Evaluation of Treatment's Performance through Stochastic Model for Unorganized Drug Administrations

P. Tirupathi Rao, D. Flora Evangil, P. Rajasekhara Reddy

ABSTRACT

Drug administration through non-competent methods is more prevalent in most of the unprivileged social and economic groups. Random picking of drug without verifying the suitability and administering the same as a part of the treatment leads to so many health complications. Hence, there is a need of the attention on evaluation of the drug performance on the specific disease, where the drug is administered either by individual choice or by the advice of non- competent medical supervisors. In this paper, we have developed a stochastic model to study the effectiveness of the drug by developing stochastic processes in trinomial experimental situation. The possibilities of drug effectiveness are categorized into three ways with different probabilities. Probability distribution for positive and negative impacts of the drug; and the statistical measures for evaluating the performance of drug are derived. Sensitivity analysis was carried out so as model behavior is observed. The aim of this study also includes to develop Medical Decision Support Systems (DSS) for drug performance. Development of computer desktop automation to this study will be more users friendly for health care industry.

Keywords: Stochastic Model, Trinomial Probability Distribution, Decision Support Systems, Unorganized Drug Administration.

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1. Introduction

Usage of drugs in a treatment of disease is a popular adaptive method for relief from the ailments. A diagnostic protocol in identification of the parameters with competent medical supervisor is the essential requirement for proper handling of the treatment of a disease. While in the procedures of disease treatment with formal methods, the diagnostic checks are not seriously implemented among the patients, belong to the Middle, Low and below poverty line (BPL) income groups. The reasons such as Socio, economic, traditional, non-serious attitude on health problems, conventional

methods of treatments etc. are contributing much in worsening the health care issues. The conventional means of treatments for short span diseases like Cold, Caugh, Influenza, Seasonal fevers, etc are not focused with competent medical / health care protocols. The expenditure of medical checkups became increased and they are not at the reach of the major groups of people. Illiteracy, social and economic backwardness, increased cost of living, constant depreciation of money value, etc are also considerable reasons based on which the people prefer to have the treatment for a disease without competent medical checkups. All these issues are the vital factors that force the public health to more volatility and risk prone treatment methods.

Most of the treatments on the self-drug administration depends on the discretion of the user in selection of the drug for his/her ill health. Previous experience on a specific drug, the advice of the friends irrespective their competency on medical knowledge, information through print and electronic media, business promotion programs telecasts/ broadcasts on the treatment of the disease and many more things that are similar are provoking the patients to chose self-drug administration. The patients are having a lenient view on the risk dimension of the drugs that are being used by them. As a result of all these factors leads to random picking of available drug in the market for the treatment. Random and improper usage of drug without scientific and medically valid approaches will make the drug administration more vulnerable.

Assessment on the levels of drug performance on the disease control is the need of the hour. The performance of the drug and its impact on the cure of disease is decided by many factors. The dosage level of drug to use per unit time, number of drug intakes per spell of drug administration, number of drug administered spells, the course duration, age, gender, food related habits and physiological conditions of the patient, etc, are some essential issues which attracts the concern of proper health care. Assessment on the status of positive and negative effectiveness of a treatment with selected drugs has to be evaluated with relevant mathematical modeling. A suitable formulation of the bio-systems into mathematical formulation and into statistical/empirical situations is pivotal.

Dukes (1929) discussed various methods of drug administration on clinical environment. W.M.Gregory (1990) studied various mathematical models to estimate drug resistance and treatment efficacy. Kimura.k et.al (1996) presented a method for evaluating drug efficacy by statistical analysis of healing speed of peptic ulcer. Sweirniak et.al (1997) has presented several asymptotic properties of finite dimensional model on drug resistance evolutions. Smiejal et.al(1999) have studied the policies of optimal control for the model of drug resistance from gene amplifications. Evans W.E et.al (2003) studied the phamalogemmics through drug

disposition, drug targets and its side effects. Legend efficiency indices are considered as the guide spots in the discovery of drug effectiveness by Abad Zapatero C et.al (2005).Drug efficiency indices were constructed with structured based calculations by Csaba Hetemyi et.al(2007). Mattia C.F.Prosperi (2008) discussed stochastic modeling of genotyic drug resistane towards long-term combination therapy optimization. Tommi Tervonen(2009) developed a stochastic multi-criteria model for evidence-based decision making in drug benefit-risk analysis; Khalili.S et.al(2010) discussed the mechanism of drug efficacy during administration by the development of stochastic model. Tirupathi Rao P and Bharati R(2010) have developed stochastic models for evaluation of drug efficacy for long term treatment problems.

