% per year, the number of pacemaker implantations climbed by 7.2% per year.

The study, which was led by Abhijit Mondal, Ph.D., and [published in \*JAMA Network Open\*](#), also found that over a 20-year span, the direct and indirect costs of pacemaker implementation and management were nearly \$200,000. For families of pacemaker patients who were younger than 4, direct costs—including implantation surgery, replacements, and follow-up care—averaged \$180,664, while indirect costs from hospital visits—hotel, gas, and meals—averaged \$15,939.

"It's a huge burden," says Kaza, who was the principal investigator of the study. "But the [financial burden](#) is only a small part of what families experience. There is also the impact of a pacemaker on heart health and the general health of a child."

## **Children can be stressed by a pacemaker**

Although it's uncommon, pacemakers can malfunction and cause complications, Mah says. Also, batteries, which last as long as 15 years, will eventually need to be replaced, usually through a medical procedure. But even if a pacemaker functions properly over long stretches, children can't avoid seeing it on their chest and recognizing they depend on a device to keep their heart functioning.

"There's growing knowledge that many children who have pacemakers can have undiagnosed anxiety," says Mah, pointing to research by Boston Children's. "Not only does a family have a financial burden, but they also might have an anxious child."

The recent financial study, though, gives Mah, Kaza, and their colleagues

an opportunity to shine a light on two Boston Children's initiatives that look to help children by preventing heart block in the first place.

## **Configuring a microscope to find conduction tissue**

Conduction tissue is invisible to the naked eye and imaging technologies in operating rooms. Heart surgeons say they instead rely on an "eye of faith." Kaza and his research team have found a different type of "eye"—a [confocal microscope](#) the size and shape of a bendable straw. Fitting comfortably in a surgeon's hands, the microscope offers a high-resolution view of tissue by blocking out-of-focus light to create a perspective that helps pinpoint the spot of the tissue.

The microscope looks about 50 millionths of a meter below the heart's surface, or about half the thickness of a standard sheet of notebook paper. It doesn't reveal conduction tissue itself but instead illustrates the visual differences between heart muscle cells and conduction tissue regions. When surgeons look at the different presentations of heart muscle cells, they will recognize areas that are known to have conduction tissue and will mark those spots to avoid them.

Kaza's team continues to test the confocal microscope. In 2022, Kaza and other Boston Children's cardiac surgeons [published a study in the \*Annals of Thoracic Surgery\*](#) detailing how the microscope assisted in the operations of 27 patients; the technology has since been used in 43 more operations. Preliminary analysis revealed substantial differences in the location of conduction tissue in hearts with ventricular septal defects, tetralogy of Fallot, and atrioventricular canal defects.

## **An EP tool guides cardiologists toward conduction tissue**

On another track, Boston Children's cardiac surgeons, cardiologists, and engineers are testing the use of an electrophysiology (EP) tool to find conduction tissue in hearts beating naturally during surgery. The team found that the tool—a grid-mapping catheter often used by electrophysiologists to treat arrhythmias—could quickly and accurately pinpoint conduction tissue during an operation.

The tool collects [electrical signals](#) that an electrophysiologist reads out in real time, helping surgeons determine where conduction tissue runs. "It allows for very quick identification and communication, from the signals that we see on the screen to what the surgeons are seeing in the operating field," says cardiologist Edward O'Leary, MD, who is working on the initiative with fellow cardiologist Elizabeth DeWitt, MD, and cardiac surgeon Eric Feins, MD.

The EP tool has aided more than 350 surgeries at Boston Children's and prevented heart block in many patients—especially those with heterotaxy who need complex biventricular repair. In that patient group, the rate of heart block has decreased from over 14% to less than 3% when conduction mapping is performed during surgery, Feins says.

## **Aiming to help children overcome psychological hurdles**

Even if incidents of postoperative heart block drastically decrease, some children will still need a pacemaker. Hospitals should remain committed to giving them high-quality care during implantation, device maintenance, and all other steps of their journeys, Mah and Kaza say. Children should also have access to social and psychological resources.

"Children worry about having to talk to airport security agents about setting off metal detectors," Mah says. "They worry about what happens

if the pacemaker gets hit during baseball, taekwondo, and other activities. We tell them it's okay, but it's hard to completely reassure them."

That's why the two innovations are important, Kaza says. "We're saying we don't have to accept the idea that everybody needs a pacemaker."

**More information:** Abhijit Mondal et al, Cost of Pacing in Pediatric Patients With Postoperative Heart Block After Congenital Heart Surgery, *JAMA Network Open* (2023). [DOI: 10.1001/jamanetworkopen.2023.41174](https://doi.org/10.1001/jamanetworkopen.2023.41174)

Provided by Children's Hospital Boston

Citation: Finding ways to reduce the financial and social costs of children's pacemakers (2024, March 8) retrieved 27 April 2024 from <https://medicalxpress.com/news/2024-03-ways-financial-social-children-pacemakers.html>

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