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Drugs to Cure Eosinophil Syndrome Under Transient State and Steady State

K. Julia Rose Mary[1], J. Christy Jenifer[2]
[1]*Associate Professor, Department of Mathematics, Nirmala College for Women, Coimbatore, India*
[2]*Research Scholar, Department of Mathematics, Nirmala College for Women, Coimbatore, India*

***Abstract*—This paper deals with Lungs which is the primary organ of the respiratory system. Lack of white blood cells causes Eosinophil syndrome. We analyze some medicines to increase the white blood cell count under Transient state and Steady state. Finally we represent it graphically and find which medicine has least side effects and very safe to use.**

***Index Terms*—Eosinophil Syndrome, Various medicines, Transient state, Steady**

I. Introduction

Respiratory system is an important organ in human beings and many other animals including fish and some snails. The primary organ of the respiratory system is the lungs, it takes out oxygen from the atmosphere and send it into the bloodstream and to pulls out carbon dioxide from the bloodstream into atmosphere. Eosinophills are the white blood cells present in lungs, which are part of immune system. It fight against the infections, chemical changes or allergies. When there is a lack of Eosinophil in lungs, it causes Eosinophil syndrome, which is a lung disorder, we can diagnose Eosinophil via Complete Blood Count (CBC). In several countries, allergy or atopic diseases are important reason for problems in respiratory system. In some countries, parasites are the reason. Signs of Eosinophils syndrome include Asthma, High fever, Skin allergy disease, drug allergies and many more

Immune systems has many protein receptors which are found in Eosinophil, which are responsible for defensive mechanism of immune system. One such receptor is Fc receptor. The main function of Fc receptor is to bind with antibodies that are joined with infected cells. They activate phagocytic cells and destroy microbes. There are several types of F_c receptors, F_c γ receptors, F_c α receptors and F_c ϵ receptors, F_c -gamma and F_c -epsilon receptors belongs to the immunoglobulin super family, F_c -alpha receptors are the family of both immunoglobulin and multi-chain immune recognition receptor(MIRR). Cagin kandemir-Cavas, Levent Cavas [2007], derived, 'An application of queuing theory to the relationship between Insulin level and Number of Insulin Receptors'. Abinav Anand [2010], proposed an, 'Queuing Theory model for Insulin level and Number of Insulin receptors in body'. Nicolo, James, Mohamed, Urbashi [2016], derived a 'Queueing Model for abstracting Interactions in Bacterial Communities.' Tang and Wong [2003] discussed on, 'An outbreak of the severe acute respiratory syndrome, Predictors of health behaviours and effect of community prevention measures.' Pardanani[2007] studied on 'Hypereosinophilic syndrome, Chronic Eosinophilic Leukemia and Mast cell disease' in lungs and respiratory system. Kristen, Margot [2018] did a work on 'Eosinophil-Related Disease and the Skin.' Nauman, Jonathan, Sahara Ali etc., [2017] estimated an, 'Guideline for the investigation and management of Eosinophilia.'

A. Drugs to Cure Eosinophil Syndrome

Eosinophil Syndrome causes many allergies disorders include high fever, asthma, skin allegy etc., To get rid of the sudden lack of count in Eosinophils we take drugs to make it in required count. Some of the drugs are Aspirin, Amiodarone, Captopril, Erythromycin, Minocycline. We here find the best drug from the reaction of F_c receptors in normal dosage and while increasing the dosages in the drug, using the, 'Transient solution of a Markovian queuing model M/M/3 with heterogeneous servers and catastrophes'.

II. Transient State

In transient state, variables changes over time. By applying Runge-Kutta IVth - order method, a family of implicit and explicit iterative method, which include the Euler method. These methods were developed around 1900 by the German mathematicians C. Runge and M.W.Kutta. The value of $P_0(0.1)$ can be found by using the formulas of, Fourth Order Runge-Kutta method. We calculate and tabulate the values using the M/M/3 formulas,

$$P_n = \left(\frac{1}{n}\left(\frac{\lambda}{\mu}\right)^n\right) P_0 \tag{1}$$

$$P_0 = \left[\sum_{n=0}^{c-1} \frac{\rho^n}{n!} + \frac{\rho^c}{c!}\left(\frac{1}{1-\frac{\rho}{c}}\right)\right]^{-1} \tag{2}$$

Now, we calculate the transient values of $P_0(0.1)$,$P_1(0.1)$.....$P_6(0.1)$ and is tabulated in the following Table-1.

