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A Correlation Study of Cardiopulmonary Arrests, Cholesterol and Pressures

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This study consisted of cardiopulmonary arrests occurring between January 1990 and December 1991 in a Midwestern City in Kansas, USA, with a population of 300,000. Admission cholesterol levels and hourly barometric pressures were obtained to show if there exists a relationship between cardiopulmonary arrests, cholesterol levels and barometric pressures. Statistical analysis was performed using Pearson-Moment Correlation Coefficient. Scattergrams amongst the dependent variables such as time, age, cholesterol, temperature and each of these dependent variables vs the independent variable, barometric pressure are depicted. Small value of the correlation coefficient in each case indicates non-significant linear correlation between sudden changes in barometric pressure, cholesterol level and cardiopulmonary arrests.

Key words: Cardiopulmonary arrests, cholesterol, pressures, temperatures, Pearson-Moment Correlation

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Introduction

Many medical professionals have long believed that weather has some contributory role in the incidence of cardiopulmonary arrests. Documentation has shown a correlation between some variables of weather and various medical conditions. If there was a significant relationship between variations in barometric pressure and cardiopulmonary arrests they could have altered certain medical procedures, such as scheduling elective surgeries, staffing adjustments and a need for educating the medical/nursing sectors as well as the general public of its possible implications.

A very early study showed a weak correlation between sudden deaths with high barometric pressure, but a stronger correlation between sudden deaths with low temperatures (Bundesen and Falk, 1926); another report related fluctuations in barometric pressure and temperatures to pulmonary embolism (Takats ***et al.***, 1940). Adesola (1960) found that the barometric pressure became a significant factor in coronary thrombosis unless the minimum temperature was constant. He further noted a significant correlation between minimum temperature and increased admission rates of myocardial infarctions. But Holland ***et al.*** (1961) found no correlation between admission notes of heart disease of any age and weather. In a study of seasonal incidence of myocardial infarctions, it was found that the month of August demonstrated the highest death rate due to the high temperature and high humidity (DePasquale and Burch, 1961).

Sarna (1977) documented that rapidly decreasing barometric pressures increased the incidence of myocardial infarction. A small but statistically significant correlation was noted between myocardial infarctions and twenty-eight kilohertz, temperature and absolute humidity at atmospheric pressures (Ruhenstroth-Bauer ***et al.***, 1985). A three year study (Choisenel ***et al.***, 1987) on acute cardiovascular attacks and weather documented an increased frequency of myocardial infarctions with rainfall along with decreased atmospheric pressure.

A follow-up study of 26 years by Lerner and Kannel (1986) showed that females had a definite advantage over males before the age of forty-five because of pre-menopausal state of women as well as estrogen in protecting women against myocardial infarction and coronary heart disease. The serum cholesterol and the risk of premature death from coronary heart disease was in fact graded and not a threshold, as once believed. Serum cholesterol levels of 180 mg dl^{-1} and greater are related to the increased risk of coronary heart disease for middle-aged American males (Stamler ***et al.***, 1986). Grundy (1986) studied the importance of the low-density lipoproteins in relation to coronary heart disease and also discussed the ways of decreasing the mean cholesterol level to decrease the risk of coronary heart disease. The levels for borderline high cholesterol is 200 to 239 mg dl^{-1}. High serum cholesterol is determined by a level greater than 240 mg dl^{-1}. Exercise training was found to increase the ratio of HDL cholesterol/cholesterol and apolipoprotein A-1/apolipoprotein B, thus decreasing the risk of cardiovascular disease (DePres ***et al.***, 1990).

High levels of cholesterol in conjunction with sudden changes of barometric pressures may still possibly be related to some incidence of cardiopulmonary arrest. The already constricted blood vessels responding to sudden change in atmospheric pressure place enormous strain upon the cardiac and pulmonary systems.

In Kansas, weather changes drastically in a matter of hours with sudden variations in barometric pressures and provides an ideal setting for weather related studies on medical conditions. No such studies have been conducted in the Kansas or Oklahoma region. There has been also no study especially focussed on cardiopulmonary arrests, cholesterol levels and barometric pressures.

