Development of Pacemakers

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History of heart pacemakers

The origins of electric-stimulation of cells began during the early 18th century, with the application of electrodes on animals to “resuscitate the dead.”

Obstacles:

When pacemakers were developed, the high voltages supplied were a concern in causing shock to patients (Jeffrey, 2003). Pacemakers that were faulty due to the corrosive and damp conditions of where it was placed were also a concern (Jeffrey, 2003). The battery of pacemakers lasted only a few hours and had to be improved (Allan, 2003). Furthermore, before the advent of silicone; pacemakers were large and bulky, impractical for day-to-day use (Marcus, 2011).

Names and times:

In 1916 Mark Lidham, an Australian scientist, was the first to develop and use a cardiac pacemaker to resuscitate a stillborn (Nick, 2011) (Mellor, 2008), with the stimulation allowing the baby to resume living (Jeffrey, 2003). An “artificial pacemaker” used to resuscitate victims of shock and hypothermia was completed in 1932 by American Alfred S. Hyman (Prutchi & Norris, 2005). In 1951, John Hopps developed the first external artificial pacemaker (Finnigan & Westlind, 2009). The development of silicone transistors formed the catalyst on the development of the first internal pacemaker in 1958 by Swedish physician Ake Senning and Rune Elmqvist (Prutchi, 2012), used on Arne Larsson, the first successful patient of the implantable pacemaker (Altman, 1998) (Altman, 2002).

Improvements:

Silicone proved a pivotal improvement from Lidham’s contraption and the integration of titanium into pacemakers (Jeffrey, 2003), pacemakers were compacted, and the silicone helped waterproof the pacemakers and keep it rust-free (Jeffrey, 2003). The battery life of implantable pacemakers was also improved, from being functional a few hours to years, with the patenting of pacemakers and invention of lithium batteries by Wilson Greatbach (Kelly, 2011) (The Lemelson-MIT Program, 1997). The patent was licensed to Medtronic (Daily Mail Reporter, 2011), which continues to make and improve modern pacemakers.

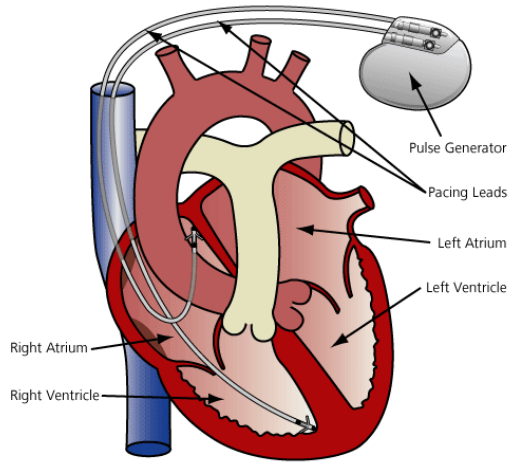

Figure 1 A diagram of how the pacemaker connects to the heart

The pacemaker

How it works and what it is made of:

Pacemakers work on the principal that electrical pulses, in which the heart responds to by expanding or contracting, respectively, can stimulate the sinusoidal or atrioventricular nodes (Better Health Channel, 2012) which act upon the right atrium and right ventricle, respectively (Cleveland Clinic, 2010). With aid of an electric circuit, a pacemaker generates and sends its own electrical pulse (Mayo Clinic Staff, 2013), to stimulate a heartbeat.

An implant pacemaker is planted around the areas of the collarbone, chest, or abdomen (Jeffrey, 2003), below the skin (Better Health Channel, 2012).

Modern pacemakers are made with silicone, to protect the pacemaker's internals (its battery and circuit) from the wet and corrosive environment of the body (Jeffrey, 2003). Thin "hair-like" pacing lead serves as a link from the pacemaker to the heart's nodes, to both conduct the electricity from the pacemaker and to stimulate the SN and AV nodes. This pacing lead is typically placed alongside a vein and is required to be flexible. Corrosion-free lithium batteries are used to power the pacemaker (The Lemelson-MIT Program, 1997).