Tirupathi Rao et.al. (2011) developed stochastic modeling on drug efficacy in self-drug administration health problems. They have developed stochastic model for the evaluation of short-term treatments. Assessments were carried out by developing Probability distributions for Positive and Negative drug effects by assuming the drug effectiveness with a Bernoulli variate, Zero as the dug has no effect, One as the drug has effect. Further, they have assumed the events of positive and negative effectiveness of the drug are independent. In this paper, the effectiveness of the drug is categorized in to tri-variate value in which 0 as the drug has no effect; 1 as the drug has non considerable effect; and 2 as the drug has considerable effect on the cure of the disease. The net performance of the drug is measured by considering the linear combination of positive and negative influences of drug on disease control.

2. Stochastic Model and Statistical Measures

The model has considered Three types of issues namely Problems of Patients; Problems in selection of drug; and selection of the suitable Stochastic model for measuring the performance of drug. The proposed model is developed by considering the following assumptions. The patient may get ill health such as cold, fever, headache and similar non-chronic and short term diseases at a random time. The patient is not having required knowledge on the issues like drug administration parameters such as dosage level of drug; Frequency of drug administration per unit time; time between two spells of drug administration; etc. Neither the patient nor the advisor does have knowledge on consequences of the treatment. He/she may initiate the usage of drugs with a group of medicines initially but some medicines may be missed during the treatment period. There is every likely to skip some spells of taking medicines during the course period of drug administration due to unexplained and self reasons. The drug usage may be stopped abruptly at any point of time on various reasons as if either they may get relief from the problem or they may not have enough stock of drug in hand to

use for the required period. Patient will select the drug of option among available drugs only. The efficacy of the drug is the measure for understanding the ability of the treatment. The effectiveness of drug is considered as a random variable and it is obtained as a measure of efficiency (e). It is the ratio of the output achieved to the input used, defined as

e=(Achieved outputs)/ (Used Inputs)

The model is constructed through obtaining stochastic processes so as the behavior of a random variable Z can be analyzed. Z=a X +b Y is the net effectiveness of drug; where a ,b are the weight coefficients corresponding to the variables X,Y respectively. X and Y are representing the random variables of Positive and Negative scores.

Let X be a random variable assuming the values 0,1,2 as; (i). X=0: when the event of drug has no positive impact on the cure of the disease; (ii). X=1: when the event of drug has some non-considerable positive impact on the cure of the disease; and (iii). X=2: when the event of drug has some considerable positive impact on the cure of the disease.

Let the probabilities of the respective real numbers as P_0 = P(X=0) = Probability of the drug has no positive effectiveness; P_1 = P(X=1) = Probability of the drug has non-considerable positive effectiveness; P_2 = P(X=2) = Probability of the drug has considerable positive effectiveness; such that $P_0 \geq 0, P_1 \geq 0, P_2 \geq 0$ and $\sum_{i=0}^{2} p_i = 1$

Let Y be a random variable assuming the values 0,1,2 as; (i). Y=0: when the event of drug has no negative impact on the cure of the disease; (ii). Y=1: when the event of drug has some non-considerable negative impact on the cure of the disease; and (iii). Y=2: when the event of drug has some considerable negative impact on the cure of the disease.