Materials and Methods

This work was conducted between 1990 and 1992 at Wichita State University. The barometric pressures were obtained from the National Weather Service, Wichita, Kansas. Records of the daily meteorological data were obtained on microfiche from the National Climatic Data Center, Division of the U.S. Commerce. Records of the cardiopulmonary arrests in one institution were obtained from the Emergency Services, Respiratory Therapy Department and Medical Records Department. From the second institution, data were obtained from the Medical Records Department. Both institutions were located in Wichita, Kansas. The Death Record was also utilized at one institution for those subjects who were not resuscitated; this record was stored in the Medical Records Department. Admission cholesterol levels were obtained from the charts of either Emergency Services or Medical Records.

The sample population in this research study consisted of all cardiopulmonary arrests that met the following criteria:

a) Cardiopulmonary arrests occurred as a result of any cardiovascular and/or pulmonary condition that occurred within Sedgwick County, Kansas.
b) Cardiopulmonary arrests occurred as a result of cardiopulmonary conditions excluding trauma, overdose, cancer and suffocation.
c) Cardiopulmonary arrests that occurred with the final diagnosis of cardiopulmonary arrest secondary to cardiopulmonary conditions.
d) Cardiopulmonary arrests that occurred within the time frame of January 1, 1990 to December 31, 1991.

Sample exclusions included

i) Cardiopulmonary arrests due to trauma, such as motor vehicle accident, gunshots, assaults, penetrating wound injury, suffocation or electrocution
ii) Cancer
iii) Overdose, intentional or accidental

iv) Those cardiopulmonary arrests that occurred outside of the Sedgwick County parameter

A patient identification umber was assigned in each case of cardiopulmonary arrest that differed from the subject's record number. This number was utilized only when analyzing data. Collection of meteorological data was derived from hourly recordings (temperature, barometric pressure, wind velocity and precipitation) from the National Weather Service, Wichita, Kansas, located west of Midcontinent Airport. These recordings were transcribed from the instruments at the weather station, such as the barograph. Hourly recordings were made along with comments such as severe weather, aircraft mishaps, peak winds, snow or rainfall amounts and lightning severity. The barometric tendency, changes in pressure during a given period of time is a very important measurement. A single barometric pressure reading is of little value in predicting weather, but the trend can be very important to foresee severe weather. If a rise or fall in barometric pressure occurs, the meteorologist reports the exact amount of change. This reading is recorded on a barograph. This instrument makes a continuous record which also helps the observer document the extremes of pressures that have passed through an area during any given period of time (Nieberger ***et al.***, 1982).

The barograph, is calibrated after every 6 h and is documented in the daily computer record. A disc copy of the data is sent to the National Climatic Data Center in Asheville, North Carolina, where it is converted to microfilm, microfiche or can be photocopied per request. In this study, microfiche was used.

Data was collected from Emergency Services records from one institution when patients arrived in cardiopulmonary arrest but were unable to be resuscitated in the Emergency Room. Respiratory Therapy records were used to document in-house cardiopulmonary arrests and to double check the Emergency Services records. The Death Record from Medical Records at one institution was reviewed to document those cardiopulmonary arrests that were not resuscitated while the subject was in the hospital. Chart review was conducted for verification of criteria and final diagnosis and to rule out those arrests that occurred due to cancer, overdose or other excluding reasons. During the chart reviews of Medical Records and Emergency Services, the admission cholesterol was documented, if a level had been drawn.

The independent variable used in this study was the barometric pressure that was documented hourly. The dependent variables were the cardiopulmonary arrests and cholesterol levels, that were documented meeting the criteria.

Meteorological data was listed year round in Central Standard Time therefore, the times of the cardiopulmonary arrests that occurred during daylight savings time were converted appropriately to the standard time. The daylight savings time occurred from the first weekend of April through the last weekend of October of each year.

