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Conducting of Monitoring and Experiments in Toxic Substances of Poisoning

I.H. Mirzazada*, U.R. Naghizade

Abstract. According to statistical data, with the development of oil, chemical, gas industries cases of poisoning caused by toxic substances employed in these branches have become more frequent recently. A special place among them is occupied by carbon monoxide, poisoning with which has been growing steadily. Considering such consequences of similar-poisonings as myocardial infarction, Parkinson's disease u.a. it is expedient to perform monitoring of a patient after staying in a stationary hospital which determines optimum time of its performance, kind and the number of analysis required for developing an intelligent system. This paper proposes an elaboration of an intelligent information system for monitoring in cases of poisonings with toxic substances using carbon monoxide as an example.

Key Words and Phrases: Carbon monoxide, poisoning, monitoring, parametric criteria, nonparametric criteria, biostatistical methods.

2010 Mathematics Subject Classifications: 004.891.3

1. Introduction

The quote adopted by the World Health Organization in 1998, says: " .... prompt and adequate treatment of acute poisoning can save lives by minimizing the impact of poisoning ". İf the poisoning was discovered and treated in ti_me, so its results can show up after a long period of time. A few weeks later, parkinsonism, heart muscle damage inflicted deaths can occur. Clearly, these people are poisoned by toxic substances or other doses are in need of long-term monitoring [1]. Monitoring changing position of the object, and its performance is desirable observation or comparison with the previous ones.

Along with the diagnosis of poisoning by carbon monoxide poisoning in order to forecast has a great importance for the consequences of monitoring. It is to be observed during a certain time health status of persons poisoned. During the monitoring, in order to solve the problem of statistical data analysis methods can be applied.

*Corresponding author.

2. Statistics and Literature review

The number of people affected by carbon monoxide in the Central Europe and Southwestern Europe over the 2004 is shown in Table 1 [2, 3].

Table 1.

Consolidated Table of carbon monoxide poisonings

Country/Region	**Extrapolated Incidence**	**Population Estimated Used**
Carbon monoxide poisoning in Central Europe (Extrapolated Statistics)		
Austria	3,406	8,174,762
Czech Republic	519	10,246,178
Germany	34,343	82,424,609
Hungary	4,180	10,032,375
Liechtenstein	13	33,436
Poland	16,094	38,626,349
Slovakia	2,259	5,423,567
Slovenia	838	2,011,473
Switzerland	3,104	7,450,867
Azerbaijan	3,278	7,868,385
Portugal	4,385	10,524,145
Spain	16,783	40,280,780
Georgia	1,955	4,693,892

The different aspect of toxic substances, including carbon monoxide poisoning is diagnose making, management and treatment for her tactics based on antidote therapy complement each other and are carried out under the supervision of a doctor, but one of the main problems seen in a long time the importance of the patient's condition after treatment. Because a number of studies have shown that carbon monoxide poisoning are not only harmful effects on the human body, its results are still manifests itself after a long period of time. This is mainly disorders of the nervous system, cardiovascular system diseases. According to scientists poisoned by carbon monoxide, 37% of patients suffered from cardiac muscle damage.1/4 of the poisoned people had died after 7 years. Professor Timothy Henry, head of the research process in the U.S, says: "The main result of the study of carbon monoxide poisoning in the delivery of long-term negative impact on health." Professor Henry said that the number of patients a result of poisoning observed in disorders of cardiac activity was higher in all the possibilities of scientists [4].

The last years innovations in the construction industry; in the narrow streets surrounded on both sides with "skyscrapers", the speed of vehicles is reduced, the carbon dioxide emitted from machines gas is accumulated in the air close to the ground surface at the respiratory level of people.

At low air condition, carbon dioxide creates a hazardous situation for people's health. One of the reasons for the increase in the number of cardiovascular diseases is carbon

dioxide poisoning. Table 5.1. was drawn by the information of Baku City Emergency and Urgent Medical Help Station (BCEUMHS).

Table 5.1

Information of BCEUMHS about myocardial infarction for 2006-2013 years.