Let the probabilities of the respective real numbers as Q_0 = P(Y=0) = Probability of the drug has no negative effectiveness; Q_1 = P(Y=1) = Probability of the drug has non-considerable negative effectiveness; Q_2 = P(Y=2) = Probability of the drug has considerable negative effectiveness; such that $Q_0 \geq 0, Q_1 \geq 0, Q_2 \geq 0$ and $\sum_{j=0}^{2} Q_j = 1$

The random variables X and Y are assumed as disjoint because the simultaneous occurrence of events say positive and negative effectiveness is not possible, hence X and Y are mutually disjoint. Z is a combined random variable, which measures the net drug effectiveness by considering both positive and negative impacts together with a relation of linear combination. The joint probability function P(X=x, Y=y) =0; for X,Y = 0,1,2. The probability distribution of Z can be expressed as additive probability distribution of X and Y with the relation Z = aX + bY. As the nature of the coefficients a,b are positive and negative values, Z may be written as Z=aX-bY.

The joint and marginal moments of X and Y can be obtained as $\mu'_{r,r} = \sum_{i=0}^{2}\sum_{j=0}^{2}(xy)^r.P(x,y) = 0$, The r^{th}

order marginal moment of X is defined as

$$\mu'_{r,0} = \sum_{i=0}^{2} x_i^r P(x_i) = p_1 + 2^r p_2$$

Basing on the above result the first four moments of origin of X are

$\mu'_{1,0} = p_1 + 2p_2$; $\mu'_{2,0} = p_1 + 4p_2$; $\mu'_{3,0} = p_1 + 8p_2$;

$\mu'_{4,0} = p_1 + 16p_2$

The r[th] order marginal moment of Y is defined as

$$\mu'_{o,r} = \sum_{j=0}^{2} y_j^r P(y_j) = q_1 + 2^r q_2$$

Similarly Basing on the above result the first four moments of origin of Y,

$\mu'_{0,1} = q_1 + 2q_2$; $\mu'_{0,2} = q_1 + 4q_2$; $\mu'_{0,3} = q_1 + 8q_2$;

$\mu'_{0,4} = q_1 + 16q_2$

The r[th] order raw moment of Z is = $\mu'_r(z) = E(Z^r) = \sum_{k=0}^{r}(r_k)\, b^k\, a^{r-k} E(Y^k)\, E(X^{r-k})$

For different values of r=1,2,3,4,

Statistical Measures:

1. The Average positive impact score: = $p_1 + 2p_2$

2. The variability of positive impact score: = $\mu_2(X) = p_1(1-p_1) + 4p_2(1-p_1-p_2)$

3. The coefficient of variation of positive impact score:

$$CV = \frac{\sqrt{p_1(1-p_1) + 4p_2(1-p_1-p_2)}}{p_1 + 2p_2}$$

4. The 3[rd] Central Moment for positive Drug effectiveness :

$$\mu_3(X) = p_1[1-3p_1-18p_2+12p_1p_2+2p_1^2+24p_2^2] + 8p_2[1-3p_2+2p_2^2]$$

5. The 4[th] Central Moment for positive Drug effectiveness:

$$\mu_4(X) = p_1[1-4p_1-40p_2+48p_1p_2 - 72p_1p_2^2-24p_1^2p_2+6p_1^2+120p_2^2 - 3p_1^3-96p_2^2]$$

6. The Coefficient of Skewness on Positive Effect of the Drug:

$$\beta_1(X) = \frac{[p_1(1-3p_1-18p_2+12p_1\,p_2+2p_1^2+24p_2^2) + 8p_2(1-3p_2+2p_2^2)]^2}{[p_1(1-p_1-4p_2)+4p^2(1-p_2)]^3}$$

7. The Coefficient of Kurtosis on Positive Effect of the Drug:

$$\beta_2(X) = \frac{p_1(1-3p_1-18p_2+12p_1\,p_2+2p_1^2+24p_2^2) + 8p_2(1-3p_2+2p_2^2)^2}{[p_1(1-p_1-4p_2)+4p^2(1-p_2)]^2}$$

8. The Average negative impact score: = $q_1 + 2q_2$

9. The variability of negative impact score: $\mu_2(Y) = q_1(1-q_1) + 4q_2(1-q_1-q_2)$

10. The coefficient of variation of negative impact score:

$$CV = \frac{\sqrt{q_1(1-q_1) + 4q_2(1-q_1-q_2)}}{q_1 + 2q_2}$$

11. The 3[rd] Central Moment for Negative Drug effectiveness:

$$\mu_3(Y) = q_1[1-3q_1-18q_2+12q_1q_2+2q_1^2+24q_2^2] + 8q_2[1-3q_2+2q_2^2]$$

12. The 4[th] Central Moment for Negative Drug effectiveness:

$$\mu_4(Y) = q_1[1-4q_1-40q_2+48q_1q_2-72q_1q_2^2 - 24q_1^2q_2+6q_1^2+120q_2^2-3q_1^3-96q_2^2]$$

