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FORECASTING PHILIPPINE PNEUMONIA MORBIDITY UTILIZING ARTIFICIAL INTELLIGENCE

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ABSTRACT

In Philippines, pneumonia remains to be on the top ten (10) leading the cause of both morbidity and mortality during many decades (Department of Health). According to the health care providers, there is a need for us to look into this alarming health scenario. One important way is to forecast the pneumonia cases based on the actual data for the last twenty (20) years. The prediction can be a good basis for the health sector to find a more effective way to manage pneumonia cases in the country. To forecast the future yearly cases of pneumonia, artificial intelligence forecasting method is used. A time series (20-year) data from 1993-2013 was utilized in data mining using minitab and Eureqa software. The trend component of forecasting pneumonia morbidity shows a flat line model indicating that pneumonia morbidity cases will remain on the same level every year of around 718,144 cases if the current health care system continues the current pneumonia management approaches. The correction factor, however, tells us that there are higher frequencies "up" and "down" pulling movement because of the presence of the sine functions. This implies that if a significant reduction of pneumonia cases is envisioned, then a planned and focused pneumonia management program shall be created and implemented.

Keywords: artificial intelligence, forecasting, pneumonia morbidity prediction

INTRODUCTION

For many years now, Pneumonia remains to be one of the greatest leading causes of both morbidity and mortality (Department of Health).So, there is a need to look into this grave scenario. Indeed, pneumonia continues to be an important health concern in the country, being one of the leading causes of morbidity and mortality among Filipinos. Pneumonia is a contagious disease which affects the respiratory system of an individual which can be transmitted through airborne and droplet contamination via coughing or sneezing. This can be diagnosed through sputum examination and chest radiographs and can be fully treated by compliance to pharmacologic regimen.

With these characteristics, one important step to manage or reduce this infection is to forecast the pneumonia cases. The prediction of cases in the next years can be a good basis for the health sector to do something that is more effective in controlling the spread of pneumonia cases. The forecast is based on actual Philippine data for the last twenty (20) years.

This study therefore aims to forecast the yearly pneumonia cases in the Philippines until 2036 using artificial intelligence.

Conceptual Framework of the Study

Under the assumption for diseases that are infectious and communicable in nature, such as pneumonia, the current incidence is a function of the immediate past cases recorded (i.e., the number of cases of the previous year) so that if the immediate past number of cases is $\{X_{t-1}\}$, then the present number of pneumonia cases becomes $\{X_t\}$.It represents the number of people infected by the previous number of pneumonia cases plus or minus new pneumonia cases. The model suggests that:

Present No.of Cases=(portion of individuals infected by past pneumonia patients)± (new cases)

A. $X_t = f(X_{t-1})$

B. It is important to note that modelling for non-communicable diseases differ from the equation above in as much as the present number of cases for non-communicable diseases does not depend upon the previous number of cases but increases as a function of time (t):

For non-communicable Disease:

$X_t = f(X_t)$

C. While there are other competing models for communicable diseases, the concepts from susceptibility to recovery, the proposed model (equation B) above represent a simpler and practical way to approximate the pneumonia morbidity cases since it does not involve the concept of Stochastic processes.

RESEARCH METHODOLOGY

This study utilized quantitative non-experimental predictive design for big data patterns. The prediction can be a good basis for the health sector to find a more effective way to manage pneumonia cases in the country. To forecast the future yearly cases of pneumonia, artificial intelligence forecasting method is used. A Philippine time series (20-year) data from 1993-2013 was utilized in data mining using minitab and Eureqa software. The available data from the Department of Health is optimized.

RESULTS AND DISCUSSIONS

To forecast the future yearly cases of pneumonia, 20-year data from 1993-2013 of the Departent of Health was processed.Pneumonia cases were autocorrelated through minitab software version 12. Based on the T values, no linear correlation is determined based on the cut off criterion of 1.96 which negates the assumptions that the present cases of pneumonia is a function of the immediate past number of cases.