Years	Appeal an hospitalization	Interest rate indicator
2006	**1573**	**1,7%**
	1205	**76,6%**
2007	**1627**	**1.1%**
	1321	**81,2%**
2008	**1797**	**1,7%**
	1472	**81,9%**
2009	**1601**	**1,5%**
	1362	**85%**
2010	**1311**	**0.3%**
	1153	**88%**
2011	**1289**	**0.2%**
	1216	**94%**
2012	**1211**	**0.2%**
	1154	**95%**
2013	**1054**	**0.2%**
	1006	**95,4%**

Comings of carbon monoxide poisoning the concentration of toxic substance in the course, the amount to be included in the body of the organism, the situation timely, adequate medical assistance provided. In general, the higher the percentage of fatal outcome. However, fixed in 2% of patients had severe poisoning neuro psychological found quitting the gap is observed. More than 10.8% of the patients after 3 years neuro physical disorders (memory disturbance, personality disorders) suffer.

In recent years, innovations in the chemical and construction industry for example, streets surrounded by tall and thin skyscrapers in both sides, traffic congestion is reduced with respect to the speed of vehicles, carbon monoxide which are removed from vehicles accumulates in the air near-surface where people breathe in a closed environment and carbon monoxide collected in the atmosphere, in less windy conditions creates a dangerous situation for the health of people. All of these lead to chronic intoxication. One of the reasons for the increase of cardiovascular diseases is chronic intoxication. For these reasons, the followings need to be considered:

- Differential diagnosis of patients in comatose;
- Health surveillance to poisoned person after a certain period of time.

3. Methods

Solution of the first problem is carried out using mathematical and artificial intelligence methods in intelligent information system. The second is monitring issue after receiving treatment outcome. Monitoring is advisable for both once poisoned also for persons affected by chronic intoxication.

Monitoring needs to be conducted after successful treatment in hospital. Therefore, starting time of monitoring should coincide with the end of the treatment. Functional parameters and biochemical analysis of carbon monoxide victim needs to be examined from time to time during the monitoring (fixed time interval). Particularly, type of poisoning, more affected poisoning of the body and more nervous and cardiovascular systems, mainly due to the majority of these indicators are checked by selecting from among the more specific ones. In most cases, the determination of patient treatment verification of indicators reflecting the health of people selects in the process of stationer treatment. Analysis in the selected interval of time should be checked for prevention and prognoses of consequences after poisoning.

Analysis should be checked in a certain time interval to carbon monoxide victim after antidote therapy and appropriate treatment in order to control the situation. Double autocorrelation and non-parametric methods [5] is used for comparison and detection of analyze results with most specificity. Any change or signs in the toxicated or treated people could be observed by using these methods. The application of appropriate methods allows the assessment of independent indications,symptoms assessment of before and after treatment, assessment of the differences between the dynamics of change and plays an important role in the detection of change differences.

4. Monitoring Tips

Time changes in carbon monoxide poisoning should be controlled after receiving treatment in order to avoid the consequences of toxication. Time series method is used in those situations. The basis of time series analysis is that former happenings have important indications for future happenings. Time series data is a sequence of successive moments of time, which reflects to the situation. In contrast to randomly selected analysis, time series based on observation data of equal times. Time series can be often found in medicine. Time series analysis has two goals: determination the nature of queue and prognosis. In both cases, the model must be specified before the turn to the interpretation of the data.

According to the analysis of time series, data consists of systematic component and a random voice complication detection components which arranged in a regular variable. Majority of research methods allows to observe the change in the index on a regular basis using a variety of methods for filtering noise. Routine variables of time series have two classes: either the trend or seasonal components.

Change dynamics reflects the trend. Trend consists of the variable components changed through the time organized in a systematic linear or non-linear. The seasonal component is repeated periodically [6].

Time series process used to identify prognostic factors of data in the past, today linked to a similar effect in the near future. Analysis of observations is a continuous process which estimated in a certain discrete moments of time (when you can evenly across the distribution). For that reason indications which can cause a dangerous development in near future should be selected (months, sometimes years).

There is not "automate" methods for detection of time series. If the trend (increasing or decreasing) is monotone, the queue is not difficult to analyze. If the time series has enough offense in that case smoothing process should be conducted primarily as a method of filtration. Smoothing process is a kind of moderation of data. In this case, the non-systematic errors repel each other. The most common method of smoothing method is moving average, when m the members of the neighboring row of each member shall be replaced by a simple average, m – is a price of intervals. Also, the trend is to be used for the detection of exponential smoothing. Many monotone time series described by linear to express analytically. If there is non-linear component, set of data needs to be carried out to remove it. For this reason, most of the time logarithmic, exponential, or polynomial transformations can be used. In some cases, the least squares method is carried out in the smoothing. All of these methods are given the relatively smooth line noise filtering, transforms to circle.

