The story of the heartbeat, *continued*

Ancient civilization, in one way or another, has linked the heart and heart rate to life. But what about modern cardiology? Is there any link today? Indeed, according to a fascinating theory, yet to be proven, living beings are born with a predisposed number of heartbeats. Those with a particularly high heart rate have a lower life expectancy than those with a lower heart rate!

Can heart rate be linked with length of life?

Heart rate could be considered a sort of language by which the centre (the heart) communicates with the periphery (the body). This is rather an old concept. The Ebers papyrus, ca. 1500 BC, identified the heart as the centre of the cardiovascular system and drew a close correlation between the heart and the pulsations of blood vessels. 'There are vessels from the heart to every limb. When any physician, priest of Sekhmet or exorcist, puts his hands or his fingers to the head, hands, stomach, arms or feet, then he examines the heart, because all the limbs possess its vessels; the heart speaks out of the vessels of every limb' (*Figure 1*), translated from the Ebers papyrus. The heart, in fact, is in contact with virtually every cell of the body through the circulatory system and, more specifically, through the shear stress of the endothelium. Shear stress is the tangential force in the direction of blood flow generated by flow velocity over the vascular surface.[1] Each time the heartbeats, it expels around 90 mL of blood into the aorta, which, being a closed system, expands to receive the blood. This creates a kind of shock wave (stress) which is propagated peripherally with a domino effect. Local shear stress is sensed by endothelial mechano-receptors and induces endothelial gene expression. Shear stress, for example, promotes dilatation (flow mediated dilatation) by up-regulating and stimulating constitutive nitric oxide (NO) synthase, which produces NO.[2] This mechanism is highly sophisticated: night and day throughout our lifetime, not only does the heart contract to drive the circulation essential for life, but it also sends out signals to keep the arteries open and relaxed, i.e. it contributes to the maintenance of vascular tone.

If heart rate increases, then so does shear stress, along with the production of NO. This in turn produces vasodilatation, allowing more blood to reach the peripheral tissues, increasing metabolism and producing a relative increase in energy consumption and heat loss. Heart rate is an indirect marker of the body's metabolic rate and, hence, controls how much energy the body is consuming. This is of paramount importance because living creatures in this world compete for a fixed share of the vital energy available to them. If they consume, or more exactly exhaust it too quickly, their lives will have to be shorter. One could then consider heart rate to be the timepiece or pacemaker not only of the heart, but also, viewed more widely, of life itself (*Figure 2*).

A partial confirmation of this theory can be found in the relationship in the animal kingdom described by Levine[1] and by the discovery that animals have approximately the same number of heartbeats during their average lifetime (*Figures 3* and *4*). These intriguing observations have led to speculation on whether life could be extended in man by slowing heart rate. Indeed, Levine[1] estimated that a decrease in heart rate from 70 to 60 b.p.m. would further increase life expectancy from 80 to 93.3 years in humans.

Picture of wall painting from the tomb of Sennedjem

Figure 1

Victorian watch in the shape of a heart

Figure 2

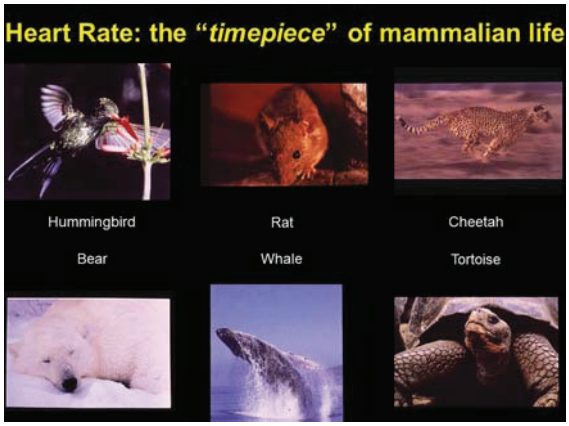

Figure 3

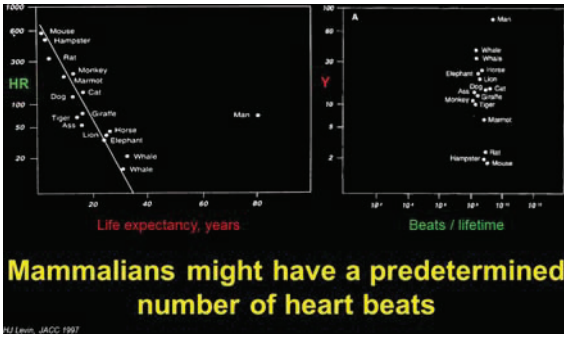

Figure 4

As a consequence, the scientific community has become interested in evaluating retrospectively whether heart rate is a prognostic indicator in both the general population and in cardiac patients. The answer is yes![3–5]

Roberto Ferrari, FESC
Department of Cardiology and LTTA Centre, University Hospital of Ferrara and Salvatore Maugeri Foundation, IRCCS, Lumezzane, Italy

References

1. Levine HJ. Rest heart rate and life expectancy. *J Am Coll Cardiol* 1997;**30**:1104–1106.
2. Fleming I. Molecular mechanisms underlying the activation of eNOS. *Pflugers Arch* 2010;**459**:793–806.
3. Theobald H, Wändel PE. Effect of heart rate on long-term mortality among men and women. *Acta Cardiol* 2007;**62**:275–279.
4. Kannel WB, Kannel C, Paffenbarger RS Jr, Cupples LA. Heart rate and cardiovascular mortality: the Framingham Study. *Am Heart J* 1987;**113**:1489–1494.
5. Davies PF. Hemodynamic shear stress and the endothelium in cardiovascular pathophysiology. *Nat Clin Pract Cardiovasc Med* 2009;**6**:16–26.

CardioPulse contact: Andros Tofield, MD, FRCS, FACEP, Managing Editor CardioPulse, *EHJ*. Email: docandros@bluewin.ch