13. The Coefficient of Skewness on Negative Effect of the Drug:

$$\beta_1(Y)=\frac{[q_1(1-3q_1-18q_2+12q_1\ q_2+2q_1^2+24q_2^2)+8q_2(1-3q_2+2q_2^2)]^2}{[q_1(1-q_1)+4q_2(1-q_1-q_2)]^3}$$

14. The Coefficient of Kurtosis on Negative Effect of the Drug:

$$\beta_2(Y)=\frac{[q_1(1-3q_1-18q_2+12q_1\ q_2+2q_1^2+24q_2^2)+8q_2(1-3q_2+2q_2^2)^2]}{[q_1(1-q_1)+4q_2(1-q_1-q_2)]^2}$$

15. The Correlation coefficient between the positive and negative effects:

$$r=\frac{-[p_1+2p_2][q_1+2q_2]}{\{[P_1(1-P_1-4P_2)+4P_2(1-P_2)]\ [q_1(1-q_1-4q_2)+4q_2(1-q_2)]\}^{1/2}}$$

16. The overall aggregated Effectiveness of drug (both positive and negative together):

$$\mu_1'(z)=a(p_1+2p_2)-b(q_1+2q_2)$$

17. Variability of Drug Effectiveness(both positive and negative together):

$$\mu_2(z)=a^2p_1(1-p_1-4p_2)+b^2q_1(1-q_1-4q_2)+4a^2p_2(1-p_2)+4b^2q_2(1-q_2)$$

18. Coefficient of Variation of Drug Effectiveness (both positive and negative together):

$$CV=\frac{\sqrt{[a^2p_1(1-p_1-4p_2)+b^2q_1(1-q_1-4q_2)+4a^2p_2(1-p_2)+4b^2q_2(1-q_2)]}}{a(p_1+2p_2)-b(q_1+2q_2)}$$

19. The 3rd Central Moment (both positive and negative together):

$$\mu_3(z)=a^3p_1\ (1-3p_1-18p_2+12p_1\ p_2+2p_1^2+24p_2^2)+8a^3p_2(1-3p_2+2p_2^2)-b^3q_1(1-3q_1-18q_2+12q_1q_2+2q_1^2+24q_2^2)-8b^3q_2(1-3q_2+2_2^2)$$

20. The 4th Central Moment (both positive and negative together):

$$\begin{aligned}\mu_4(z)=&a^4p_1(1-4p_1-40p_2+48p_1p_2-72p_1p_2^2-24p_1^2p_2+6p_1^2+120p_2^2-3p_1^3-96p_2^3)\\&+b^4q_1(1-4q_1-40q_2+48q_1q_2-72q_1q_2^2-24q_1^2q_2+6q_1^2+120q_2^2-3q_1^3-96q_2^3)\\&+6a^2b^2p_1q_1(1-p_1-q_1-4p_2-4q_2+p_1q_1+4p_1q_2+4p_2q_1+16p_2q_2)+24a^2b^2p_1q_2(1-p_1-q_2-4p_2+p_1q_2+4p_2q_2)\\&+24a^2b^2p_2q_1(1-q_1-p_2-4q_2p_2q_1+4p_2q_2)+96a^2b^2p_2q_2(1-q_2-p_2+p_2q_2)\\&+16a^4p_2(1-4p_2+6p_2^2-3p_2^3)+16b^4q_2\ (1-4q_2+6q_2^2-3q_2^3)\end{aligned}$$

