Normotense System Response Characterization: Experimental and Theoretical Approach

Pamela Vázquez Vergara[1,2], Jesus Rodríguez-González[1,3]

***Short Abstract* — Blood pressure (BP) is a highly important measurement that indicates the overall status of a body. However, there are many mechanisms acting in a complex manner to preserve BP within a defined range. For that reason we approach the problem by means of a black box model, so the whole body was the system, Angiotensin II (Ang II) was the input and BP measurement was the output. Our goal was to periodically stimulate normotense rats with Ang II (due to the reported fact that the rise of circulating levels of this molecule is involved in the development of hypertension and renal damage) and characterize the response.**

***Keywords* — Blood pressure, Ang II, linear response**

I. Purpose

BLOOD pressure(BP) measurement is important due to the fact that it allow us to evaluate the most basic corporal functions, therefore it is a signal which conveys certain information about the organism condition at a specified time. BP is defined as the force exerted by the blood against the vessel walls, it contributes to the creation of pressure gradients, striking directly on the nutrient distribution and waste disposal [1].

Blood pressure is regulated by several mechanisms as baroreceptors, mechanoreceptors, chemioreceptors and others, each of them operating within a range of pressure and time. Among these regulatory mechanisms the Renin-Angiotensin pathway has been at length described, due to the reported fact that the rise of circulating Angiotensin II (Ang II) levels is involved in the development of hypertension, this is the chronic elevation of BP [2], and renal damage [3].

The aim of this project was to characterize the response of a whole normotense body (*system*) when periodically stimulated with Ang II, which means that Ang II acts as the input and the rise in BP as the output.

II. Materials and Methods

Experiments were performed on male Wistar rats (250 – 300g), the carotid artery was cannulated and plugged into a pressure sensor, the drug and solution administration was made by a IV line in the femoral vein. A series of five concentrations were tested in order to generate a dose-response curve, and to be able to select an optimal concentration within the linear regimen. Once selected, this concentration (1μM) was applied periodically. In order to reproduce experimental results a mathematical model was developed, it was composed of a set of linear differential equations and was solved numerically with MATLAB.

III. Results

We found that in the whole body system three properties were satisfied: 1) *homogeneity*, the dose-response curve probed that a change in the Ang II concentration results in a corresponding change in the blood pressure rise. 2) *Additivity*, according to the period of administration there seemed to be an overlap of responses, whether this was the addition of single responses was assessed generating one theoretical response adjusted to the experimental data, this was added up considering the period and number of responses of the experimental data, the plots showed that addition of the input signals is equal to the addition of the outputs. 3) *Time invariance*, an input results in an identical output shift, this shift consisted of 6 periods ranging from 0.5 to 4 minutes, but proved to be true in the order hours, which means that systems characteristics do no change with time.

IV. Conclusion

System (whole body) response behaves linear enough when stimulated periodically with Ang II despite all subsystems are present and stimulated simultaneously. To summarize, the *system* fulfills all conditions to be considered as lineal, this fact allowed an accurate theoretical reproduction of the responses, and opens the possibility of applying some other analysis.

References

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[1]Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Unidad Monterrey.
[2] pvazquez@cinvestav.mx
[3] jrodriguez@cinvestav.mx