In this present study, the Pearson Product-Moment Correlation Coefficient was also utilized by a McIntosh computer programme to analyze data. Each dependent variable was measured against the independent variable, as well as each dependent variable. Documentation of each correlation was described by a table and scattergram.

Results

The population sample totaled 209 subjects from one hospital. All subjects suffered a cardiopulmonary arrest due to cardiopulmonary conditions not attributed to trauma, overdose or cancer. All of the arrests occurred between January 1, 1990 and December 31, 1991. Means were obtained on the dependent variables - time, age, cholesterol level, temperature; as well as the independent variable - barometric pressure. The group mean time was 1251 Central Standard Time, the mean age was 72.9 years, mean serum cholesterol was 173 mg dl^{-1}, mean temperature was 56°F and the mean barometric pressure was inches of mercury, the 28.60 mean of each variable, standard deviation, minimum and maximum of each variable, as well as the total count was observed (Table 1).

Gender, for data analysis, was recorded as 1 for male and 2 for female to facilitate correlation of each group with individual variables (Table 2). The number of males totaled 121, as compared to 88 females. Females ranged higher in all categories with the exception of temperature for their means (Table 2). The 42% of the cardiopulmonary arrests occurred in females, whereas 58% occurred in males.

Table 1: Mean values of time, age, cholesterol, temperature and barometric pressure of 209 subjects occurred between January 1, 1990 to December 1, 1991

	Overall means					
Variables	Mean	S. D	Min	Max	Range	Count
Time	1251	700.645	005	2400	2395	209
Age	72.9	13.928	27	98	71	209
Cholesterol	172.6	58.277	66	401	335	172
Temperature	55.8	21.597	2	104	102	209
Barometric pressure	28.60	0.187	28.04	29.05	1.01	209

S. D: Standard Deviation, Min: Minimum, Max: Maximum

Table 2: Data regarding male/female means of time, age, cholesterol, temperature and barometric pressures in 821 males and 88 females

	Male/female mean values					
	Mean	S. D	Min.	Max.	Range	Count
M-Time	1230	693.203	0005	2310	2305	121
F-Time	1329	709.919	0010	2400	2390	87
M-Age	71.8	12.63	28	98	70	121
F-Age	74.4	15.56	27	98	71	87
M-Cholesterol	168.1	51.484	66	302	236	105
F-Cholesterol	180.1	67.989	73	401	328	67
M-Temperature	56.9	22.053	2	104	102	
F-Temperature	54.3	21.081	2	100	98	87
M-Barometric pressure	28.57	0.18	28.04	29.05	1.005	121
F-Barometric pressure	28.63	0.193	28.115	29.055	0.940	87

M: Male, F: Female

Table 3: Correlation co-efficient of different variables

	Count	Co-variance		Corrleation	R^2
Corr. co-eff. of age with cholesterol	172	-93.00	-826	-0.112	0.013
Corr. co-eff. of age with date	209	-613.00	-979	-0.120	0.015
Corr. co-eff. of age with temperature	209	-39.00	-536	-0.131	0.017
Corr. co-eff. of age with barometric pressure	209		0.094	0.036	0.001
Corr. co-eff. of date with cholesterol	172		-2202.179	-0.106	0.011
Corr. co-eff. of time with cholesterol	172		930.050	0.023	0.001
Corr. co-eff. of cholesterol with temperature	172		-34.977	-0.029	0.001
Corr. co-eff. of cholesterol with barometric pressure	172		0.091	0.009	0.0007384
Corr. co-eff. of temperature with barometric pressure	209		-1.466	-0.363	0.132
Corr. co-eff. of date with barometric pressure	209		-2.156	-0.031	0.001

