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Research Article

EVALUATING ANTI-ASTHMATIC EFFECT OF POLYHERBAL AYURVEDIC DRUG BHARANGYADI ON RESPIRATORY MECHANICS USING MATLAB

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ABSTRACT
Asthma is one of the most prevalent chronic inflammatory lung diseases among children and adults. A lot of work had been done in various field (including both modern and Ayurvedic) on anti-asthmatic drugs to evaluate their action on lungs. The parameters chosen for assessing the properties of drug is mainly based on clinical improvement and improvement in pulmonary function test. These all method employed so far are indirect method for assessment of action of drug on lungs as change in pulmonary function may appear without any relevant change in lungs mechanics. In present study we assess the anti-asthmatic effect of drug directly on respiratory parameter by using MATLAB lung mechanics modeling. Administration of drug is equally distributed throughout lungs and produces significant increase in lung volume which is attributed to the decrease in airways resistance and increase in lung compliance.
Key Word: Bharangyadi polyhedral drug, lung mechanics, MATLAB.

INTRODUCTION

The Global Strategy for Asthma Management and Prevention Guidelines define Asthma as 'a chronic inflammatory disorder of the airways associated with increased airway hyper-responsiveness, recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night/early morning'. Airway inflammation produces airflow limitation through acute bronchoconstriction, chronic mucus plug formation and airway wall swelling or remodeling. Despite the availability of a wide range of anti-asthmatic drugs, the relief offered by them is mainly symptomatic and short lived. Moreover their side effects are also quite disturbing. Hence a continuous search is needed to identify effective and safe remedies to treat bronchial asthma. Herbs being promising in the management of asthma since time immemorial. Many active component isolated from herbs prove highly beneficial in management of Bronchial Asthma, e.g. Ephedra. Isolating active component and screening its pharmacodynamic and pharmacokinetic properties for use as medicine is modern approach of drug preparation. This approach gives some better results but not beyond toxic side effects. Thus in the present trial we use polyherbal compound rather than single herbal preparation and prepare drug according to Ayurvedic principles. *Bharangyadi* is a self-experienced Ayurvedic drug use for the management of Bronchial asthma. It consists of three herbs namely; *Bharangi (Clerodendrum serratum), Sati (Hedychium spicatum)* and *Pushkarmula (Inula racemosa)*.Equal amount of all the three herbs is extracted through hot percolation method and diluted in distilled water and alcohol (2:1). Hydroethanolic extract of the drug is given through nebulization machine.

To assess that whether the drug produces any change or the clinical improvement is merely a placebo effect it is necessary to validate the efficacy of drug on Lung mechanics. To evaluate the dynamics of respiratory process in term of statistic various mathematical model having various variable parameters can be use such as[1,2]

Change in volume, Airway resistance, Lungs compliance. Aim of the present study is to search a best fitted linear model by using MATLAB for single breath data and estimating its parameter. The estimated model parameters reflect the dynamic changes in respiratory mechanics.

Method Employed[3,4]

After giving medicine (*Bharangyadi*) in the dose of 3ml-B.D. for 15 days in patients of moderate asthma with FVC< 1.50 + 0.45, PEFR< 120+ 20 and FEV1< 1.20+0.20, we had taken Volume versus Time variation through graphical method. The graph obtained is shown in Figure 1.

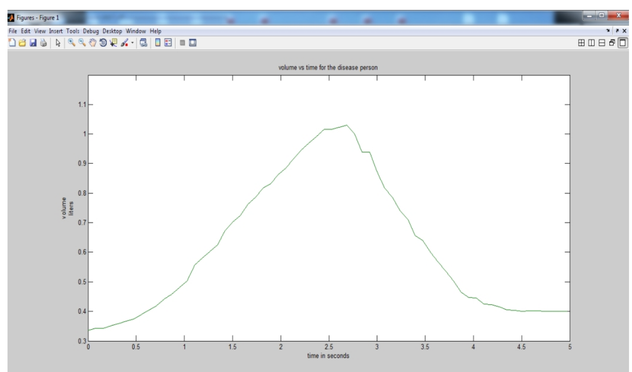

Figure 1, Volume vs. Time Curve

The parameters which are used to evaluate the effect of medicine in term of mechanics are volume, airways resistance and compliance. To evaluate the effect of drug we had fitted a suitable MATLAB model using following models.[5,6,7]

We estimates the following types of models and adds the following to the System Identification Tool GUI (Graphical User Interphase) in MATLAB to obtain the best model which represent the volume variation of the patient after giving medicine:

- IMP — Step response over a period of time.
- SPAD — Frequency response over a range of frequencies.
- ARXQS — Fourth-order autoregressive (ARX) model.

This model is parametric and has the following structure:

$Y(t) + a_1 y(t-1) + \ldots + a_{na} y(t-na) = b_1 u(t-n_k) + \ldots\ldots + b_{nb} u(t-n_k-n_b+1) + e(t)$.

Y (t) = output at time t. n_a =number of poles

U (t)=input at time t. n_b = number of zeros +1.

n_k = delay or dead time.

In arxqs, $n_a=n_b=4$, and n_k is estimated from the step response model imp

- THE ARX MODEL arx692
  - Number of poles n_a= 6
  - Number of zeros +1=n_b=9
  - Delay n_k = 2 .
- THE ARX MODEL arx223
  - Number of poles n_a= 2
  - Number of zeros +1=n_b=2
  - Delay n_k = 3.