Moving average method determine the start of a new trend, also warns of the end or return. This method allows you to keep track of the development process, it can be viewed as trend lines. However, this method is not used for making predictions, because it follows a trend, but it can't predict only shows the start of a new trend. Smoothed curve and the trend observed during the performance of the simplified average, short-term floating-average rate reflect dynamics more accurately for long intervals calculation.

Moving average is defined as follows:

$$y_t = \frac{1}{m} \sum_{i=t-p}^{t+p} y_i \,, \tag{1}$$

wherey_i, - value of the i-th level; m - the number of levels from smooth intervals - $(m = 2p + 1)$; y_t dynamic row of the current level; i- number smooth level range; p-m single range value$p = (m - 1)/2$.

Smooth change interval depends on the determination of the indicators. Thus, indicators of irregular, small changes smooth interval assumed to be more. If you are required to take into account changes in smoothing, small gap becomes smaller.

Moving average method is used if time series is organized in straight lines. Because this time is not misrepresent the dynamics of the index. If the range is non-linear, usage of this method can cause distortion of indicators . It is used when smooth is exponential [7].

Analytical smoothing method is an identification of development trends as time series function.

$$\hat{y}_t = f\,(t)\ , \tag{2}$$

where$\hat{y}_t$- theoretical value of time series with analytical expression for the time t-time.

Theoretical value are derived from the mathematical model.

Indicating the trend of development, the following features are implemented:

1. The linear function with straight line graphs:

$$\hat{y}_t = a_0 + a_t t$$

2. Exponential function

$$\hat{y}_t = a_0 * a_1^t ,$$

3. Exponential function second degree (parabola)

$$\hat{y}_t = a_0 + a_1 * t + a_2 t^2 ;$$

4. Logarithmic function:

$$\hat{y}_t = a_0 + a_1 \ln t .$$

Estimation of functions parameters are carried out by least squares method. In this case, the solution is the minimum value of the sum of theoretical and empirical levels squares:

$$\sum (\hat{y}_t - y_i)^2 \to \min , \tag{3}$$

where $\hat{y}_t$, — calculated,y_t — real levels.

Smooth on a straight line is used in cases where the increments are fixed.

Smooth with exponential function is applied in geometric changes in the when there is a steady increase in the ratios.

Secondary exponential function smooth is used to changes dynamic range and stable chain increases.

The smooth on logarithmic function reflects growth of the number of decrease, the recent increase in the time series.

Counting accuracy of the analytical expressions is defined as follows: sum of empirical series of price must coincide with the sum of the smoothed series levels. In this case, small errors can occur due to the calculated values:

$$\sum y = \sum \hat{y}_t . \tag{4}$$

Autocorrelation is used to determine patterns of additional data change in time series smooth method. Autocorrelation function, determine indication whether it is increasing or decreasing based on seasonal fluctuations.

Determination model is used to assess the trend model accuracy:

$$R^2 = \frac{\sigma_{\hat{y}}^2}{\sigma_y^2} , \tag{5}$$

where $\sigma_{\hat{y}}^2$- theoretical model dispersion of the data variance,σ_y^2- empirical dispersion of the data.

Trend model shows development tendency of R^2 close to 1 indicators in values. According to the time series method, data processing is carried out in three stages:

In the first phase filtering is carried out not to take into consideration distortions resulting from seasonal or other changes. The main goal of filtration is to find out$y$-changes affected from x-changes, eliminate factors that will affect that relationship further. A few known methods for filtering floating above the average value is the most widely used.

According to the moving average price at the time of moving to and from in the price index is calculated by determining the average number. In this situation, the long-term periods doesn't show accurately value compared to the changes in the short-term periods. However, filtration should be conducted carefully. Important information may be lost as a result of the smoothing filter. Therefore, filtration should be carried out in several ways, the results should be verified with the help of correlation analysis.