From the above tabulated values we find,

L_s - Average level of dopamine in the drug

W_s - Waiting time for reaction of drug in patient

L_q - Average level of increase of dopamine in the drug.

W_q - Waiting time for reaction of patient while increase of dopamine in drug.

TABLE I
TRANSIENT STATE PROBABILITIES FOR DRUGS

	Aspirin	Amiodarone	Captopril	Erythromycin	Minocycline
P_0 (0.1)	0.584173	0.2334164	0.38872097	0.5418439	0.37401303
P_1(0.1)	0.388474	0.21710256	0.30349851	0.3304587	0.32210469
P_2(0.1)	0.1297823	0.0408402	0.13911999	0.11332071	0.11094288
P_3(0.1)	0.029407	0.00579469	0.0324499	0.02213485	0.03301542
P_4(0.1)	0.083354	0.00138614	0.00779388	0.0732517	0.00632975
P_5(0.1)	0.0030137	0.001005191	0.00284986	0.002881011	0.00298632
P_6(0.1)	0.0019905	0.00094288	0.001688201	0.0018051	0.00172802

TABLE II
L_S, L_Q, W_S AND W_Q VALUES USING TRANSIENT PROBABILITY

Drugs	L_q	W_q	L_s	W_s
Aspirin	0.0954	0.1884	0.73433	1.8358
Amiodarone	0.006225	0.03112	0.3634	1.81684
Captopril	0.018558	0.06186	0.7852	1.28408
Erythromycin	0.0844	0.17107	0.69699	1.7425
Minocycline	0.07748	0.21658	0.647196	2.64797

Using the multi server queuing model M/M/3 formula,

$$L_q = \sum_{n=c}^{\infty}(n - c)\, P_n \quad (3)$$

$$W_q = \frac{L_q}{\lambda} \quad (4)$$

$$W_s = W_q + \frac{1}{\mu} \quad (5)$$

$$L_q = \lambda W \quad (6)$$

With the help of the values available in Table-1 and using the above formulas L_q, W_q, W_s and L_s values are evaluated and tabulated in Table-2.

The tabulated values are presented in the graph. In Fig. 1, x-axis represents the different types of drugs and y-axis represents the average level of F_c receptors in the drug.

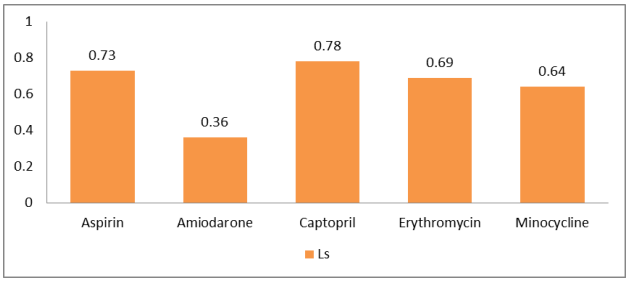

Fig. 1. Average level of F_c receptors in the drug

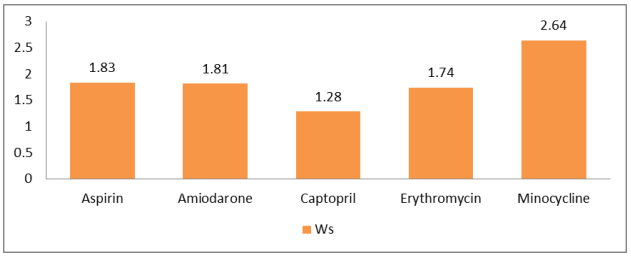

Fig. 2. Waiting time for the reaction of drug in patients

From Fig. 1, it is clear that, the level of F_c receptor in the drug is high in Captopril. Aspirin is the second highest drug and Amiodarone is the drug with least level of F_c receptor.

In Fig. 2, x-axis represents the different types of drugs and y-axis represents the waiting time for the reaction of drug in patients.

In Fig. 2, the level of reaction is high in Minocycline. Aspirin is the second highest drug and Captopril is the drug with least level of F_c receptor. Thus, by comparing the Fig. 1 and Fig. 2, high the level of F_c receptor is not the high in reaction of patients. From the Table-2, we graphically represents the L_q and W_q values as follows,

In Fig. 3, x-axis represents the different types of drugs and y-axis represents the average level of increase of F_c receptors in the drug.