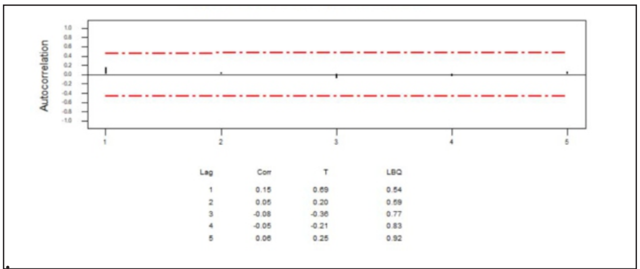

Figure1. Autocorrelation of Pneumonia Cases

To determine the presence of other non-linear correlations, symbolic regression using Eureqa software was used.The formula that was utilized as reflected in the framework (equation B) was $\mathbf{X_t = f(X_{t-1})}$.

Equation D shows the prediction equation for the pneumonia morbidity cases. It reflects the curve fitting performed by artificial intelligence through Eureqa software. The curve tells us the best fit to forecast the future pneumonia cases with the lowest Mean Average Error (MAE) of 8109 after 100% data convergence. The equation contains two major components namely; the trend (refer to equation E) and the correction factor (refer to equation F).

$$\mathbf{X_t = 687785-112709*\sin(5.062*X_{t-1})*\exp(\sin(6.21+X_{t-1}))-92920*\exp(\sin(6.21+X_{t-1}))*\sin(\sin(\sin(\sin(5.098*X_{t-1}+0.38*\sin(0.13+X_{t-1})))))} \quad \mathbf{D}$$

$$\mathbf{Trend = 687785} \quad \mathbf{E}$$

Correction Factor

$$=-112709*\sin(5.062*X_{t-1})*\exp(\sin(6.21+X_{t-1}))-92920*\exp(\sin(6.21+X_{t-1}))*\sin(\sin(\sin(\sin(5.098*X_{t-1}+0.38*\sin(0.13+X_{t-1}))))) \quad \mathbf{F}$$

The trend component represented by the first term 687785 shows a flat line model indicating that pneumonia morbidity cases stays on that number every year. The correction factor, however, tells us that there are higher frequencies "up" and "down" pulling movement because of the presence of the sine functions. The correction factor reflects the management of pneumonia at national, community or even at the individual levels of the Filipinos. Therefore, in order to lower the incidence rate, the correction factor should be looked into in order to lower down the cases. Using equation D, the forecast of the future pneumonia morbidity cases is presented below:

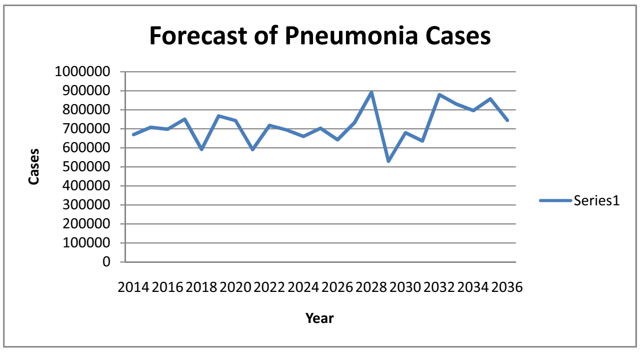

Figure 2. Forecast of Pneumonia Morbidity

The figure above is the graph of the predictedcases of pneumonia until year 2036 with an average of 718,144 cases per year. Roughly, the lowest level that it can get is only 530,000 cases which is still very high if we continue doing what are currently being implemented.It is therefore imperative that the health sector must do something better if we aimed to reduce pneumonia cases significantly. A well-planned and focused pneumonia management program shall be created and implemented.

The findings are supported by the study on "Costs of Treating Pneumonia will more than double by 2015" which found that the incidence rates are expected to rise nearly 20% among those aged 75 and older over the forecast period (CISION, 2017).

In addition, according to Sriwattanapongse, Khanabsakdi & Wongtra-ngan (2009) in the study on forecasting the monthly incidence rate of pneumonia in Mae Hong Son province, Thailand, the largest residual obtained for Mae Hong Son was 2.00 - corresponding to 5 cases reported among the 5- to 14-year-old age group - in pang ma pha district in April 1999 with an incidence rate of 2.76 per 1,000(Sriwattanapongse, Khanabsakdi, & Wongtra-ngan, 2009).

CONCLUSION

The trend component of forecasting pneumonia morbidity shows a flat line model which indicates that pneumonia morbidity cases will remain on the same level every year of around 718,144 cases if the current health care system continues the current pneumonia management approaches. The correction factor, however, tells us that there are higher frequencies "up" and "down" pulling movement because of the presence of the sine functions.

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