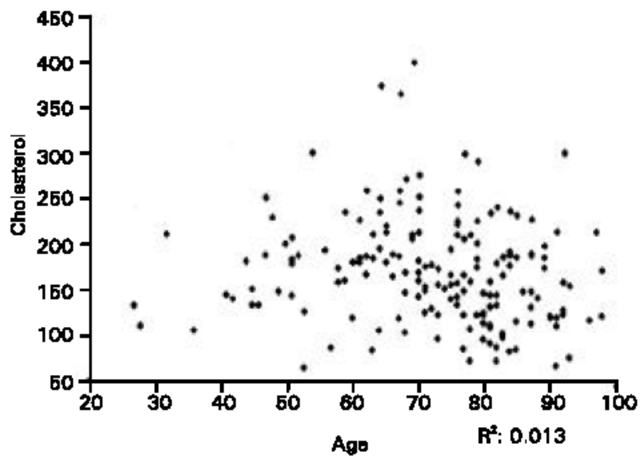

Fig. 1: Scattergram of age vs. cholesterol

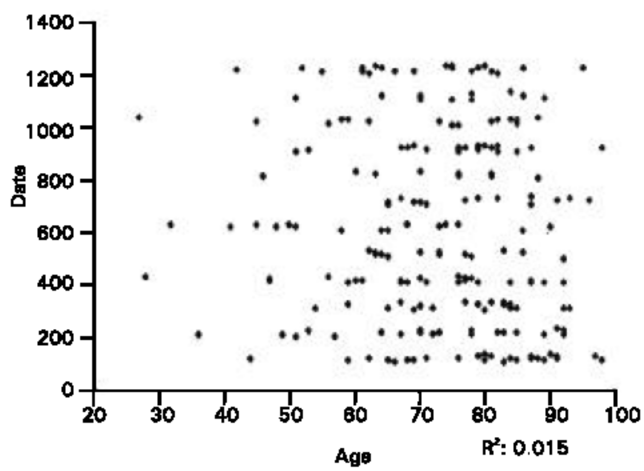

Fig. 2: Scattergram of age vs. date

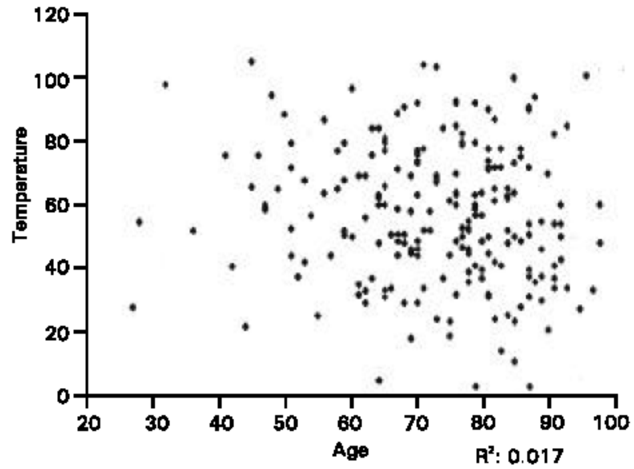

Fig. 3: Scattergram of age vs. temperature

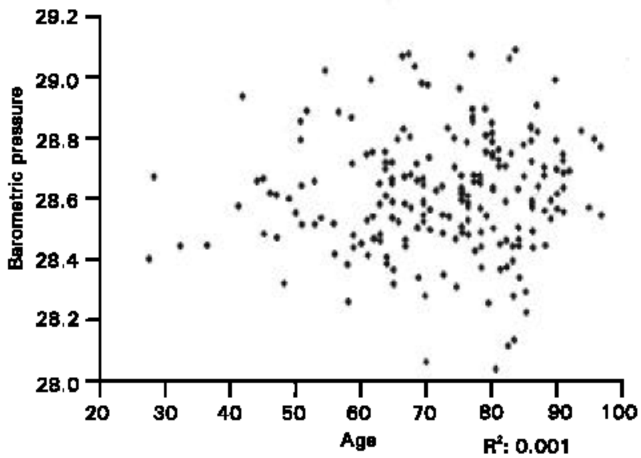

Fig. 4: Scattergram of age vs. barometric pressures

Age

Cardiopulmonary arrests occurred in a wide range of ages, 27 to 98 years of age. The age groups were separated into decades, such as fifty to 50-59 year olds. The mode fell in the 70 year old group, with 27% of the total arrests occurring in this age group (N=58). The next frequent age group was the 80 year old group with 26% of the total arrests that occurred (N=56), followed by the 60 years old age groups with 21% of the cases (N=45). The 50 and 90 years old age groups both possessed less than one percent 0.9% of the total cardiopulmonary arrests (N=19 each group). The incidence of cardiopulmonary arrests became less frequent as the ages decreased; with the 40, 30 and 20 years old age groups, each group possessing <1% of the total number of cardiopulmonary arrests, N=10, N=3 and N=2, respectively.