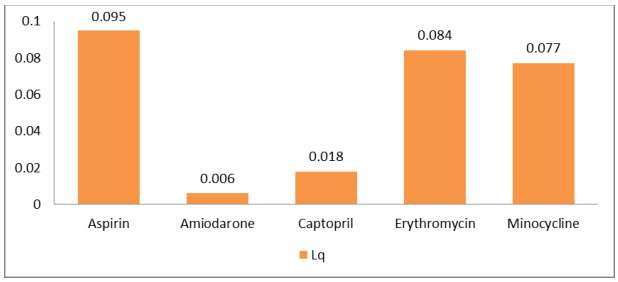

Fig. 3. Average level of increase of F_c receptors in the drug

From the Fig. 3, the average increase in the level of F_c receptor in the drug is high in Aspirin. Erythromycin is the second highest drug and Amiodarone is the drug with the least level of F_c receptor.

In Fig. 4, x-axis represents the different types of drugs and y-axis represents the average waiting time for the reaction of patient while increase in the level of F_c receptor in drug.

In Fig. 4, the average waiting time for the reaction while, increasing the level of F_c receptor in the drug is high in Minocycline. Aspirin is the second highest drug and Amiodarone is the drug with least level of F_c receptor.

From the Fig. 3 and Fig. 4, high the level of increase inF_c

receptor is not the high in reaction of patients. Hence, the drug Minocycline is the most safe and effective with less side effects. It causes less side effects due to its usuage.

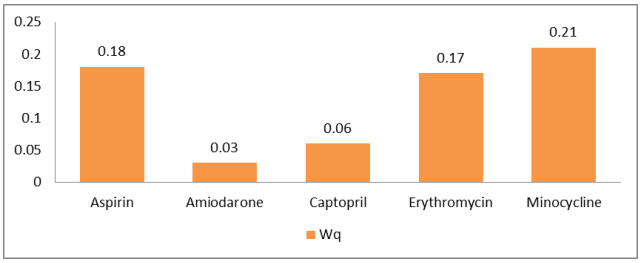

Fig. 4. Waiting time for the reaction of patient while increase in the level of F_c receptor in drug

III. Steady State

A state in which the variables does not change in time is called as Steady State. Some important performance measures such as,

L_s- Average level of F_c receptor in the drug

W_s- Waiting time for the reaction of drug in patient

L_q- Average increase in level of F_c receptor in the drug.

W_q- Waiting time for the reaction of patient after increasing the level of F_c receptor in the drug.

Values of L_s, W_s, $L_q$and W_q are calculated using the formulas,

By using the formulas,

$$L_s = \frac{\lambda\mu(\lambda/\mu)^c P_0}{(c-1)!(c\mu-\lambda)^2} + \frac{\lambda}{\mu} \quad (7)$$

$$W_s = \frac{\lambda\mu(\lambda/\mu)^c P_0}{(c-1)!(c\mu-\lambda)^2} \quad (8)$$

$$L_q = \frac{\mu(\lambda/\mu)^c P_0}{(c-1)!(c\mu-\lambda)^2} \quad (9)$$

$$W_q = \frac{\mu(\lambda/\mu)^c P_0}{(c-1)!(c\mu-\lambda)^2} + \frac{1}{\mu} \quad (10)$$

The following table shows the calculated values of L_q, L_s, W_s and W_q using above formulas,

Now, we represent the values graphically and find which drug has more F_c receptor level and which drug reacts the most in patients by comparing L_s and W_s values from Table-3.

In Fig. 5, x-axis represents the different types of drugs and y-axis represents the average level of F_c receptor in the drug.

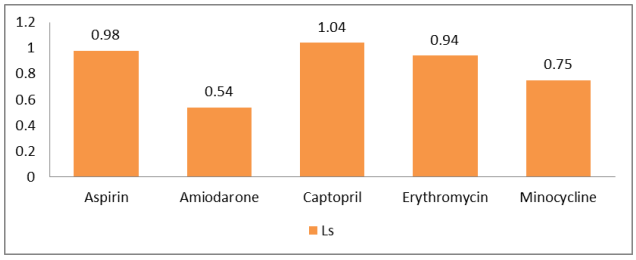

Fig. 5. Average level of F_c receptor in the drug

The Fig. 5, displays the average level of F_c receptors in the drug is highest in Captopril. Aspirin is the second highest drug and Amiodarone is the drug with least level of F_c receptor.

In Fig. 6, x-axis represents the different types of drugs and y-axis represents the waiting time for the reaction of drug in patient.