The second stage is a conduction of the forecast index. For this reason regression model selection and installation is carried out.

Regression analysis is used for two reasons:
- Detection of relationship between the measured parameters;
- Prognoses of the value of a variable based on the value of regression equation for non-dependent.

Monitoring with carbon monoxide poisoning shows interesting facts according to the method of time series in the monitoring of indicators to determine whether certain moments of time, but also forecast of the change indicators. Time series method is using to show the changed indicators of regression equation by time to time. Single regression equation shows the variation of the moments and observation of a person poisoned by a factor. Changes of signs in time, creates time series of dynamic rows. The characteristics of that rows is time factor (x), and dependant variable (y) factor, the sign of the value change. The dependence between them can be shown as regression equation.

The changes indications by using the method of time series depends on single factor regression equation or multivariate factor of regression equation. In addition, the figure forecast in a single-factor regression equation is given by:

$$y = a + b \ * x \tag{6}$$

where a - the free member; b - determines the slope of the regression line rectangular axes. According to the least squares method to determine the parameters of the equations will be as follows:

$$a * n + b \sum x = \sum y \tag{7}$$

$$a \sum x \ + b \sum x^2 = \sum y * x \tag{8}$$

Formulas given for determination of parameters:

$$a = y - b * x \tag{9}$$

$$b = \frac{y * x - \bar{y} * \bar{x}}{x^2 - \bar{x}^2} \tag{10}$$

Multivariate regression equation is used to monitor and prediction of the dynamics of change of many traits at the same time:

$$\hat{y}_x = a + b_1x_1 + b_2x_2 + ... + b_mx_m \tag{11}$$

Based on the assumption of multivariate regression testing is not possible, dependants becomes more obvious on the basis of the probabilities. Because the regression coefficients for the various tendencies traits values cause a shift in the regression line, and can change direction. Even one trait value in the presence causes a change in the outcome. Despite it is necessary to monitor the observation of a large number of indicators in carbon monoxide poisoning, more realistic indication of each individual was considered more appropriate to the forecast by the factorial regression. This has been confirmed in numerous experiments. The prognosis by regression equation is given for a certain time after the end of the monitoring period.

In the third stage, the quality of the model should be estimated.
The regression is carried out by adequacy of the model determination:

$$R^2 = \sum_{i=1}^{N}(\widehat{y}_i - \bar{y})^2 / \sum_{i=1}^{N}(y_i - \bar{y})^2. \tag{12}$$

where - $\hat{y}_i$- relevant to $x_i$the theoretical or estimated valuey_i.

Determination coefficient shows variables depending on the degree of compared dispersion. The adequacy of the regression equation is increasing in respect to R^2 high value. Determination coefficient regression model useful for prediction. The regression equation for the determination of a criteria of Fisher are used:

$$F = \frac{R^2}{1' - R^2} * \frac{n - m - 1}{m} \tag{13}$$

where R - determination coefficient, n - number of observations, m - number of parameters in x variables (the number of factors in linear regression model).

This criterion assesses the significance factors included in the regression equation. Calculated F-value of the significance level αup, are compared with 1 and n-$m-1$ in table value. If the calculated Fvalue exceeds the value of the table, i.e., $F \geq F_{table}$, then x factor included in the model is statistical significance. If the calculated F is less than table value, x variable doesn't affect to y variables changes and the inclusion in the model is inappropriate.

Determination coefficient with the help of correlation is defined as follows:

$$r = \sqrt{R^2} \tag{14}$$

Determination coefficient, -1, +1 varies in correlation coefficient. Determination coefficient is close +1 shows close relation of y variables with x factor to prove that indicator is the most significant factors for formalization of consequences. In this regard, the regression model can be used to forecast the indicator.

The indicators selected for monitoring medicine will be:

$$x_i \in \{X\} \ , \quad i = \overline{1,n}$$

where x_i– indicator.

