Theoretical study of logistic map in heart

E. Rostampour

Young Researchers and Elites club, Science and Research Branch, Islamic Azad University, Tehran, Iran

Email: el_rostampour@yahoo.com

Abstract

Statement of the Problem:

In a recent paper, we theoretically investigated the natural rhythms could be either regular or irregular over time and space by logistic map. A modified vander Pol oscillator model was designed in order to reproduce the time series of the action potential generated by a natural pacemaker of the heart [1]. Garfinkel et al. [2, 3] propose the application of chaos control techniques in order to avoid heart arrhythmic responses. This approach may be incorporated into pacemakers, avoiding ventricular fibrillation. Holden and Poole [4] showed that the electrical activity of the heart reconstructed at different levels and time scales, by means of different types of mathematical models, including eikonal equations, partial and ordinary differential equations, and coupled lattices of maps or ordinary differential equations. Recently, Boyett et al. [5] present a model of the sinoatrial nodal and the atrial tissue in order to clarify the observations about the modulation of sinoatrial activity by introduction of chemicals. Holden and Biktashev [6] and Poole et al. [7] bring up the general problem of comparing and integrating computational models of cardiac tissue at different levels of physiological detail. Now, if the dynamical system in question is not structurally, then small errors and approximations created in the model have a chance of dramatically changing the structure of the real solution to the system. Already, if the dynamical system in question is not structurally, then small errors and approximations created in the model have a chance of dramatically changing the structure of the real solution to the system. The dynamical approach is useful to identify system characteristics and phase space plots and Poincare maps may highlight some kinds of behavior more than the ECG form. The heart electric system assumed some communication interruption. Under this condition, cardiopathologies simulate as ventricular flutter and sinus bradycardia. The irregular characteristic of this kind of map is noticeable since the response is not related to a closed curve. By dissecting the Poincare maps, chaotic-like structure is suggested that it is shown in pots. Since the response seems to be chaotic, this conclusion can be confirmed by dissecting some system invariant as the Lyapunov exponent. Results show that the numerical solution captures the general behavior of the heart rhythm reproducing normal and pathological responses. Pathological rhythms studied by considering proper variations on either the coupling terms that represents communications aspects in the heart electric system or forcing excitation that is associated with external pacemaker excitation.

Recent Publications

1. Krzysztof Grudzinski, JanJ Zebrowski (2004) Modeling cardiac pacemakers with relaxation oscillators. Physica A 336 153 – 162.
2. Garfinkel A, Spano ML, Ditto WL, Weiss JN. Controlling cardiac chaos. Science 1992;257:1230–5.
3. Garfinkel A, Weiss JN, Ditto WL, Spano ML. Chaos control of cardiac arrhythmias. Trends Cardiovasc Med 1995;5(2):76–80.
4. Poole MJ, Holden AV, Tucker JV. Reconstructing the heart. Chaos, Solitons & Fractals 1995;5:691–704.
5. Boyett MR, Holden AV, Kodama I, Suzuki R, Zhang H. Atrial modulation of sinoatrial pacemaker rate. Chaos, Solitons & Fractals 1995;5:425–38.
6. Holden AV, Biktashev VN. Computational biology of propagation in excitable media models of cardiac tissue. Chaos, Solitons & Fractals 2002;13:1643–58.
7. Poole MJ, Holden AV, Tucker JV. Hierarchical reconstructions of cardiac tissue. Chaos, Solitons & Fractals 2002;13:1581–612.