21. Coefficient of Skewness (both positive and negative together):

$$\beta_1(z)=\frac{\left[\begin{array}{l}[a^3p_1\ (1-3p_1-18p_2+12p_1\ p_2+2p_1^2+24p_2^2)\\+8a^3p_2(1-3p_2+2p_2^2)-b^3q_1(1-3q_1-18q_2\\+12q_1q_2+2q_1^2+24q_2^2)-8b^3q_2(1-3q_2+2_2^2)]\end{array}\right]^2}{\left[\begin{array}{l}a^2p_1(1-p_1-4p_2)+b^2q_1(1-q_1-4q_2)\\+4a^2p_2(1-p_2)+4b^2q_2(1-q_2)]\end{array}\right]^3}$$

22. Coefficient of kurtosis (both positive and negative together):

$$\beta_2(z) = \frac{\left[\begin{array}{l} a^4p_1(1-4p_1-40p_2+48p_1p_2-72p_1p_2^2-24p_1^2p_2 \\ +6p_1^2+120p_2^2-3p_1^3-96p_2^3)+b^4q_1(1-4q_1-40q_2 \\ +48q_1q_2-72q_1q_2^2-24q_1^2q_2+6q_1^2+120q_2^2-3q_1^3 \\ -96q_2^3)+6a^2b^2p_1q_1(1-p_1-q_1-4p_2-4q_2+p_1q_1 \\ +4p_1q_2+4p_2q_1+16p_2q_2)+24a^2b^2p_1q_2(1-p_1 \\ -q_2-4p_2+p_1q_2+4p_2q_2)+24a^2b^2p^2q^1(1-q_1-p_2 \\ -4q_2p_2q_1+4p_2q_2)+96a^2b^2p_2q_2(1-q_2-p_2 \\ +p_2q_2)+16a^4p_2(1-4p_2+6p_2^2-3p_2^3) \\ +16b^4q_2\,(1-4q_2+6q_2^2-3q_2^3) \end{array}\right]}{\left[\begin{array}{l} a^2p_1(1-p_1-4p_2)+b^2q_1(1-q_1-4q_2) \\ +4a^2p_2(1-p_2)+4b^2q_2(1-q_2)] \end{array}\right]^2}$$

3. Methodology

The usual practices that are happened in assessment of clinical treatments. They are based on the readings of pre and post tests. The diagnosis procedures at clinical treatment are based on the screening tests. If we consider an example of screening tests of fever, the intensity of fever can be assessed with the temperature such as screening tests of fever ,the intensity of fever can be assessed with temperature of the body, pulse rate of the nerve, number of breaths of the patient, skin temperature etc. Fever may be caused due to so many reasons like infections, indigestion, insect bite etc and many unexplained also. His objective is to get rid of fever by consuming some pills. In this context the drug may give the effect on four folds namely, (i). Positive effect: The drug shall decrease the temperature through the means of suppressing the fever; (ii). Non-positive effect: The drug may not decrease the temperature as it has no influence on suppression of the fever; (iii). Negative effect: The drug may give adverse effects on general health of the patient causing unwanted side effects; and (iv). Non-negative effect: The drug may not give unwanted side effects exclusive of positive or non-positive effects.

The concepts of non-positive and non-negative effects of drug, though they appear to be the same we have considered those two are significantly differed as the impact of non-positive effect of the drug is not equal to the impact of non-negative effect of drug. The coefficient of positive effectiveness (a) may be influenced by many factors. It is defined as $a = \frac{\sum_{i=1}^{r} e_{pi}}{r}$; e_{pi} is the positive effectiveness measure of i^{th} factor=1,2,……r. Where r is the total number of factors on which the positive effectiveness of drug is attained. Similarly, the coefficient of negative effectiveness (b) may also be obtained by non suitability or mismatching of drug to the disease under treatment. It is defined as .There are k types of factors that are making negative effectiveness, then the overall negative effectiveness is obtained as, $b = \sum_{j=1}^{k} \frac{e_{Ij}}{k}$.