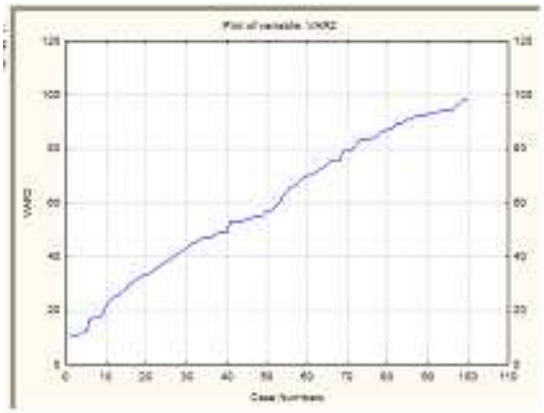
There are ending regulatory values for given parameters. Based on this, there is specific change interval for $\forall x_i$ (in some cases, the standards are different for men and women). Standards in accordance with the upper and lower boundaries is y_i and z_i. Then

$$y_i < x_i < z_i$$

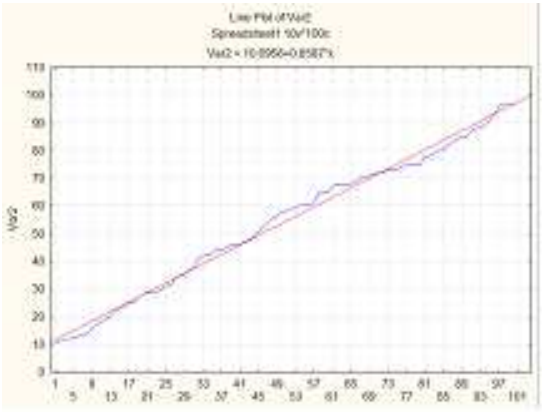
should be. Each x_i is observed in $T = \{t_1, t_2, ..., t_k\}$ time. k– is the number of measurements. Then x_i^j can be described as an arbitrary parameter, where $i = 1, 2, ..., n$, $j = 1, 2, ..., k$. Lower and upper variables can be considered as pathology:

$x_i^j < y_i$ or $x_i^j > z_i$

Autocorrelation functions are established for observation of any change of variable x_i ^{j} in $T = \{t_1, t_2, ..., t_k\}$time. It should be noted that the numbers do not reflect the cost of health indicators, the random number generator has been used. Kas the number of points used in the determination during the observation period, sometimes it means the number of years or months. For example, 100-point numbers with a given distribution (fig.2a), trend (fig.2b), smoothing curve (moving average) (fig.2c), forecasting (fig.2d), shown a certain time autocorrelation (fig.2e) and partial autocorrelation function (fig.2d). This series show ascending value of numbers.



a)



b)

