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Solar energy to power medical devices



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SOLAR ENERGY TO POWER MEDICAL DEVICES

Fiona Dunlevy
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Many medical devices such as pacemakers rely on electricity to work. Batteries are obviously better than being tethered to a plug but as anyone who ever owned a Walkman or an iPhone will understand, batteries need to be recharged. This month, we talk to Andreas Haberlin, medical doctor and researcher at Bern University Hospital, Switzerland, who is developing a range of innovative ways to remove batteries from the equation. His most recent foray? Using solar energy to power a pacemaker.

In his clinical work, Haberlin routinely sees patients with pacemakers having surgery just to change the battery. "This is quite a simple operation, it's often just a hassle for patients," says Haberlin, who realised that cutting out batteries would cut down on surgeries. When Haberlin read a paper claiming to power a pacemaker using transcutaneous light, he was initially sceptical, but several calculations later he realised



A BRIGHT IDEA

Several simple experiments later, Haberlin had demonstrated proof of concept. "We took pig skin flaps from the slaughterhouse and put a solar panel underneath," explains Haberlin, "We were quite surprised that we measured a lot of energy." It turns out that enough infrared light penetrates the skin to charge the solar panel implanted beneath. With these encouraging results, several postgraduate students were recruited to investigate further. The team have now published two papers describing how solar panels implanted in pigs can harvest light energy through the skin and power pacemakers. Tests suggest that just a few minutes of sunlight could power a pacemaker for 24 hours (1, 2).

Encouraging so far, but what happens during the hours of darkness, or when the weather is grim for weeks on end? Haberlin got around this problem by designing a prototype pacemaker with a small storage capacity. It's not quite a battery but Haberlin concedes that "we do have to implement some sort of storage and this is much smaller than a conventional battery." Tests showed that, once fully charged, his prototype pacemaker could run in darkness with no further solar charging for 40 days (2).

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WHAT NEXT?

Substantial optimisation is needed before we see this technology in humans. One reason is our attachment to wearing clothes which limits implantation sites for the solar panel under the skin. Haberlin suggests the side of the neck. Frequent sunburn pinpoints it as a highly irradiated area of the body and the superior clavicle vein offers easy access to the heart. One problem with the neck, says Haberlin, is that "we often move our heads around", which could dislodge the leads feeding the harvested energy down to the heart. To overcome this problem, Haberlin is currently working on a flexible photovoltaic panel with flexible circuitry.

Solar power isn't Haberlin's only idea for liberating pacemakers from fixed-life batteries. Miniature turbines in blood vessels "harvest really a lot of energy that is by far sufficient to power a pacemaker" but the potential for blood clots is a problem. Another approach tested by the team is a fitting solution from the Swiss team. Here, movement from the heart beat winds up a clockwork-like mechanism implanted directly onto the heart that, in turn, powers a pacemaker. Each avenue, although promising, presents its own set of challenges. Solar power has the advantage that photovoltaic panels are highly reliable, and have already withstood harsh conditions such as outer space.



Haberlin is practically a one stop shop when it comes to multidisciplinary collaboration with a degree in medicine, a PhD in biomedical engineering and experience as a statistician. Not surprising, then, that he believes "collaboration is crucial." Haberlin is part of a small, young research group that includes electrical engineers, mechanical engineers, physicists, computer scientists, and psychologists. "We all share a common passion, a common curiosity and we all come from different directions," says Haberlin, "this increases the probability that you come up with innovative solutions. If you're having coffee with a colleague and start to think aloud then you can end up with fancy ideas." This keeps the interest in research alive and, as Haberlin enthuses "it's just fun!"

Funding such work is often the less fun side of research but Haberlin has no complaints so far. "Some mentors at the clinical department and my former PhD supervisor have allowed me to follow my own direction and have given me some basic funding," he says, "and with this sort of innovative research you can convince other partners - foundations etc - to spend some money on you." The group is also supported by the university to protect their intellectual property. "We did extensive patient research and we have options to make patents."

Haberlin has important advice to other medics with a bright idea. "Not everything that is thinkable is do-able from an engineering point of view. So first sit together with an engineer and don't be disappointed if he says this can be difficult." Then start out small with simple experiments to get some preliminary results - essential for further finance. "It's difficult to get funding if you just have a nice idea!" he says. Personal motivation also plays a big part. For Haberlin, it's curiosity. "If it could be done, why shouldn't we try it?"

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