4. Numerical Illustrations and Sensitivity Analysis:

Values of some statistical measures for Overall drug performance:

Table:4.1

p_2	q_1	q_2	a	b
0.4	0.5	0.6	0.2	0.3

p_1	Mean	Variance	C.V	$ß_1$	$ß_2$
0.1	0.69	0.037	0.277	0.072	3.077
0.2	0.71	0.033	0.255	0.08	3.973
0.3	0.73	0.029	0.231	0.046	5.518
0.4	0.75	0.023	0.204	0.013	8.668

Table: 4.2

p_2	q_1	q_2	a	b
0.4	0.3	0.6	0.2	0.3

p_1	Mean	Variance	C.V	$ß_1$	$ß_2$
0.6	0.73	0.05	0.307	0.013	2.787
0.7	0.75	0.043	0.275	0.046	2.404
0.8	0.77	0.034	0.24	0.08	0.934
0.9	0.79	0.025	0.2	0.072	4.665

Table: 4.3

p_1	q_1	q_2	a	b
0.3	0.1	0.4	0.7	0.2

p_2	Mean	Variance	C.V	$ß_1$	$ß_2$
0.5	1.09	0.334	0.531	0.233	2.072
0.55	1.16	0.3	0.472	0.212	2.389
0.6	1.23	0.256	0.411	0.109	2.8
0.65	1.3	0.202	0.346	0.212	3.157

Table: 4.4

p_1	q_1	q_2	a	b
0.3	0.5	0.4	0.1	0.2

p_2	Mean	Variance	C.V	$ß_1$	$ß_2$
0.7	0.43	0.019	0.316	0.233	2.43
0.75	0.44	0.017	0.296	0.212	2.201
0.8	0.45	0.015	0.275	0.109	1.701
0.85	0.46	0.013	0.252	0.029	0.623

Table: 4.5

p_1	p_2	q_2	a	b
0.3	0.4	0.7	0.4	0.3

q_1	Mean	Variance	C.V	$ß_1$	$ß_2$
0.6	1.04	0.056	0.228	0.029	1.293
0.65	1.055	0.043	0.196	0.109	8.748
0.7	1.07	0.029	0.158	0.212	1.031
0.75	1.085	0.014	0.109	0.233	5.166

Table: 4.6

p_1	p_2	q_2	a	b
0.8	0.2	0.7	0.3	0.1

q_1	Mean	Variance	C.V	$ß_1$	$ß_2$
0.4	0.54	0.014	0.219	0.471	2.811
0.41	0.541	0.014	0.217	0.245	2.736
0.42	0.542	0.013	0.214	0.086	2.651
0.43	0.543	0.013	0.212	9.19E-03	2.555

Table: 4.7

p_1	p_2	q_1	a	b
0.5	0.6	0.3	0.2	0.1

q_2	Mean	Variance	C.V	$ß_1$	$ß_2$
0.4	0.45	0.007	0.19	0.073	1.699
0.5	0.47	0.007	0.172	0.121	2.911
0.6	0.49	0.005	0.143	0.165	4.541
0.7	0.51	0.003	0.098	0.188	1.787

Table: 4.8

p_1	p_2	q_1	a	b
0.3	0.4	0.5	0.1	0.3

q_2	Mean	Variance	C.V	$ß_1$	$ß_2$
0.6	0.62	0.008	0.142	0.164	2.801
0.61	0.626	0.005	0.116	0.137	2.832
0.62	0.632	0.003	0.081	0.108	1

Table: 4.9

p_1	p_2	q_1	q_2	b
0.2	0.4	0.5	0.3	0.1

a	Mean	Variance	C.V	$ß_1$	$ß_2$
0.2	0.31	0.037	0.62	0.083	1.667
0.3	0.41	0.077	0.676	0.66	1.462
0.4	0.51	0.133	0.715	0.427	1.375
0.5	0.61	0.205	0.742	0.208	1.332

Table: 4.10

p_1	p_2	q_1	q_2	b
0.6	0.3	0.2	0.4	0.1

a	Mean	Variance	C.V	$ß_1$	$ß_2$
0.6	0.82	0.138	0.452	7.30E-02	2.6
0.7	0.94	0.184	0.457	6.50E-06	2.59
0.8	1.06	0.238	0.461	7.23E-03	2.583
0.9	1.18	0.3	0.464	0.023	2.578

Table: 4.11

p_1	p_2	q_1	q_2	a
0.2	0.4	0.5	0.3	0.1

b	Mean	Variance	C.V	$ß_1$	$ß_2$
0.2	0.32	0.028	0.519	0.04	2.369
0.25	0.375	0.039	0.524	0.146	2.321
0.3	0.43	0.052	0.531	0.089	2.271
0.35	0.485	0.068	0.538	0.028	2.228

