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A Thesis Submitted for PhD in Statistics

Forecasting the Demand of Medical Oxygen by Using Box Jenkins Methodology and Analyze the Factors Affecting the Demand (*Case Study, Soba University Hospital*)

التنبؤ بالطلب على الأكسجين الطبي بإستخدام منهجية بوكس جنكيزوتحليل العوامل المؤثرة على الطلب

(دراسة حالة على مستشفى سوبا الجامعي)

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Dedication

I dedicate this thesis to my parents, my wife, teachers, friends and fellow members without whom it was almost impossible for me to complete my research.

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مستخلص البحث

يهدف البحث الى قياس وتحليل العوامل المؤثرة على الطلب على الأوكسجين الطبي بالمستشفيات الحكومية بولاية الخرطوم منها عدد المرضي الذين يحتاجون الأوكسجين كعلاج ، الوقت المستغرق في أخذ العلاج بالأوكسجين إضافة الى معدل نقل الأوكسجين من الجهاز الى المريض أيضا يهدف البحث الى إختبار أثر عوامل : نوع المرض ، الفئات العمرية للمرضى المحتاجين للأوكسجين في العلاج . وقياس موسمية الطلب على الأوكسجين .أجري المسح الميداني على عدد 15 مستشفي من المستشفيات الحكومية بولاية الخرطوم (9 حضر ،6 ريفي) أختيرت عشوائياً بإستخدام طريقة المعاينة العشوائية العنقودية . أظهرت نتائج تحليل بيانات المسح أن عوامل : عدد المرضي الذين يحتاجون الأوكسجين كعلاج ، معدل نقل الأوكسجين من الجهاز الى المريض و الوقت المستغرق في أخذ العلاج بالأوكسجين وإختلاف نوع المرض ..جميعها تؤثر على متوسط الإستهلاك الشهري للأوكسجين الطبي من قبل المستشفيات بالمتر المكعب -P value<0.05)(. كذلك كشفت نتائج التحليل أن الطلب على الأوكسجين الطبي لا يتأثر بإختلاف الفئات العمرية للمرضي أو الاختلاف في فصول السنة (P-value<0.05).

يهدف البحث كذلك الى تحليل السلاسل الزمنية بإستخدام منهجية (Box & Jenkins)بوكس جنكينز في التحليل (التشخيص ، التقدير ،إختبار ملائمة النموذج ، التنبؤ) لإيجاد افضل نموذج للتنبؤ بالطلب على الأوكسجين الطبي في المستشفيات الحكومية بولاية الخرطوم دراسة تطبيقية على مستشفي سوبا الجامعي بالإعتماد على البيانات الشهرية (يناير 2005- ديسمبر 2014) .

وقد أظهرت نتائج تحليل البيانات أن النموذج الملائم لها هو نموذج الإنحدار الذاتي المتكامل ARIMA (0,1,1). أخيراً، قدم البحث عدد من التوصيات، أهمها: استخدام نظام اسطوانات والعمل على التحول إلى إعتماد إنتاج الأكسجين مركزياً في المستشفيات.وضع خطط واستراتيجيات وبرامج تهدف إلي خفض إنتشار أمراض الجهاز التنفسي وسط تلاميذ المدارس.تطوير نماذج مماثلة يمكن استخدامها للتنبؤ بالطلب على الأكسجين الطبي، ليشكل قاعدة علمية لوضع خطط جيدة لتجنب أي نقص في الأكسجين في مستشفيات ولاية الخرطوم.تعزيز وتوفير مدخلات الخدمات الطبية، وخاصة الأكسجين في المستشفيات الريفية في ولاية الخرطوم .

Abstract

This research aim to measuring the factors in terms of a number of patients who take oxygen therapy, time spent by patients in treatment and oxygen rate flow that affect medical oxygen demand by the governmental hospitals in Khartoum State. As well as to testing the effects of type of diseases, age groups of patients who need medical oxygen as a treatment and seasonality of the demand of medical oxygen. The survey covered a number of (15) governmental hospitals in Khartoum State (9 urban & 6 rural) .Were selected randomly by using the cluster random sampling method .The study found that factors of a number of patients who take oxygen therapy in a month, oxygen transfer rate to patient and the time period which spent by a

patient in treatment , the difference of diseases are affect monthly average of medical oxygen consumption in hospitals per m^3 ($p < 0.05$). Also it detected that the demand of medical oxygen is not affected by the differenceoftheage groups of patients who need medical oxygen as a treat ment. The demand of medical oxygen is not affected by the deference of season of year ($p>0.05$).Also this research aims to find a suitable model to predict the demand of medical oxygen. The study data contained a number of 120 observations of oxygen consumption(in m^3) were taken from Soba University Hospital in Khartoum state, since January 2005 to December 2014. We have used Box-Jenkins, Auto Regressive Integrated Moving Average (ARIMA) methodology for building forecasting model. Results suggest that ARIMA(0,1,1) is the most suitable model to be used for predicting the demand of medical oxygen. For testing the forecasting accuracy Root Mean Square Error, Mean Absolute Error, and Mean Absolute Percentage Error are calculated.Finally, the research recommended: The use of cylinders system and work on the transition to the production of oxygen Center in hospitals. Develop plans and strategies and programs that aim to reduce the incidence of respiratory disease rates, especially (Asthma, pneumonia).Develop a model that can be used to predict the demand of medical oxygen, what constitutes a scientific base to put good plans to avoid any shortage of oxygen in the hospitals of Khartoum State.Promote and provide input medical services, especially oxygen in rural hospitals in Khartoum State.

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Glossary

WHO	World Health Organization
ARIMA	Autoregressive Integrated Moving Average
AR	Auto Regressive
MA	Moving Average
K.C.E.H	Khartoum Children Emergency Hospital
COPD	Chronic Obstructive Pulmonary Disease
RT	Respiratory Therapist

JCAHO	Joint Commission of Accredited Health Organizations
SBC	Schwartz Bayesian Criterion
ACF	Autocorrelation function
PACF	Partial autocorrelation function
ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criteria
SIC	Schwarz Information criteria
RMSE	Root Mean Square Error
MAE	Mean Absolute Error
MOD	Medical Oxygen Demand
DW	Durbin-Watson
RSS	Residual sum of squares