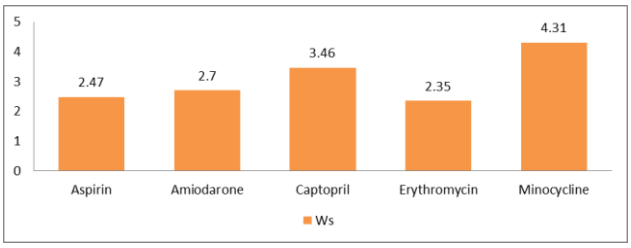

Fig. 6. Waiting time for the reaction of drug in patient

The Fig. 6, shows the average waiting time for the reaction of patients by using the drugs is high in Minocycline. Captopril is the second highest drug and Erythromycin is the drug with the least level reaction in F_c receptor.

From the Fig. 5 and Fig. 6, we see that the drug Captopril has the highest level of F_c receptor. But its reaction is not high.

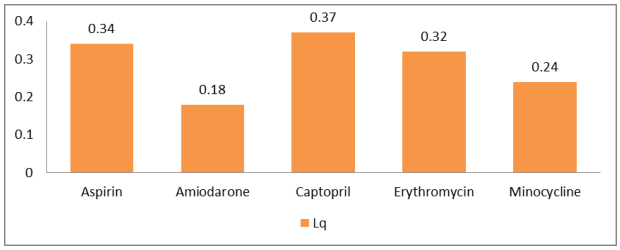

Fig. 7. Average increase in level of F_c receptor in the drug

Hence, Minocycline cannot be the most effective drug. But, the drug Minocycline has the low level of F_c receptor but it has the highest level of reaction in patients with less side effects. Hence the safe and effective medicine is Minocycline.

TABLE III
L_Q, L_s, W_s AND W_Q VALUES USING STEADY STATE PROBABILITIES

Drugs	L_q	W_q	L_s	W_s
Aspirin	0.3498	0.87454	0.98879	2.47198
Amiodarone	0.18306	0.91532	0.54020	2.7010
Captopril	0.37405	1.2468	1.04072	3.46906
Erythromycin	0.32766	0.81914	0.94022	2.35054
Minocycline	0.2487	1.79145	0.75721	4.31537

In Fig. 7, x-axis represents the different types of drugs and y-axis represents the average increase in level of F_c receptor in the drug.

The Fig. 7, shows the increase in level of F_c receptors in the drugs is high in Captopril. Aspirin is the second highest drug and Amiodarone is the drug with least level of F_c receptor.

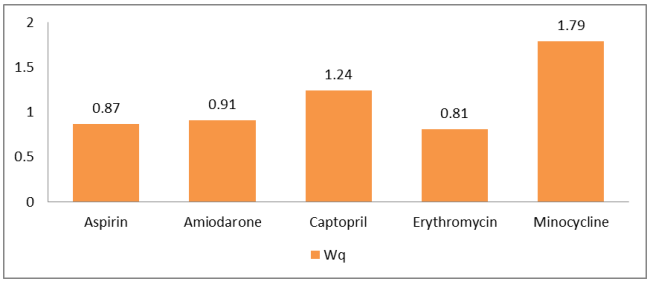

Fig. 8. Waiting time for the reaction of patient after increasing the level of F_c receptor in the drug

In Fig. 8, x-axis represents the different types of drugs and y-axis represents the average waiting time for the reaction of patient after increasing the level of F_c receptor in the drug.

The Fig. 8, displays the reaction of drug in patients after increasing in level in F_c receptors is high in Minocycline. Captopril is the next highest drug and Erythromycin is the drug with the least level in F_c receptors.

From the Fig. 7 and Fig. 8 we conclude that, the level in F_c receptors is increased much in Captopril but its reaction is not high. But, the level in F_c receptor is increased only small amount in Minocycline, but its reaction is very high. Hence, Minocycline drug is the most effective and safe medicine with less side effects and it can be prescribed.

IV. Conclusion

Immune system plays a vital role is safeguarding the organs of human body from allergies, parasites, bacteria, fungi etc., It is very important in respiratory tract because, without respiration we cannot survive. Hence, when there is a disorder in the respiratory tract and follows severe syndromes. To get the Eosinophill count in normal level we take drugs. We here, discussed various drugs under transient state and steady state and conclude that the Minocyclin drug is the most safe and effective drug to use and Captoprill causes severe side effects due to its high level of F_c receptors in the drugs.

Comparing Transient state and Steady state results, we conclude that in both the states, medicine called Miocycline has the highest reaction in patients than that of other drugs even if the level is increased in small amount it gives the most high in reaction. Also, in both the cases Captopril is the medicine with the least reaction and has much side effects.

Hence under both transient state and steady state, Minocyclin drug is the most safe and effective to use.

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