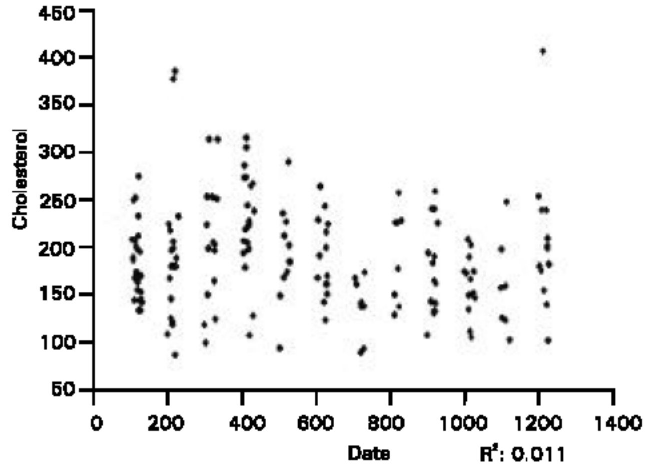

Fig. 5: Scattergram of date vs. cholesterol

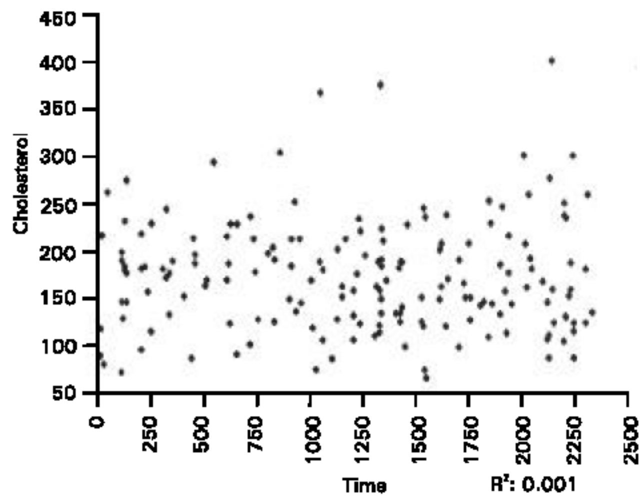

Fig. 6: Scattergram of time vs. cholesterol

Age was correlated with cholesterol (Table 3) with no significant linear correlation (-0.112) noted. A cholesterol level was not drawn on every patient; this was the decision of the physician at the time of admission. The 82% of the total sample population had a cholesterol level drawn upon admission; 18% did not have a cholesterol level drawn.

There is no significant correlation amongst the pertinent variables (Table 3). The scattergrams (Figs. 1-10) presented below visualize the non-significant linear correlation amongst the variables through linear regression. Scattergram of cholesterol vs barometric pressures (Fig. 8) exhibits a nonlinear regression. Same of barometric pressure vs temperature (Fig. 9) presents a slight