To see the various ARX model fitting the time plot is used which is as show as:

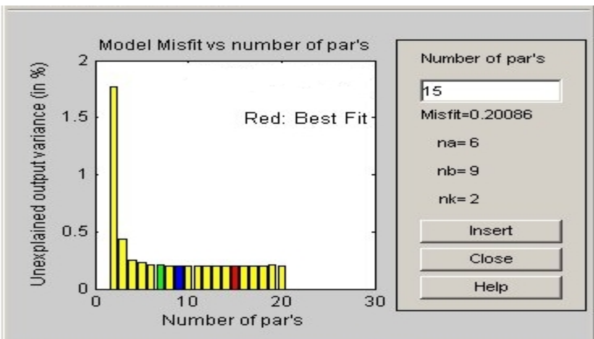

Figure 2: Time Plot

According to this time plot the best ARX model which shows the variation of the volume curve is arx692 but lower order model is giving also good response.

n4s3—State-space model calculated. The model order is selected automatically.

This model is parametric and has the following structure:

X (t+1) =Ax (t) +Bu (t) +ke (t)

Y (t) =Cx (t) +Du (t) +e (t)

Y (t) = output at time *t*,

U (t) = input at time *t*,

x =state vector,

e (t) = white-noise disturbance.

The System Identification Toolbox product estimates the state-space matrices *A*, *B*, *C*, *D*, and *K*.

State-Space Model n4s2 of the second order.

- amx2222
  - n_a=2
  - n_b=2
  - n_c=2 (is the number of poles for the disturbance model)
  - n_k=2
- amx3322
  - n_a=3
  - n_b=3
  - n_c=2 (is the number of poles for the disturbance model)
  - n_k=2

Following is the system identification tool box graphical user interphase model for pressure versus time in Fig.1 which is used for estimation and validation.

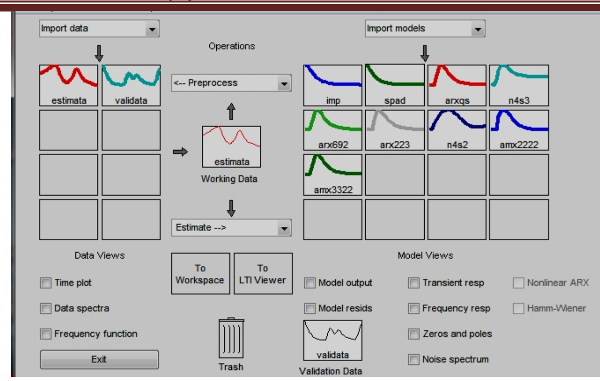

Figure 3: System Identification Tool Box

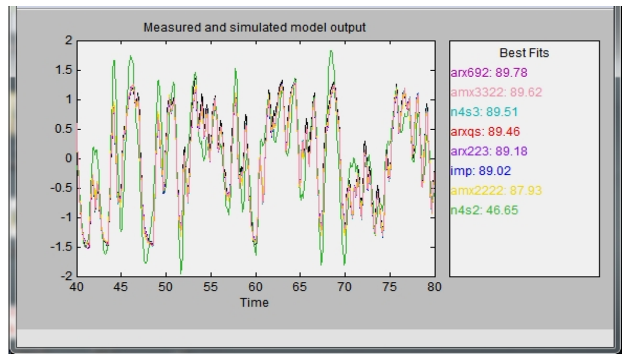

Figure 4: Model fitting curve

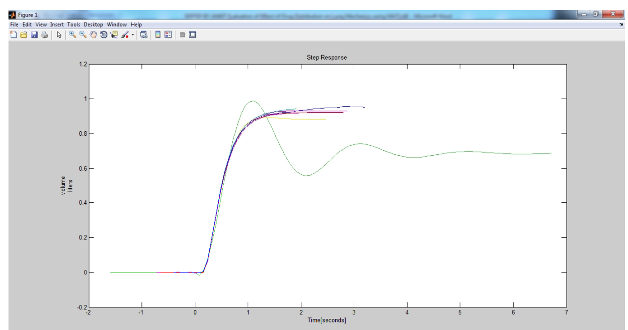

Figure 5: Step Response Comparison Curve

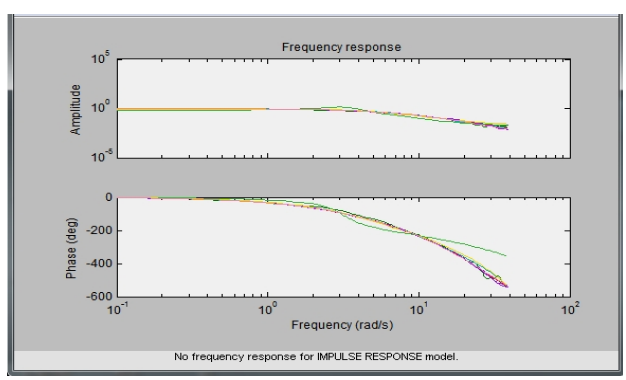

Figure 6: Frequency Response Comparison Curve

DISCUSSION

Although the best fitted model according to model fitting curve is arx692 among the all model used to fit the data of volume variation curve which showing fitting up to 89.78% but since the lower order similar model arx 223 gives the similar fitting and is giving linear response hence used as best fit model for the given data curve.

The curve chosen as best fitting model having under damped step response, which shows that it is having a stable system and having decreased settling time[8,9]. Here $\pm$ 5% tolerance is found in the step response. The frequency response of these curve are giving the Gain margin and Phase margin both positive which again confirms that the system used as best fitted model is giving a stable system.[10]

The graph clearly depicted that there is significant increase in lung volume and compliance and decrease in airways resistance which can be seen as the decrease in the settling time in respect to normal patient response justifying the use of drug in Asthma. The graph obtained from the patients showed significant change in lung parameters signifying that the result obtained after treatment with Ayurvedic drugs produces measurable physiological change.

CONCLUSION

There was significant change found in Respiratory mechanics after treatment with Polyherbal compound. The volume- time graph obtained showed significant increase in Lung volume which may be attributed to decrease in airways resistance.

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