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Research Article

TIME SERIES MODELLING OF HOSPITAL CENSUS: APPLICATION ON OUT PATIENT DEPARTMENT DATA OF AN AYURVEDIC SECONDARY CARE HOSPITAL

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ABSTRACT

The main objective of this paper is to fit a curve on OPD data, for predicting the hospital OPD data. Four models were selected for curve fitting. All four models were fitted to old and new OPD patients for male and female separately. Models equations and coefficient of determination were calculated. Second order polynomial model was fitted well in all situations though exponential model was fitted well on old OPD patient data.

KEYWORDS: Modelling of Hospital Census, Out Patient Department, Ayurvedic Secondary Care Hospital.

INTRODUCTION

Data in any hospital is generated from various working unit of hospital. The Out Patient Department (OPD) is also a part of this hospital. Patients visit the OPD either old or new. The OPD record is created on day basis /month basis or yearly basis. This data shows the time related fluctuation of OPD attending patients. By the use of this type of data further projections of patient's load at OPD could be possible[1]. One way of projection in time domain is time series modelling or curve fitting[2]. This type of projection is necessary to know the future budget requirement for proper functioning of OPD's. Efficient OPD data projections enable health authorities to evaluate the relationship between demand and supply of various medicines and hospital facilities. By this an improvement will be occurred in patients care as well as the quality and quantity of the work in hospital. It helps in planning regional services and facilities, in reviewing hospital budgeting and in evaluating applications for National health grants for research training and equipment.

Time series modelling describes the fact that data points taken with time have some internal linkage[2,3] (certain type of autocorrelation or trend). This internal linkage is the key point of time series analysis. The main difference of time series modelling with linear regression analysis is that data are not necessarily independent and not necessarily identically distributed which is the condition for linear regression. Time series models may or may not be linear[4]. The main models which are being used are Linear, Exponential, Power and polynomial. In any time series different type of models or curves fitted to data to find out best one model to predict the future outcome[4,5].

Here the yearly basis data of patient attending OPD at Central Ayurveda Research Institute of Drug Development, Kolkata (CARIDD), Kolkata is taken for the analysis. The main purpose of this study to understand the time related changing pattern of patient, those are attending OPD for Ayurvedic treatment.

Methodology

The four different type of time series model were considered for fitting on the hospital OPD data. If y is taken as the no. of patient and x is taken as the time factor then

Linear model[4, 5] is described as $Y = \alpha + \beta * x$

If certain phenomena have the constant increasing or decreasing with time then this model could be applicable and would explainable. The trend of y on time x is not always linear i.e. increase or decrease in y does not occur at a constant rate with time. Therefore some other models are also necessary for a curvilinear trend. The most applicable curvilinear curves[4,5] are Exponential ($\alpha e^{\beta x}$), power (αx^{β}) and second order polynomial ($\alpha x^2 + \beta x + \gamma$). Linear as well as these three models are used here.

Least square procedure[6] is used to estimate the parameters of the model. It is based on the minimization of sum of squares created by selected model. Square is calculated by squaring the distance between data points and the selected model. Coefficient of determination[7] (R^2) is used here to explain the suitability of selected model. It is defined

on the correlation between observed value and expected values come out from the model. In nutshell it gives the proportion of variance explained by model from original data.

Forecast has not been made for next few years because 10 years period is not sufficient for forecast, moreover trend line by least square method is not very appropriate for projection until and unless the same situation continues to prevail during the period of projection[6,8].

Four different type of data selected for the modelling those are new male OPD patient, Old male OPD patient, new female OPD patient and old female OPD patient.

Result & Discussion

The data for the selected period is gone through the modelling by four models. The compatibility of each model with selected type of data is shown from figure-1 to 4. Estimated equations for models and R^2 are mentioned in table-1. From figures it is clear that no. of patient is increased year by year in hospital. Every model is close with observed data as depicted from the graphs. Power distribution gave the worse fit in all data type; remaining three models have the R^2 more than 65%. It can easily conclude that exponential and polynomial model has done better on the basis of R^2 values. But for the interpretation purpose linear model is also an option because it has good R^2 values. Figure-1 and Figure-2 show the fit on new male and female OPD patient. It is clear that second order polynomial is very close to the observed data. R^2 values are very high as compared to other models. In female new OPD patient exponential ($R^2 = 0.76$) and linear ($R^2 = 0.77$) models are fit better as compared to the new male patient data. In Figure-3 and 4 all curves are very close to observed data except power curve, this is also detectable from the table-1 that the R^2 is more than 0.87 for all situation.