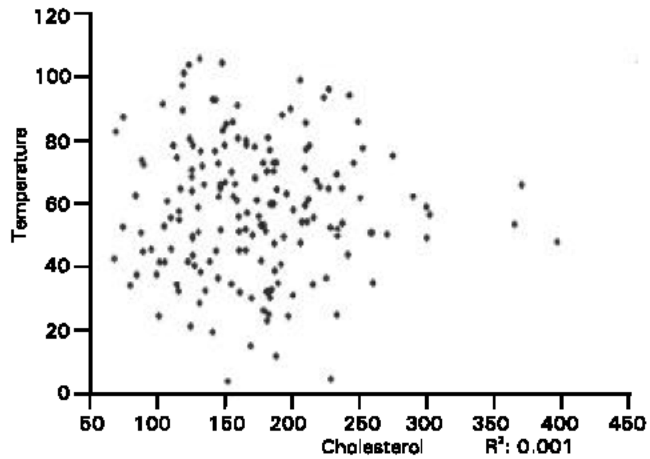

Fig. 7: Scattergram of cholesterol vs. temperature

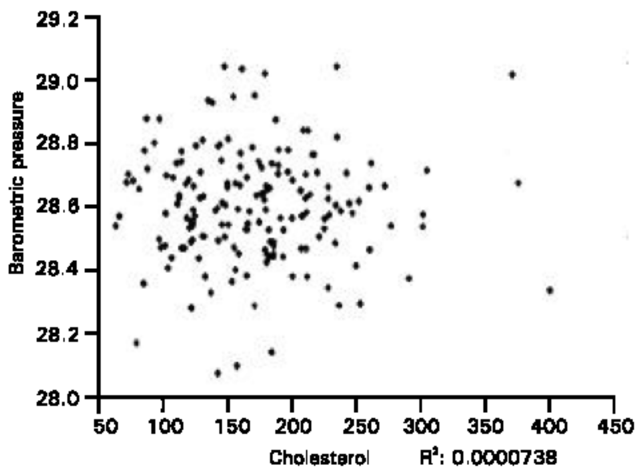

Fig. 8: Scattergram of cholesterol vs. barometric pressures

negative linear regression. Also the scattergram of barometric pressure vs date (Fig. 10) illustrates an almost "bowtie" configuration - a nonlinear correlation. They all suggest further investigation.

It is to be noted that 56% of the total number of cardiopulmonary arrests occurred on days with sudden changes in barometric pressure. The most frequently cited (61%) change was 0.04 of an inch of mercury. Sudden changes in barometric pressure ranged from 0.04 to 0.195 inches of mercury. Sixteen cases, less than 1% of cardiopulmonary arrests occurred at the time or within 1 h of the documented change in pressure. The 62% of those were with increasing barometric pressures and 38% were with decreasing barometric pressures.