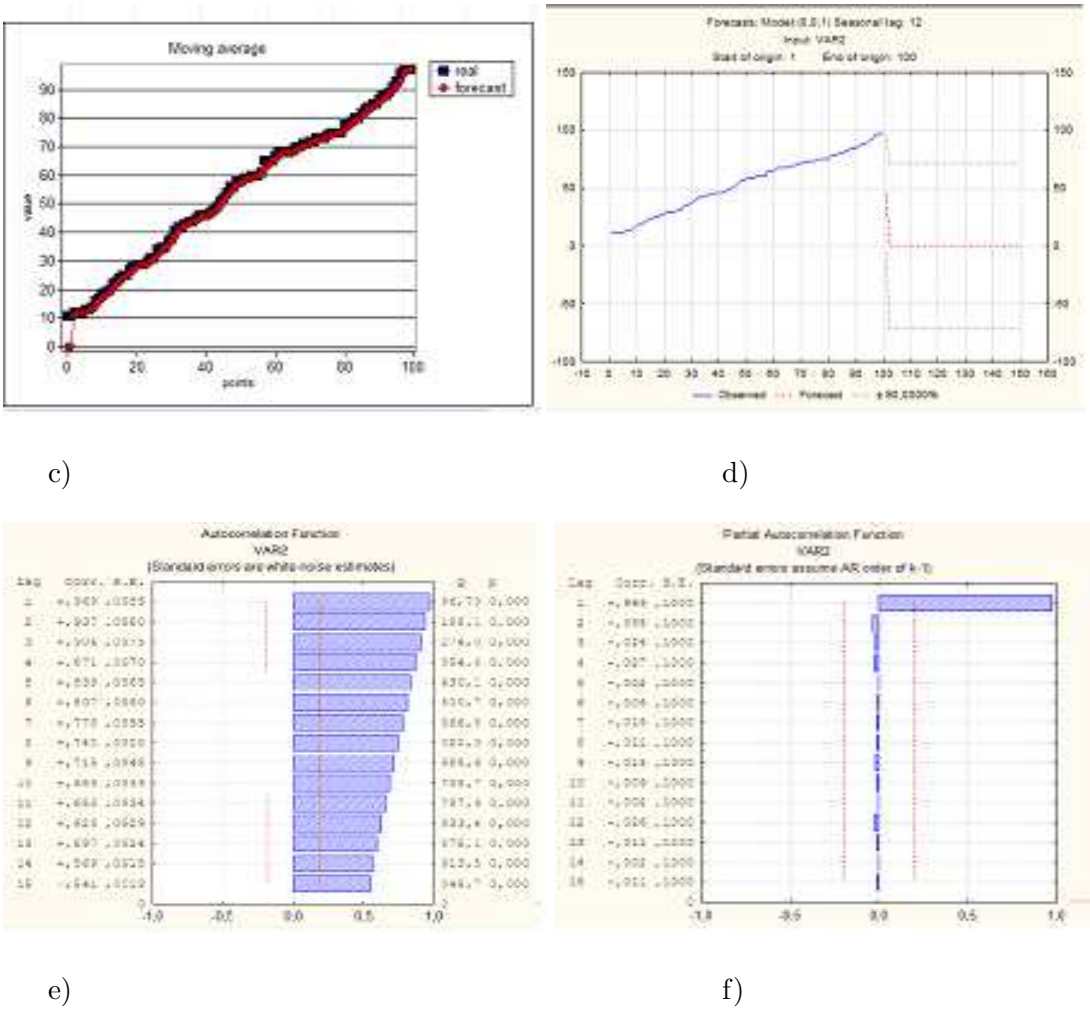


Fig.2. Characteristic of time series with ascending numbers

Partial correlation shows variables between two random variables, when taken the effect of internal values of autocorrelation doesn't take into account. Partial autocorrelation is almost same with simple autocorrelation in small moving. In practice, the periodic dependence of the specific autocorrelation is showing as "clean". The appearance of autocorrelation and partial autocorrelation depends on the length of the time series. Autocorrelation function shows the model accurately when the series is long. When the range is short, correlation loses its accuracy and autocorrelation and autocorrelation estimation degree is decreasing. Meanwhile, the trend shows that there is not a periodic function in autocorrelation changes.

Regression equation for distribution, coefficient of determination (fig.3a), scatter regression of the order given as follows (fig.3b):

Regression

Dependent Y	per2
Independent X	per1

Sample size	100
Coefficient of determination R^2	0,9970
Residual standard deviation	1,3550

Regression Equation

y = 11,4976 + 0,8414 x

Parameter	Coefficient	Std. Error	95% CI	t	P
Intercept	11,4976	0,2731	10,9557 to 12,0394	42,1077	<0,0001
Slope	0,8414	0,004694	0,8321 to 0,8507	179,2498	<0,0001

Analysis of Variance

Source	DF	Sum of Squares	Mean Square
Regression	1	58995,0514	58995,0514
Residual	98	179,9386	1,8361

