Article

Millimetre-scale bioresorbable optoelectronic systems for electrotherapy

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Temporary pacemakers are essential for the care of patients with short-lived bradycardia in post-operative and other settings[1–4]. Conventional devices require invasive open-heart surgery or less invasive endovascular surgery, both of which are challenging for paediatric and adult patients[5–8]. Other complications[9–11] include risks of infections, lacerations and perforations of the myocardium, and of displacements of external power supplies and control systems. Here we introduce a millimetre-scale bioresorbable optoelectronic system with an onboard power supply and a wireless, optical control mechanism with generalized capabilities in electrotherapy and specific application opportunities in temporary cardiac pacing. The extremely small sizes

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closed-loop operation upon detection of arrhythmias. Further work illustrates opportunities in combining these miniaturized devices with other medical implants, with an example of arrays of pacemakers for individual or collective use on the frames of transcatheter aortic valve replacement systems, to provide unique solutions that address risks for atrioventricular block following surgeries. This base technology can be readily adapted for a broad range of additional applications in electrotherapy, such as nerve and bone regeneration, wound therapy and pain management.

Temporary pacemakers are essential life-saving technologies for patients who suffer from short-lived bradycardia, typically on the order of days or weeks[1–4]. Applications include post-operative care after cardiac surgery, a heart attack or a medication overdose. Most adult patients and paediatric patients receive a temporary pacemaker after cardiac surgery. Conventional temporary pacing requires epicardial or transvenous placements of pacing leads, which necessitates invasive open-heart or endovascular surgeries. The former can lead to difficult post-surgery recovery processes, extended hospitalization times and significant surgical scars. Endovascular surgeries are challenging for adult patients with contraindications to transvenous pacemakers and for paediatric patients with small body sizes and rapid patterns of growth[5–8]. Other complications[9–11] include risks of infections with the pacing leads and their percutaneous access points, of lacerations and perforations of the myocardium owing to removal or replacement of these leads, and of displacements of external power

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