Figure 1: Time series models for male new OPD patient

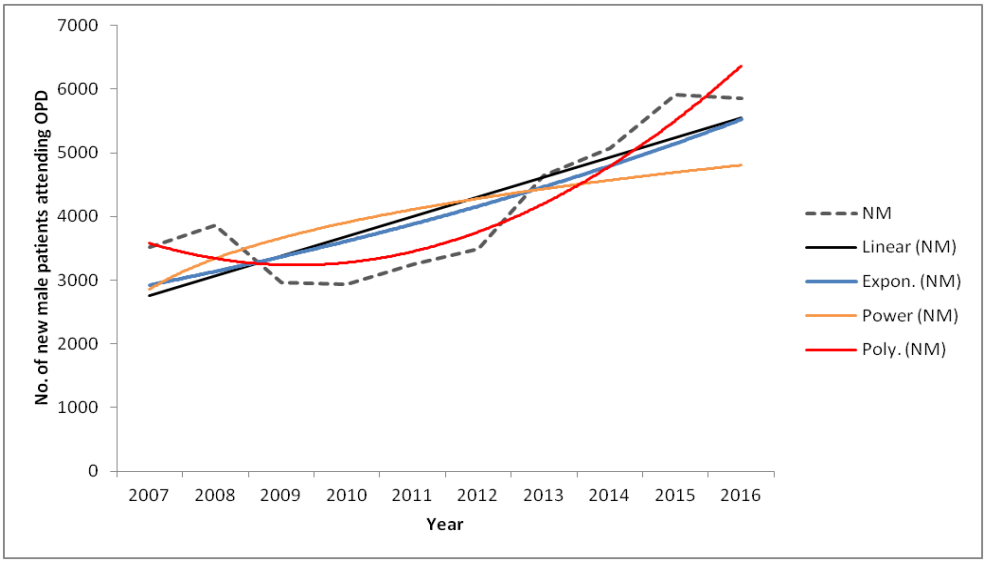

Figure 2: Time series models for Female new OPD patient

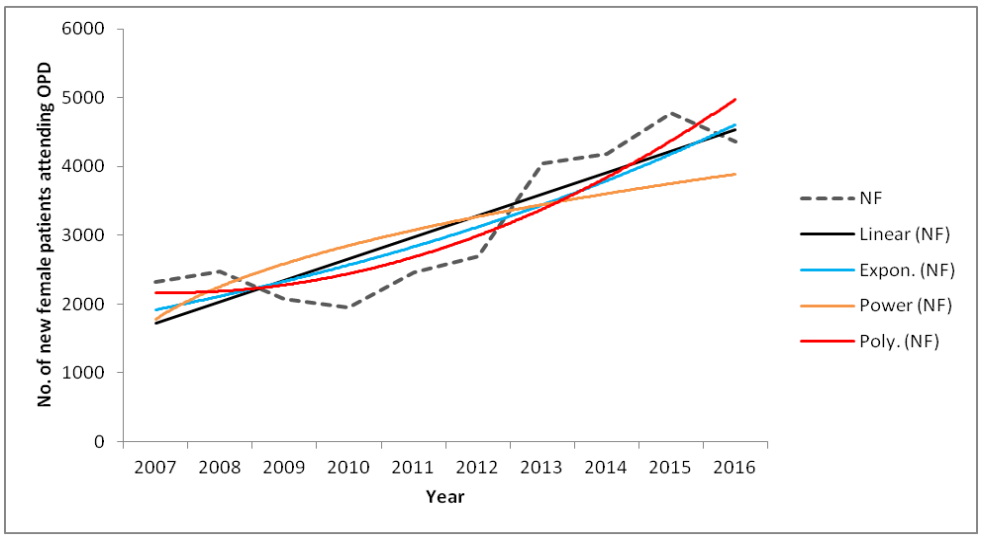

Figure 3: Time series models for male Old OPD patient

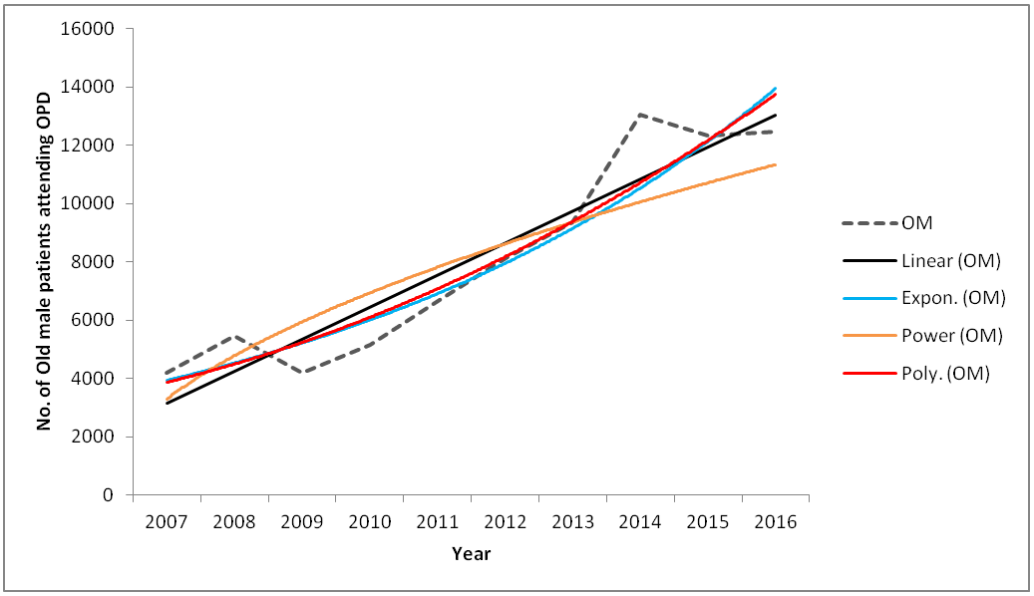

Figure 4: Time series models for Female Old OPD patient

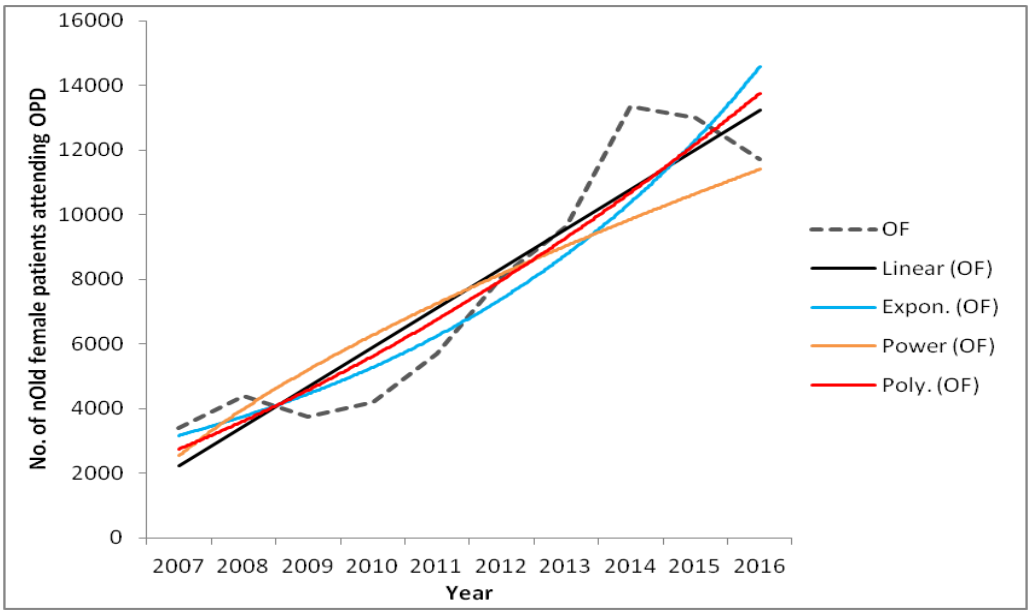

Table 1: Outcome of models fit on selected data by time series modelling

Model	Model Characteristics	New OPD Patient		Old OPD patient	
		Male	Female	Male	Female
Linear	Equation	$310.8x$ +2447	$312.5x$+1413.8	$1097.4x$ +2060.6	$1223.1x$+997.8
	R^2	0.68	0.77	0.89	0.87
Exponential	Equation	$2724.4e^{0.071x}$	$1739.3e^{0.098x}$	$3419e^{0.141x}$	$2682.8e^{0.169x}$
	R^2	0.65	0.76	0.90	0.90
Power	Equation	$2857.7x^{0.226}$	$1782x^{0.339}$	$3296.6x^{0.536}$	$2541x^{0.652}$
	R^2	0.39	0.54	0.77	0.79
Polynomial	Equation	$68.4x^2$ - $442.3x$ + 3951.3	$36.8x^2$ – $92.4x$ + 2223.6	$59.2x^2$ + $446.1x$ + 3363.3	$44.2x^2$ - $737.1x$ + 1970
	R^2	0.89	0.84	0.91	0.88

CONCLUSION

This study performed to see the trend of OPD data of CARIDD, Kolkata. Four models were proposed to fit on the data. Every model explains the trend very well but polynomial and exponential performed good in all situations. If linear model is considered for the interpretation so in new OPD patient male on average 2447 subject dealt every year. The said number increases 311 subjects per year. Similarly for new OPD patient female in one year 1414 subject dealt on average. It is increases 313 subject per year. From old OPD patient male as well female subject increase in per year is quite high; it is due to follow up reporting of the patient.

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