F-ratio	32130,4845
Significance level	P<0,0001

Fig.3a

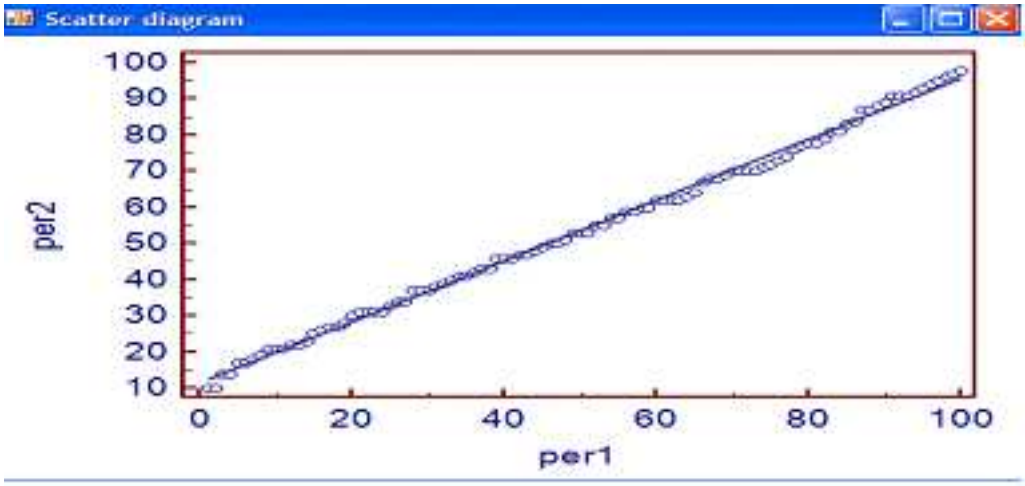
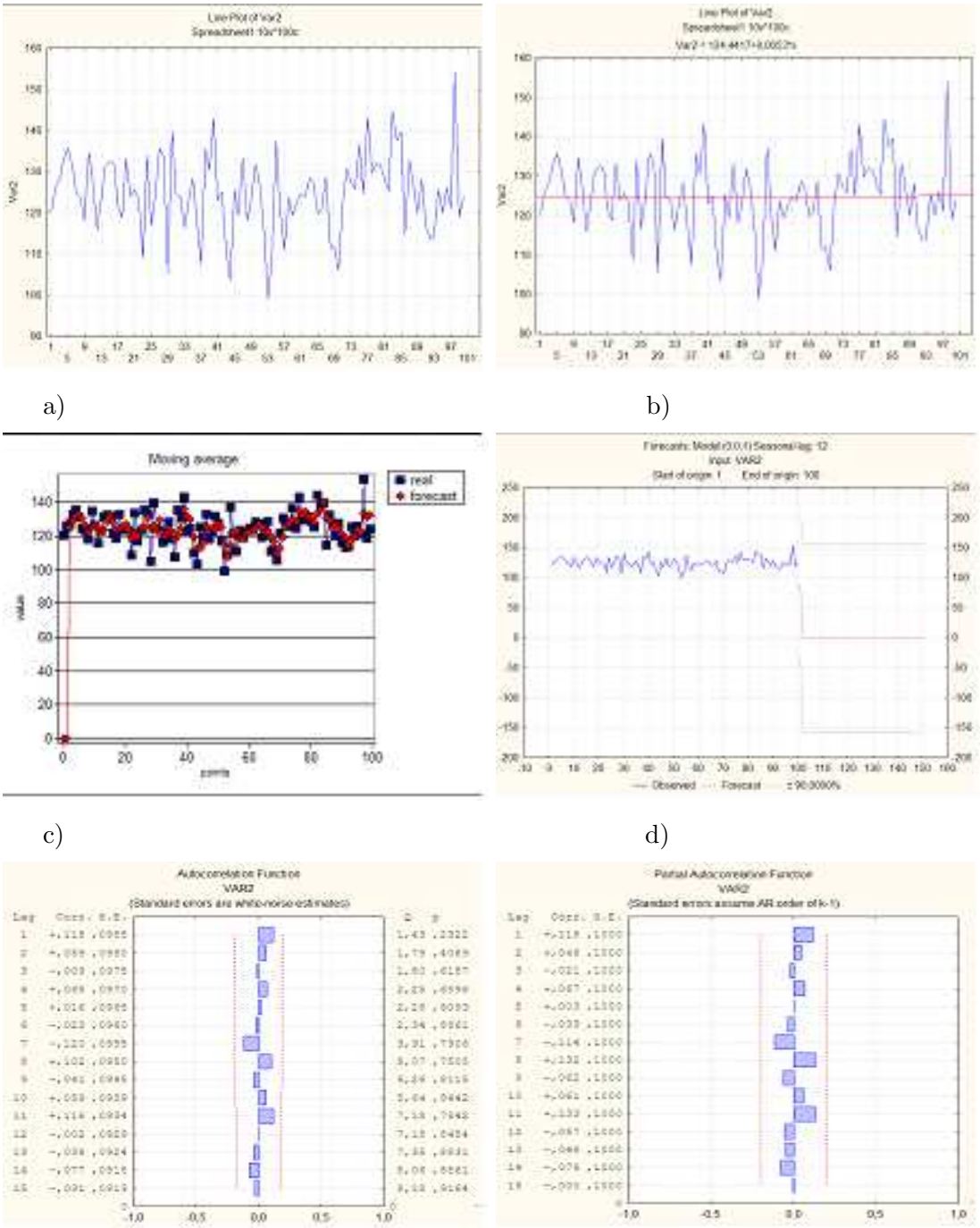


Fig.3b

According to Fisher criteria, this statistics is significance.