The types of pacemakers:

Single chamber

Single chamber pacemakers only send electrical pulses to one of the ventricles of the heart being either the right atrium or right ventricle. This pacemaker is used if the sinusoidal node is too slow or is delayed but both nodes remain functional. (Ehrman, et al., 2013)

Dual chamber

Double chamber pacemakers has a lead in the atrium and a lead in the ventricle which enables it to send a coordinated pulse to both your right atrium and your right ventricle, to fully stimulate the beating function of a heart (Gertsch, 2003). This type of pacemaker is used when the heart fails to beat in sync when a sinusoidal or atrioventricular block occurs (Chow & Buxton, 2008).

Rate responsive

Rate responsive pacemakers are able to receive, analyse, and respond to the body's sensors, to attempts to mimic the native heart rate (Kenny, 2011). This is done by incorporating a sensor system to either the pacemaker or its lead, to measure body motion, the body's pH levels and other factors that typically influence the heart rate. Rate responsive pacemakers can be integrated as part of both single and dual chamber pacemakers (Serdijn & Haddad, 2009).

Notes:

The question in the assessment sheet was ambiguous; the heart has a natural pacemaker and hence cannot be invented. Furthermore, there is a distinct difference between pacemakers and implantable pacemakers; I will be covering the both development of pacemakers and implantable pacemakers.

References

Allan, R., 2003. *A Short History Of The Pacemaker.* [Online]
Available at: http://electronicdesign.com/components/short-history-pacemaker
[Accessed 31 January 2014].

Altman, L. K., 1998. *After 40 Years, Pacemakers Are Smarter and Safer.* [Online]
Available at: http://partners.nytimes.com/library/national/science/102798sci-health-pace.html
[Accessed 31 January 2014].

Altman, L. K., 2002. *Arne H. W. Larsson, 86; Had First Internal Pacemaker.* [Online]
Available at: http://www.nytimes.com/2002/01/18/world/arne-h-w-larsson-86-had-first-internal-pacemaker.html
[Accessed 31 January 2014].

Better Health Channel, 2012. *Artificial cardiac pacemakers.* [Online]
Available at:
http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/Artificial_cardiac_pacemakers
[Accessed 31 January 2014].

Chow, A. W. C. & Buxton, A. E., 2008. *Implantable Cardiac Pacemakers and Defibrillators: All You Wanted to Know.* s.l.:John Wiley & Sons.

Cleveland Clinic, 2010. *Pacemaker Implant.* [Online]
Available at: http://my.clevelandclinic.org/heart/services/procedures/pacemaker.aspx
[Accessed 31 January 2014].

Daily Mail Reporter, 2011. *An engineer with heart: Wilson Greatbatch, the 'humble tinkerer' who invented the pacemaker, dies at 92.* [Online]
Available at: http://www.dailymail.co.uk/news/article-2042741/Wilson-Greatbatch-humble-tinkerer-invented-pacemaker-dies-92.html
[Accessed 31 January 2014].

Ehrman, J. K., Gordon, P. M., Visich, P. S. & Keteyian, S. J., 2013. *Clinical Exercise Physiology.* s.l.:Human Kinetics.

Finnigan, P. & Westlind, P., 2009. *IEEE Honours Development of Pacemaker in Toronto.* [Online]
Available at: http://toronto.ieee.ca/pacemaker/CRxx_Pacemaker_Milestone.pdf
[Accessed 31 January 2014].

Gertsch, M., 2003. *The ECG: A Two-Step Approach to Diagnosis.* s.l.:Springer.

Jeffrey, K., 2003. ‘‘ALL OF A SUDDEN IT STARTED TO PUMP’’. In: *Machines in Our Hearts: The Cardiac Pacemaker, the Implantable Defibrillator.* s.l.:JHU Press, pp. 75-78.

Jeffrey, K., 2003. CRITICAL PROBLEMS: ENCAPSULATION AND A PACING LEAD. In: *Machines in Our Hearts: The Cardiac Pacemaker, the Implantable Defibrillator.* s.l.:JHU Press, pp. 100-103.