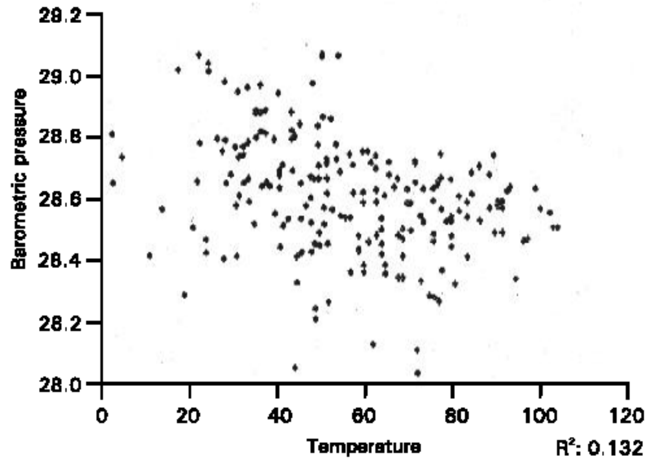

Fig. 9: Scattergram of temperature vs. barometric pressures

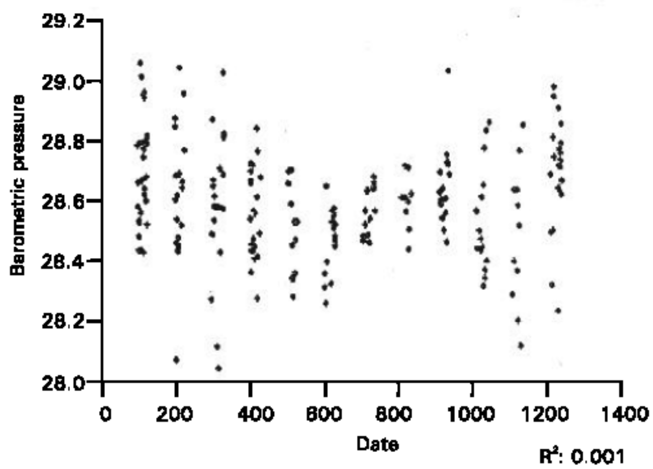

Fig. 10: Scattergram of date vs. barometric pressures

The 58% of the total number of cardiopulmonary arrests occurred at times of sudden increase in barometric pressure, whereas 42% of the total number of cardiopulmonary arrests occurred at times of sudden decrease in barometric pressure. Most days exhibited both sudden increases and decreases in pressure. Approximately 50% of these sudden changes in barometric pressure happened prior to the arrest occurring with the other 50% manifesting from 1-23 h after the cardiopulmonary arrest had occurred.

Discussion

Studies conducted by Lerner and Kannel (1886) has documented cholesterol as a major contributor to coronary heart disease, as well as sedentary lifestyle, dietary habits, stress levels and family history. Cardiopulmonary arrest is a complication of certain physical disorders such as electrolyte imbalance, pulmonary embolism, pneumonia, congestive heart failure and most common myocardial infarction. Research in biometreorology by Ruhenstroth-Bauer (1984), Rogot (1974), Sarna (1977) and Heyer (1953) has documented significant correlations between certain disorders such as epilepsy, pneumonia, congestive heart failure, strokes and myocardial infarctions with meteorological variables such as temperature, barometric pressure, precipitation, humidity and front passages.

This was a retrospective, nonexperimental research design to test the nondirectional alternative hypothesis that a statistically significant relationship exists between cardiopulmonary arrests, cholesterol level and sudden changes in barometric pressure.

The data included date, time of the cardiopulmonary arrest, age of the subject, temperature at the time of the arrest, sex and barometric pressure. These variables were correlated with each other as a single event, such as age with cholesterol, age with temperature and so on, with no linear correlation noted in any of the combination of variables. A very slight, but non-significant negative relationship (-0.363) was noted on the scattergram between temperature and barometric pressure (Table 3, Fig. 9). Other linear correlations noted ranged from 0.009 with cholesterol and barometric pressure, to -0.106 with date and cholesterol levels, to -0.112 correlation with age and cholesterol levels.

Date and barometric pressure were correlated and demonstrated a correlation of -0.031. The scattergram visualized a “bowtie” pattern, depicting that a nonlinear correlation may exist, but further investigation is needed.

The results did not support the hypothesis as conducted with the correlation coefficient, with each variable correlated as a single event. Time of year and day along with age, sex, weather temperature, cholesterol level and barometric pressure occurred simultaneously; however, multiple correlation such as MANOVA, or multiple regression would possibly depict some interaction within the variables not evidenced simply by correlational studies. With the replication of this study and utilizing more advanced statistical analysis, a significant correlation may be demonstrated, with the ability to predict an outcome.

This study did not determine a significant linear correlation between sudden changes in barometric pressure, cholesterol levels and cardiopulmonary arrests; however, the statistical analysis of correlation coefficient only analyzed two variables at one time, whereas all the variables occurred simultaneously. More advanced statistical analysis is needed to determine if interaction exists between one or more of the variables. More specific categorizations of age groupings, specific disease entities, such as pneumonia, myocardial infarction, may also have demonstrated a possible correlation. This study only utilized overall serum cholesterol levels, since separation of cholesterol into high-density lipoproteins (HDL) and low-density lipoproteins (LDL) categories are not routinely performed on all patients. A more in-depth study of specific cholesterol levels may also document a significant correlation.

This research was informative and the potential exists to correlate meteorological phenomenon with medical events. More studies need to be conducted to assist in determining possible links with man and his environment. Knowledge of such relationships would facilitate appropriate planning for addressing such crises.

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