Another example for number of shows with normal distribution in fig.4a,b,c,d,e,f [8].



a) b)

c) d)

e) f)

Fig.4. Characteristic of time series with normal distribution numbers

Regression equation for distribution, coefficient of determination, scatter and regression of the order given as follows (fig.5a,b):

Regression

Dependent Y	per2
Independent X	per1

Sample size	100
Coefficient of determination R^2	0.004941
Residual standard deviation	10.4833

Regression Equation

y = 123.6061 + 0.02533 x

Parameter	Coefficient	Std. Error	95% CI	t	P
Intercept	123.6061	2.1125	119.4140 to 127.7983	58.5120	<0.0001
Slope	0.02533	0.03632	-0.04674 to 0.09740	0.6976	0.4871

Analysis of Variance

Source	DF	Sum of Squares	Mean Square
Regression	1	53.4811	53.4811
Residual	98	10770.2386	109.9004

F-ratio	0.4866
Significance level	P=0.4871

Fig.5a

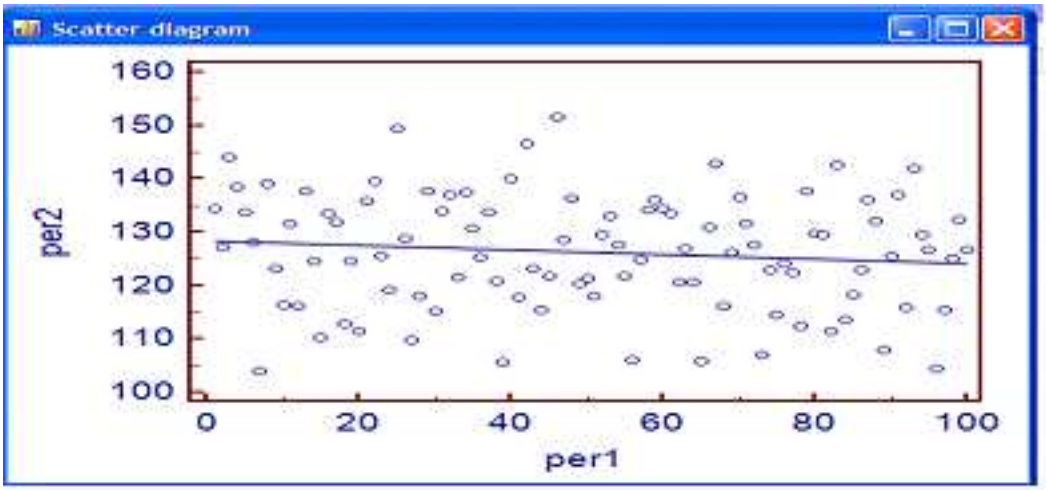


Fig.5b

Smoothing curve,autocorrelation and special autocorrelation functions shows that there is trend in that range. Determination coefficient value shows that forecast is impossible. According to Fisher theory, the value of indication is not significance.

During the course of the monitoring indicators of each time interval along with the observation of one or several indicators needs to be found observed. Mann-Whitney criteria is used for the evaluation of the difference between two independent indicators, Wilcoxon T-criterion is used for evaluation of monitoring from treatment period, any indication of a change in a certain time, Friedman method is used to measure the difference between double monitoring difference evaluation and Kruskal-Wallis criterion is applied for assessment

of presence of indicators in several measurements.

Conclusions. This work proposes a time series method for monitoring the state of a patient after treatment of carbon monoxide poisoning. The said method allows to trace dynamics of indices in time intervals and detect a more important index for observation of treatment resistant symptoms and elimination of excessive checks. For comparison of the indices in time intervals parametric and non-parametric criteria of biostatistics are employed.

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Irada H. Mirzazada
Institute of Mathematics and Mechanics of Azerbaijan National Academy of Sciences, Azerbaijan
E-mail: irada811@gmail.com

Ulkar R. Naghizade
Clinic of internal medicine and geriatrics of Hospital Marbach, Germany
E-mail: ulker245b@yahoo.com

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