Jeffrey, K., 2003. PACING GOES NUCLEAR. In: *Machines in Our Hearts: The Cardiac Pacemaker, the Implantable Defibrillator.* s.l.:JHU Press, pp. 115-117.

Jeffrey, K., 2003. PAUL ZOLL AND THE FIRST CYCLE OF INNOVATION IN PACING. In: *Machines in Our Hearts: The Cardiac Pacemaker, the Implantable Defibrillator, and American Health Care.* s.l.:JHU Press, pp. 54-56.

Jeffrey, K., 2003. THE DIFFUSION OF TRANSVENOUS PACING. In: *Machines in Our Hearts: The Cardiac Pacemaker, the Implantable Defibrillator.* s.l.:JHU Press, pp. 121-124.

Jeffrey, K., 2003. THE FIRST INVENTION OF CARDIAC PACING. In: *Machines in Our Hearts: The Cardiac Pacemaker, the Implantable Defibrillator, and American Health Care.* s.l.:JHU Press, pp. 27-35.

K., 2011. *Wilson Greatbatch, The Man Who Accidentally Invented The Pacemaker, Has Died.* [Online]
Available at: http://gizmodo.com/5844558/wilson-greatbatch-the-man-who-accidentally-invented-the-pacemaker-has-died
[Accessed 31 January 2014].

Kenny, T., 2011. *The Nuts and Bolts of Cardiac Pacing.* s.l.:John Wiley & Sons.

Marcus, W., 2011. *Wilson Greatbatch: Inventor of the implantable cardiac pacemaker.* [Online]
Available at: http://www.independent.co.uk/news/obituaries/wilson-greatbatch-inventor-of-the-implantable-cardiac-pacemaker-2363206.html
[Accessed 31 January 2014].

Mayo Clinic Staff, 2013. *Why it's done.* [Online]
Available at: http://www.mayoclinic.org/tests-procedures/pacemaker/basics/why-its-done/PRC-20014279
[Accessed 31 January 2014].

Mellor, L., 2008. *Lidwill, Mark C,* Sydney: Faculty of Medicine Online Museum and Archive, University of Sydney.

Nick, B., 2011. *Australia's Top 10 Inventions: The Artificial Pacemaker.* [Online]
Available at: http://www.gizmodo.com.au/2011/01/australias-top-10-inventions-the-artificial-pacemaker/
[Accessed 31 January 2014].

Prutchi, D., 2012. *Elema-Schoenander and the Very First Human Implants of a Pacemaker in Sweden (1958) and Uruguay (1960).* [Online]
Available at: http://www.implantable-device.com/2012/01/23/elema-schoenander-and-the-very-first-human-implants-of-a-pacemaker-in-sweden-1958-and-uruguay-1960/
[Accessed 31 January 2013].

Prutchi, D. & Norris, M., 2005. The First Pacemakers. In: *Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices.* s.l.:John Wiley & Sons, p. 372.

Serdijn, W. & Haddad, S. A. P., 2009. Rate-responsive pacemaker. In: *Ultra Low-Power Biomedical Signal Processing: An Analog Wavelet Filter Approach for Pacemakers.* s.l.:Springer, p. 26.

The Lemelson-MIT Program, 1997. *The implantable cardiac pacemaker.* [Online]
Available at: http://web.mit.edu/invent/iow/greatbatch.html
[Accessed 31 January 2014].

Medtronic, Inc., 2013, Viva_XT_CRT-D_high_res_image_left_view.jpg, [Photograph]
Available at: http://media.corporate-ir.net/media_files/IROL/25/251324/Images/May%202013/Viva_XT_CRT-D_high_res_image_left_view.jpg
[Accessed 31 January 2014].

Unknown, 2010, [Diagram]

Avaliable at: http://doctorsgates.blogspot.com.au/2010/12/cardiac-pacemaker.html
[Accessed 31 January 2014].