Table: 4.12

p_1	p_2	q_1	q_2	a
0.5	0.3	0.2	0.4	0.6

b	Mean	Variance	C.V	$ß_1$	$ß_2$
0.4	1.06	0.304	0.52	4.75E-04	2.368
0.45	1.11	0.338	0.524	0	2.338
0.5	1.16	0.376	0.529	0	2.295
0.55	1.21	0.418	0.535	0	2.244

In order to get the insights of the drug efficacy, a data is considered with inputs p_1, p_2, q_1, q_2, a and b. The outputs like average drug effectiveness, variability in the drug effectiveness, coefficient of variation, coefficient of Skewness, coefficient of kurtosis etc are calculated with software MATHCAD. The numerical data sets are placed in the tables from 4.1 to 4.12.

It is observed that average drug efficiency is an increasing function of p_1 and it is positive, variance is a decreasing function, coefficient of variation is decreasing and beta2 is a decreasing function having negative impact when $p_1 < q_1$, $p_2 < q_2$, $a < b$ and other parameters are constants. The average drug efficiency is an increasing function of p_1 and it is positive, variance is a decreasing function, coefficient of variation is decreasing and beta2 is a decreasing function having positive impact when $p_1 > q_1$, $p_2 < q_2$, $a < b$ and other parameters are constants .

It is observed that mean efficiency is an increasing function of p_1 and it is positive, variance is a decreasing function, coefficient of variation is decreasing and beta2 is a increasing function having positive impact when $p_1 > q_1$, $p_2 > q_2$, $a > b$ and other parameters are constants. The average drug efficiency is an increasing function of p_1 and it is positive, variance is a decreasing function, coefficient of variation is decreasing and beta2 is a decreasing function having positive impact when $p_1 < q_1$, $p_2 > q_2$, $a < b$ and other parameters are constants.

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The average drug efficiency is an increasing function of p_1 and it is positive, variance is a decreasing function, coefficient of variation is decreasing and beta2 is a decreasing function

having positive impact when $p_1<q_1$, $p_2 > q_2$, a >b and the other parameters are constants. The mean efficiency is an increasing function of p_1 and it is positive, variance is an increasing function, coefficient of variation is an increasing function and beta2 is a decreasing function having positive impact when $p_1 >q_1$, $p_2<q_2$, a>b and the other parameters are constants.

The average drug efficiency is an increasing function of p_1 and it is positive, variance is an increasing function, coefficient of variation is increasing function and beta2 is a decreasing function having positive impact when $p_1<q_1$, $p_2>q_2$, a<b and the other parameters are constants. The mean efficiency is an increasing function of p_1 and it is positive, variance is an increasing function, coefficient of variation is increasing function and beta2 is a decreasing function having positive impact when $p_1 >q_1$, $p_2<q_2$, a>b and the other parameters are constants.

5. Summary and Conclusions:

Our study observed that the chance of having positive impact of the drug is giving an increasing impact on its average performance, decreasing impact on variability when $p_1 < q_1$, $p_2 < q_2$, a < b. The coefficient of variation is a decreasing function of performance of positive impact when $p_1 < q_1$, $p_2 < q_2$, a < b. Consistency of drug performance may be increased by maintaining more positive impact than negative impact. The chance of having negative impact of the drug is giving an decreasing impact on its average performance, increasing impact in variability when $p_1<q_1$, $p_2 > q_2$, a >b . The coefficient of variation is a increasing function of performance of positive impact when $p_1 < q_1$, $p_2 > q_2$, a >b . The chance of having positive impact of the drug is giving an increasing impact on its average performance, increasing impact on variability when a>b. The coefficient of variation is a decreasing function of performance of positive impact when $p_1 < q_1$, $p_2 < q_2$, a < b . Consistency of drug performance may be increased by maintaining more positive impact than negative impact. This model will help the individual patients in quantification of the problem severity with drug misuse. Development of software to this model will assist in the health monitoring of self health care takers for their decision support systems. The scope for future work may be done with multinomial cases and may be extended to more contexts that are suitable.

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