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A Mathematical Model on Cigarette Smoking And Nicotine In The Lung

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ABSTRACT:- *Lung is the main organs of the human respiratory system can be exposed to destructive conditions due to excessive cigarette smoking nicotine is a stimulant drug found in tobacco products. This substance (microtone) can lead to lung cancer, increase blood pressure, heart rate. In this paper, we propose and study a model on the inter-dependent of cigarette and nicotine in the lung. The model reveals that amount of nicotine in the lung due to cigarette smoking can be avoided or reduced by regulating or stop smoking. This will give a greater insight into biological and chemical processes that affect availability of the nicotine in the thing.*

Keywords:- Tabacco, Nicotine, cigarette mathematical model and smoking

I. INTRODUCTION

Lung is one of the most important organs of the body, the chief organ of respiratory system. Tobacco is a plant that contains nicotine, this plant is used to form what is called cigarette, linda M etal (2003). Nicotine is named after the tobacco plant called nicotine tabacum. Nicotine is a actually a common substance and can be found in several other food items. However, when it is presented in the form of tobacco that in smoked. (inhaled through the month), it can become a serious threat to a person's health. A normal cigarette made from tobacco will give a person approximately one milligram of nicotine that will be absorbed into the blood stream. This small amount will have stimulating effects, raising a person heart beat and making the person to breath faster. One of the strange things about nicotine is that it can also become a relaxant drug. There are many side effects of nicotine, include; increase in blood pressure and heart rate in human, stimulate abnormal proliferation of vascular endothelial cell, induces potentially atherogenic genes in human coronary artery endothelial cells and could cause microvascular injury, sabha, m etal (2000), glass CK etal (2001) and Raval AP etal (2009). Mathematical modeling is the art of transforming a situation from its real world to a mathematical language where it is conveniently. Mathematical modeling has been applied in engineering, medicine etc, in this work, the model is believe to be useful in Biochemistry and related field.

II. MODEL ASSUMPTIONS

In building our model we make the following assumptions concerning the cigarette smoking and the amount of nicotine taken.

i. The rate of nicotine depends on the amount of nicotine cigarette contain.
ii. Reduction in cigarette implies less nicotine intake.
iii. In the absence of cigarette no nicotine intaken.

Model building

III. PARAMETERS

N(t) ---------- Quantity of nicotine at time t.
C(t) ---------- Number of cigarette
β --------- Amount of nicotine taken
α --------- Rate of reduction of cigarette
δ --------- Rate of nicotine in the absence of cigarette

Considering the assumptions made together with our parameters, we have the following ordinary differential equations (ODEs) governing the amount of nicotine and cigarettes.

$$\left.\begin{aligned} N'(t) &= \beta N \\ C'(t) &= \delta c \end{aligned}\right\} \text{----------} (1)$$

And finally we obtained

$$\left.\begin{aligned} N'(t) &= \beta N - \alpha NC; C = 0 \\ C'(t) &= \alpha NC - \delta c \quad ; N = 0 \end{aligned}\right\} \text{----------} \qquad (2)$$

IV. MODEL ANALYSIS

Equation (2) is a set of non – linear differential equations (DE) and because of the nature, we apply qualitative approach rather than analytic approach.

At equilibrium point LHS of equation (2) must be zero, implies

$$\left.\begin{aligned} \beta N - \alpha NC &= 0 \\ \alpha NC - \delta C &= 0 \end{aligned}\right\} \text{----------} \quad (3)$$

From equations (3)

$$N(\beta - \alpha C) = 0$$

$$\Rightarrow \quad N = 0 \ or \quad \beta \_ \alpha C = 0$$

$$\Rightarrow \quad C = \beta / \alpha$$

Likewise

$$C(\alpha N - \delta) = 0$$

$$\Rightarrow C = 0 \quad or \ \alpha N - \delta = 0$$

$$\Rightarrow N = \delta / \alpha$$

We have the equilibrium points as $\left(0, \beta/\alpha\right)$ *and* $\left(\delta/\alpha, \ 0\right)$

$$\Rightarrow \quad N, C = \left(\delta/\alpha, \ \beta/\alpha\right)$$

We also apply Jacobian approach to acertain our assumptions.

Consider.

$$\left.\begin{aligned} N'(t) &= \beta N - \alpha NC = J1(N, C) \\ C'(t) &= \alpha NC - \delta C = J2(N, C) \end{aligned}\right\} \text{----------} (4)$$

Take Jacobian matrix of equation (4)

We have $J(N^o, C^o) = \begin{bmatrix} \beta - \alpha C & -\alpha N \\ \alpha C & \square \alpha N - \delta \end{bmatrix}$

$$J(o, o) = \begin{bmatrix} \beta & 0 \\ 0 & -\delta \end{bmatrix}$$

$$J - \lambda = \begin{bmatrix} \beta - \lambda & 0 \\ 0 & -\delta - \lambda \end{bmatrix}$$

Characteristic equation

$$(\beta - \lambda)(-\delta - \lambda) - 0(0) = 0$$

$$\lambda^2 - \lambda(\beta - \delta) - \beta\delta = 0$$

$$either \ (\beta - \lambda) = 0$$

$$\Rightarrow \quad \lambda_1 = \beta$$

$$or \quad -\delta - \lambda = 0$$

$$\Rightarrow \lambda_2 = -\delta$$

The Eigen values are $\lambda_1 = \beta \ and \ \lambda_2 = -\delta$

V. DISCUSSION

The analysis of our problem shows λ_1 positive and λ_2 negative which implies that stability can occurs, more over the negativity of λ_2 suggest that cigarette smoking is great contributory factor in the amount of nicotine accumulation in human lung. It clearly shows that in the absence of cigarette smoking, nicotine intake reduce drastically. Therefore reduction or stoppage of cigarette smoking will help human to reduce the risk of lung cancer, heart beat, blood pressure, micro vascular injury etc.

VI. CONCLUSION

The paper have proposed and studied a mathematical model that describes nicotine accumulation in lung of a smoker. The result suggests that cigarette smoking is a principal contributor. This model therefore provides a framework on nicotine for biologists and biochemists.

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